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Catalyst for Improving the Environment

Evaluation Report

Monitoring Needed to Assess Impact of EPA's Clean Air Mercury Rule on Potential Hotspots

Report No. 2006-P-00025

May 15, 2006

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Abbreviations

CAMR	Clean Air Mercury Rule
CMAQ	Community Multiscale Air Quality
EPA	Environmental Protection Agency
Hg	Mercury
IPM	Integrated Planning Model
km	kilometer
MACT	Maximum Achievable Control Technology
MDN	Mercury Deposition Network
mg/kg	milligram per kilogram
OIG	Office of Inspector General

Cover photo: A fisherman holding a walleye, a predator fish for which mercury contamination is a concern (photo courtesy EPA).

U.S. Environmental Protection Agency
Office of Inspector General

2006-P-00025
May 15, 2006

At a Glance

Catalyst for Improving the Environment

Why We Did This Review

In support of its Clean Air Mercury Rule (CAMR), the Environmental Protection Agency (EPA) conducted a detailed analysis of mercury emissions and deposition. EPA concluded that "utility-attributable" hotspots would not occur after implementation of CAMR's mercury trading program. This evaluation assesses the basis for EPA's conclusion.

Background

About 40 percent of U.S. man-made airborne mercury is emitted from coal-fired utilities. EPA revised a previous finding that mercury emissions from coal-fired utilities be regulated with a Maximum Achievable Control Technology standard. Instead, EPA adopted a cap-and-trade program to reduce mercury emissions. Several State agencies and environmental groups objected to these actions. One concern was that a cap-and-trade program could result in localized areas with unacceptably high levels of mercury, or "hotspots."

For further information, contact our Office of Congressional and Public Liaison at (202) 566-2391.

To view the full report, click on the following link: www.epa.gov/oig/reports/2006/20060515-2006-P-00025.pdf

Monitoring Needed to Assess Impact of EPA's Clean Air Mercury Rule on Potential Hotspots

What We Found

EPA brought significant scientific, technical, and modeling expertise to bear in developing a specific methodology to consider the potential for mercury hotspots. Several uncertainties associated with key variables in the analysis could affect the accuracy of the Agency's conclusion that the Clean Air Mercury Rule (CAMR) will not result in "utility-attributable" hotspots. We noted:

- gaps in available data and science for mercury emissions estimates,
- limitations with the model used for predicting mercury deposition,
- uncertainty over how mercury reacts in the atmosphere, and
- uncertainty over how mercury changes to a more toxic form in waterbodies.

Two recent studies support the need for additional monitoring to ensure that EPA's analysis has properly estimated the contribution of local, regional, and global sources on U.S. deposition. These studies are "*Mechanisms of Mercury Removal by O_3 and OH in the Atmosphere,*" published in *Atmospheric Environment* in June 2005; and "*Sources of Mercury Wet Deposition in Eastern Ohio, USA,*" submitted for publication in a scientific journal in February 2006. Results of both studies were not available until after EPA issued CAMR in March 2005, and thus could not have been considered in EPA's deliberations on CAMR. Although EPA indicated in CAMR that it would monitor the impact of the cap-and-trade rule on mercury deposition, the Agency has not yet developed a monitoring plan for this purpose. Without field data from an improved monitoring network, EPA's ability to advance mercury science will be limited and "utility-attributable" hotspots that pose health risks may occur and go undetected.

Based on our interpretation of CAMR, EPA could not take action to mitigate a mercury hotspot unless the Agency first determined that the hotspot was solely "utility-attributable." Therefore, EPA could not require additional utility emission reductions if utilities contributed significantly, but not solely, to a mercury hotspot. This could limit EPA's ability to mitigate human health hazards by reducing potentially harmful levels of mercury in waterbodies and fish tissue. This could also limit EPA's ability to reduce the number of waterbodies with fish consumption advisories.

What We Recommend

We recommend that EPA develop and implement a mercury monitoring plan to (1) assess the impact of CAMR, if adopted, on mercury deposition and fish tissue; and (2) evaluate and refine mercury estimation tools and models. Further, if CAMR is adopted after the rule reconsideration process is complete, we recommend that EPA clarify in the final rule that the "utility-attributable" hotspot definition does not establish a prerequisite for making future revisions to CAMR. In response to the draft report, the Agency agreed that additional mercury monitoring is needed and explained that CAMR does not establish the "utility-attributable" hotspot definition as a prerequisite for future changes to CAMR.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
INSPECTOR GENERAL

May 15, 2006

MEMORANDUM

SUBJECT: Monitoring Needed to Assess Impact of EPA's Clean Air Mercury Rule on Potential Hotspots
Report No. 2006-P-00025

TO: William L. Wehrum
Acting Assistant Administrator for Air and Radiation

This is our report on the subject evaluation conducted by the Office of Inspector General (OIG) of the U.S. Environmental Protection Agency (EPA). This report contains findings that should help EPA to better monitor the impact of the Clean Air Mercury Rule and refine performance standards under the rule, if necessary. This report represents the opinion of the OIG and the findings in this report do not necessarily represent the final EPA position. Final determinations on matters in the report will be made by EPA managers in accordance with established procedures.

Action Required

In accordance with EPA Manual 2750, as the action official, you are required to provide a written response within 90 days of the final report date. The response should address all recommendations. For the corrective actions planned but not completed by the response date, please describe the actions that are ongoing and provide a timetable for completion. Where you disagree with a recommendation, please provide alternative actions for addressing the findings reported.

We appreciate the efforts of EPA managers and staff in working with us to develop this report. If you or your staff have any questions regarding this report, please contact me at 202-566-0847, or Rick Linthurst at 919-541-4909.

Sincerely,

Bill A. Roderick
Acting Inspector General

Table of Contents

Chapter 1
Introduction

Purpose

A prior Environmental Protection Agency (EPA) Office of Inspector General (OIG) report cited concerns about EPA's limited assessment of the potential for mercury hotspots resulting from a cap-and-trade program under the Clean Air Mercury Rule (CAMR). We issued this prior report, *Additional Analyses of Mercury Emissions Needed Before EPA Finalizes Rules for Coal-Fired Electric Utilities* (Report No. 2005-P-00003), on February 3, 2005. In support of CAMR, EPA conducted a detailed analysis of mercury emissions and deposition and concluded that "utility-attributable" hotspots would not occur after implementation of the mercury emissions trading program.

EPA's Water Quality Trading Assessment Handbook defines hotspots as "localized areas with unacceptably high levels of pollutants." In this evaluation report, however, a hotspot is a waterbody containing consumable fish with elevated levels of methylmercury in their tissues.

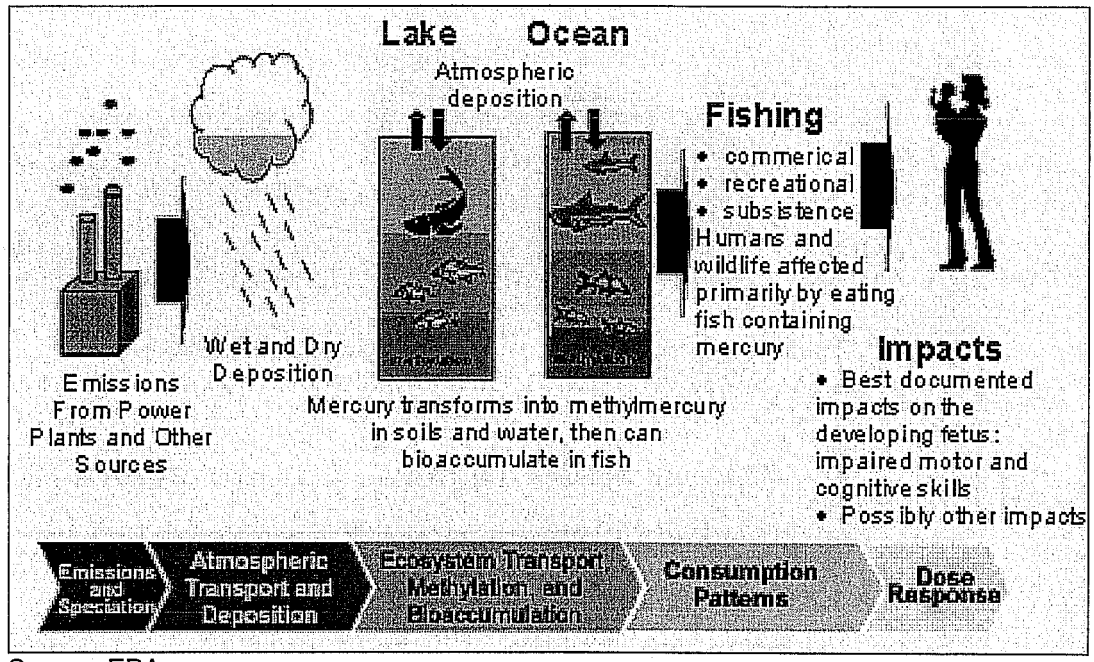
We conducted this evaluation to assess the basis for the Agency's determination that CAMR would not result in "utility-attributable" hotspots.

Background

Mercury (Hg) is released into the atmosphere through natural processes and through human activities, such as combustion processes. Once emitted, atmospheric mercury undergoes several chemical and physical processes and can then be deposited to the ground or waterbodies via wet or dry processes. In wet deposition, mercury is deposited by precipitation, such as rain or snow. In dry deposition, mercury settles to the earth's surface and sticks to or is absorbed by trees, soil, water, or other surfaces. The largest source of airborne mercury emissions in the United States is the coal-fired electric utilities industry, representing an estimated 40 percent of total U.S. man-made airborne mercury.

Although airborne mercury is generally not considered to be a serious health concern, once mercury enters freshwater and salt-water bodies, it can bioaccumulate in fish and other animal tissues in its more toxic form, methylmercury. As methylmercury bioaccumulates in the food chain, its concentration becomes increasingly higher in animals at the top of the food chain (such as larger predatory fish) that consume smaller, contaminated organisms. Figure 1-1 illustrates the exposure pathway of mercury.

Figure 1-1: How Mercury Enters the Environment



Source: EPA

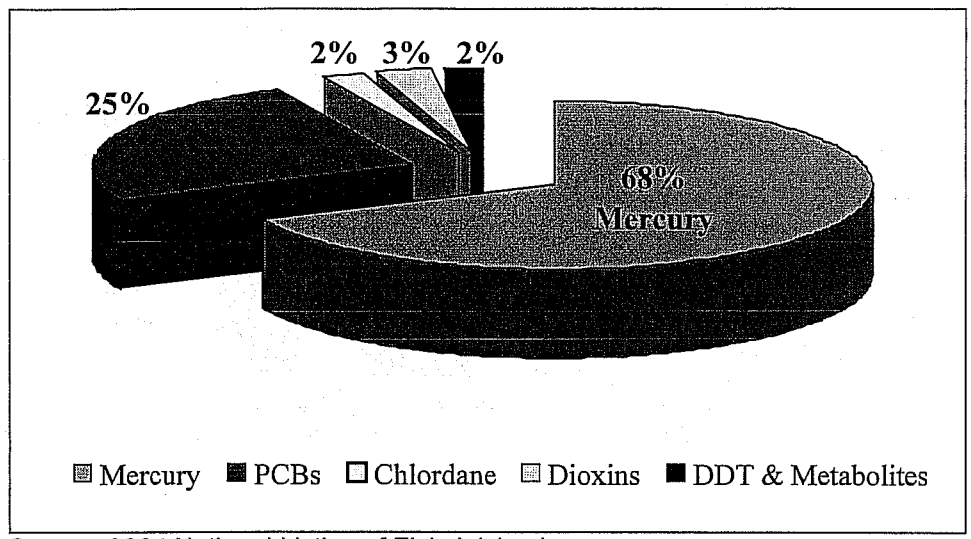
Fish consumption is the main route by which methylmercury harms human health. Excessive human exposure to methylmercury has been associated with severe detrimental neurological and developmental health effects. Research has shown that the developing fetus is at risk for impaired motor and cognitive skills. Thus, exposure to mercury by women of child-bearing age is of particular concern.

Most U.S. Fish Advisories Due to Mercury Contamination

When levels of chemical contamination in fish are considered unsafe, States, tribes, and territories can issue consumption advisories that may recommend that people limit or avoid eating certain species of fish caught in certain places. Each State sets its own criteria and decides which bodies of water to monitor. Monitored waterbodies may vary from year to year. Fish advisories are voluntary State recommendations not governed by Federal regulations. In 2004, 44 States issued fish advisories for mercury. The number of mercury-related fish advisories continues to rise as States increase fish tissue testing.

EPA recently reported in its 2005 *Performance and Accountability Report* that the Agency did not meet its goal of reducing the number of overall fish advisories by at least 1 percent from 2002 levels. From 2003 to 2004, the number of mercury advisories rose from 2,362 to 2,436, or 3.1 percent. According to the 2004 National Listing of Fish Advisories, the vast majority (68 percent) of fish advisories in the United States are due to mercury contamination, as illustrated in Figure 1-2.

Figure 1-2: Percent of Fish Advisories for Each of the Top Five Bioaccumulative Contaminants in 2004



Source: 2004 National Listing of Fish Advisories

CAMR First Rule for Mercury Emissions from Coal-Fired Utilities

On March 15, 2005, EPA issued CAMR, which established the country's first regulation of mercury emissions from coal-fired power plants. CAMR uses a declining cap-and-trade approach to regulating coal-fired utilities under Section 111 of the Clean Air Act by setting a fixed national cap. Utilities can buy and sell credits among one another in a national emissions market. Utilities that cannot cost-effectively reduce emissions may buy allowances from units that reduced emissions below established allowance limits. Under CAMR, an interim national cap of 38 tons per year becomes effective in 2010 and a final annual cap of 15 tons becomes effective in 2018. EPA's first cap is based on mercury reductions expected to be achieved as a co-benefit of implementing the Clean Air Interstate Rule, issued in March 2005. That rule requires utilities to take actions to reduce emissions of sulfur dioxide and nitrogen oxides, and those actions are also projected to reduce mercury emissions.

EPA Revised its Prior Regulatory Finding Regarding Utilities

To use a cap-and-trade program to regulate coal-fired utilities, EPA first had to revise a December 2000 regulatory finding[1] that indicated it was appropriate and necessary to regulate coal-fired utilities under Section 112 of the Clean Air Act. This finding required EPA to regulate utilities using a Maximum Achievable Control Technology (MACT) standard. MACT standards are

[1] *Regulatory Finding on the Emissions of Hazardous Air Pollutants From Electric Utility Steam Generating Units,* December 20, 2000; Vol. 65, No. 245.

industry-specific, technology-based standards designed to reduce hazardous air pollutant emissions. These standards can require facility owners/operators to meet emission limits, install emission control technologies, monitor emissions and/or operating parameters, and use specified work practices. In March 2005, EPA issued a *Revision of December 2000 Regulatory Finding,*[2] stating that the Agency no longer found it appropriate or necessary to regulate utilities under Section 112. This released the Agency from the requirement to regulate utilities using a MACT standard. EPA issued the finding the same day it issued CAMR, which established a mercury cap-and-trade program under Section 111.

For its *Revision of December 2000 Regulatory Finding*, EPA interpreted Section 112(n) to mean that utilities alone had to be the sole cause of a health hazard in order to be regulated under Section 112 and subject to MACT standards. Specifically, EPA developed the following "utility-attributable" hotspot definition for its revision: ". . . a waterbody that is a source of consumable fish with Methylmercury tissue concentrations, attributable solely to utilities, greater than EPA's Methylmercury water quality criterion of 0.3 milligrams per kilogram (mg/kg)."

EPA Response to Petitions for Reconsideration

Several State agencies and other organizations oppose EPA's adoption of a cap-and-trade program for mercury. These groups separately petitioned for reconsideration of the *Revision of December 2000 Regulatory Finding.* Among other things, they asserted that, in its analysis, EPA underestimated the impact of deposition resulting from local and regional sources and overestimated the impact of emissions from global sources. Thus, they argue, some mercury hotspots already exist, and requiring sources to comply with MACT standards would immediately reduce deposition in those areas. Further, these opponents to the cap-and-trade program believe the program could result in new mercury hotspots if some utilities bought excess emission credits instead of reducing emissions.

On October 21, 2005, EPA reopened for public comment certain aspects of its CAMR and, in a separate action, reopened for public comment certain aspects of its *Revision of December 2000 Regulatory Finding.* The action to reopen comment on CAMR was taken in response to petitions filed by 14 States, 5 environmental groups, a public utility, and a waste services association. The Agency stated that it agreed to reconsider several aspects regarding CAMR. The action to reopen comment on EPA's *Revision of December 2000 Regulatory Finding* was based on two petitions, one from 14 States and a second from 5 environmental groups and 4 Indian tribes. The Agency agreed to reconsider the legal issues underlying the decision as well as the methodology used to assess the

[2] *Revision of December 2000 Regulatory Finding on the Emissions of Hazardous Air Pollutants from Electric Utility Steam Generating Units and the Removal of Coal- and Oil-fired Electric Utility Steam Generating Units from the Section 112(c) List; Final Rule*, March 15, 2005.

amount of "utility-attributable" mercury levels in fish tissue and the public health implications of those levels. The Agency also agreed to reconsider how it defined a utility hotspot for the purposes of its finding concerning regulation of Utility Units under Clean Air Act Section 112. Comments regarding this reconsideration were accepted until December 19, 2005. The Agency was still evaluating comments at the time our field work ended.

Scope and Methodology

We conducted our review from September through December 2005, in accordance with *Government Auditing Standards* issued by the Comptroller General of the United States. We performed field work at EPA's Office of Air and Radiation in Washington, DC; the Office of Air and Radiation's Office of Air Quality Planning and Standards in Research Triangle Park, North Carolina; the Office of Research and Development in Research Triangle Park; and the Office of Water in Washington.

To answer our evaluation's objective, we examined: (1) the basis for the Agency's "utility-attributable" hotspot definition and the consistency of this definition with any prior Agency decisions regarding hotspots; (2) the key attributes, assumptions, and limitations of the models used to assess the impact of mercury emissions from coal-fired electric utility units under CAMR; and (3) the key variables used as inputs to the models as well as the basis for selecting these variables.

To gain an understanding of the definition of "utility-attributable" hotspots, the modeling and analyses EPA used to determine the potential for "utility-attributable" mercury hotspots after CAMR, and the inputs and assumptions associated with the Agency's analyses, we interviewed EPA staff involved in the development of CAMR or knowledgeable about the processes and models used in EPA's analyses. We also interviewed officials from State agencies and external organizations familiar with CAMR's development and EPA's hotspots analysis. We reviewed data and analyses developed in support of the rule, and selected public comments included in the rulemaking docket. We also reviewed related information provided by both EPA and non-EPA officials.

Our analysis focused on the key assumptions and limitations of the Community Multiscale Air Quality model, which was used to estimate mercury transport and deposition. We did not review in detail the assumptions, limitations, and uncertainties associated with the other models used in the Agency's analyses.

Appendix A provides additional details on scope and methodology.

Chapter 2
Monitoring Plan Needed to Address Uncertainties in EPA's Hotspots Analysis

As with any modeling assessment, uncertainties may exist. Uncertainties regarding EPA's analysis and conclusion that CAMR will not result in "utility-attributable" hotspots include:

- gaps in available data and science for mercury emissions estimates,
- limitations with the model used for predicting mercury deposition,
- uncertainty over how mercury reacts in the atmosphere, and
- uncertainty over how mercury changes to a more toxic form in waterbodies (i.e., methylation) and accumulates in fish tissue.

Two recent studies support the need for additional monitoring to ensure that EPA's hotspots analysis has properly estimated the contribution of local, regional, and global sources to U.S. deposition. These studies are:

(1) "*Mechanisms of Mercury Removal by O_3 and OH in the Atmosphere,*" Calvert, J.G., Lindberg, S.E., (published in *Atmospheric Environment*, Volume: 39, Number: 18, Page: 3355-3367), June 5, 2005, referred to in this report as the "Mechanisms of Mercury Removal Study;" and

(2) "*Sources of Mercury Wet Deposition in Eastern Ohio, USA,*" Keeler, G.J., et al., referred to in this report as the "Steubenville Study" (a peer review of the Steubenville Study was completed in December 2005 and the study was submitted for publication in a scientific journal in February 2006).

Results of both studies were not available until after EPA issued CAMR in March 2005, and thus could not have been considered in EPA's deliberations on CAMR. We believe the uncertainties associated with its CAMR analysis underscore the need for EPA to develop and implement a plan for monitoring the impact of CAMR on mercury deposition and mercury concentrations in fish tissue. Without implementation of a monitoring plan and/or improvements to current models, "utility-attributable" hotspots that can pose health risks may occur and go undetected.

EPA Analyzed Potential for "Utility-Attributable" Hotspots

In its *Revision of December 2000 Regulatory Finding,* EPA states it "does not believe that there will be any [utility-attributable] hot spots after implementation of CAIR [Clean Air Interstate Rule] and CAMR." EPA's analyses of mercury hotspots considered many factors that influence the way mercury is deposited to land and waterbodies. For its CAMR analysis, EPA used the Community

Multiscale Air Quality (CMAQ) model as the principal tool to predict patterns of mercury deposition and as an important part of assessing the potential for "utility-attributable" mercury hotspots under CAMR.

EPA considers the CMAQ to be the most capable model available for assessing the impacts of CAMR on mercury deposition within the United States. The model is designed to estimate pollutant concentrations and depositions over large areas, such as the continental United States. The model accounts for variations in mercury emissions, differences in the atmospheric reactions of mercury, and the impact of those factors on deposition.

However, there are important limitations associated with some of the inputs EPA used in CMAQ for its CAMR analysis. The July 2005 *Final Report: Second Peer Review of the CMAQ Model*, conducted by an independent panel that included State, academic, and private organizations, notes the following limitations:

> *CMAQ is a modeling system that simulates a wide range of physical, chemical and biological processes . . . Some of these processes are well understood, some reasonably well understood, and some only poorly understood. This wide range in the level of knowledge about the processes being modeled, and the fact that uncertainties in characterizing some of the processes correspond to areas of active research worldwide, means that some parts of the model code are sufficiently well established as to be considered fixed, while other parts of the code are under continuing development.*

Other models also played a role in EPA's analysis of the potential for hotspots under CAMR by contributing input data to CMAQ (see Appendix B for details on some of these other models). For example, a separate model was used to estimate the amount of mercury emissions from utilities based on certain economic assumptions, and another was used to predict weather patterns. Both the emissions and weather data were fed into CMAQ, and CMAQ predictions on deposition were fed into another model to estimate the effects of deposition on future mercury fish tissue concentrations.

In its hotspots analysis, the Agency discussed instances where conservative assumptions were used to avoid underestimating the impact of utilities. For example, in its hotspots analysis EPA did not screen out watersheds in which sources of mercury other than air deposition were significant. According to EPA, this may result in higher concentrations of methylmercury in fish being attributed to power plants than would be the case had EPA been able to account for non-air sources. In addition, EPA's hotspots analysis discusses the conservative estimates used in determining the oral reference dose for mercury (i.e., an estimate of the daily exposure to the human population, including sensitive subgroups, that is without an appreciable risk of deleterious effects during a lifetime). The reference dose and human exposure information were used to establish the water

quality criterion for methylmercury in fish tissue, the criterion used by EPA to represent a mercury hotspot.

Data and Science Gaps Exist for Mercury Emissions Estimates

While EPA has conducted activities to greatly increase its knowledge of mercury emissions from coal-fired utility plants, the Agency acknowledges that some uncertainty still exists when estimating total and speciated[3] mercury emissions and in projecting these emissions after implementation of various control technologies.

CMAQ requires the input of emissions inventory data to predict how emissions will transport and deposit. CMAQ was first run with a full emissions inventory to establish a base case scenario assuming the presence of all emissions. Next, CMAQ was run with emissions from coal-fired utilities removed, in what is called a "zero-out" run, to determine the impact of the variable that was zeroed out. EPA used this zero-out method to determine that no "utility-attributable" hotspots would occur after accounting for emissions reductions expected to be achieved from the Clean Air Interstate Rule and CAMR.

The utility emissions input into CMAQ were developed from the Integrated Planning Model (IPM). The IPM is a model of the U.S. electric power sector that can be used to evaluate the cost and emissions impacts of proposed policies to limit emissions of pollutants, including mercury. EPA has used the IPM in rulemakings since the mid 1990's. As part of that process, EPA takes comments on the underlying assumptions of the model and makes changes as a result. For its Clean Air Interstate Rule and CAMR analyses, EPA used IPM to estimate base case and future year national inventories of unit-specific mercury emissions under different control scenarios.

IPM uses equations (emission modification factors) to estimate utility emissions given the chemical composition of the coal being burned as well as various operating characteristics of the utility unit (e.g., type of control technology installed). These equations were based on various coal composition and emissions testing data collected during a 1999 Information Collection Request and more recent testing conducted by EPA, the Department of Energy, and industry participants.

While extensive data have been collected on mercury emissions from coal-fired utilities, some data and science gaps still exist with respect to understanding the effectiveness of specific controls in reducing mercury emissions from coal. As noted in the EPA Office of Research and Development's February 18, 2005,

[3] Mercury speciates into three basic forms: elemental, ionic, and particulate. Estimating the amount of speciated mercury emissions is important since the type of mercury emitted impacts how effectively it is captured by control technologies, and how it will react when emitted into the atmosphere. Differences in atmospheric reactions impact the amount and location of the mercury's deposition.

update of its study on control of mercury emissions, data and science gaps exist with respect to existing controls that are intended to reduce emissions of other pollutants with the co-benefit of reducing mercury, as well as emerging technologies specifically designed to reduce mercury emissions. The impact of these uncertainties on EPA's estimates of mercury emissions in base case and future years is qualitatively discussed in Agency documents but has not been quantified. The uncertainties could impact the accuracy of the estimated utility emissions input into CMAQ and CMAQ's resulting deposition estimates.

CMAQ Model Uncertainties and Limitations

CMAQ is useful for predicting regional and national patterns of deposition, but it has limitations that need to be carefully considered when used for modeling small areas of localized deposition and, thus, identifying hotspots. When emissions data are fed into CMAQ, the model averages the data over an area known as a "grid cell." CMAQ can predict deposition results over grid cells of various sizes (or resolutions) as specified by the modeler.

For CMAQ, EPA used a 36 kilometer (km) grid resolution (36 km x 36 km) for its Clean Air Interstate Rule and CAMR modeling, which equates to a surface area approximately 22 miles wide by 22 miles long, or approximately 484 square miles. The model provides one average concentration for the entire area. For example, if there is only one power plant in the corner of a grid square, that plant's emissions are averaged over the entire 36 km x 36 km area. Averaging over grid cells may result in a smoothing out of areas of high and low deposition. EPA acknowledges this limitation in its *Effectiveness Technical Support Document*:[4]

> *CMAQ immediately dilute[s] simulated emissions into the entire grid volume in which they are released. This causes an artificially fast dilution and under-represents direct deposition from air to surfaces near emission sources . . .*

When looking for hotspots, the ability to identify areas of localized deposition is important. Using the CMAQ model at 36 km x 36 km, in the opinion of some EPA officials we interviewed, was too coarse a resolution to be able to pinpoint small areas of localized deposition. Some EPA officials stated that use of a finer resolution, such as 12 km grid size, is possible in CMAQ. However, at very fine resolutions – for instance, a 4 km grid size – the meteorological components of the model probably fall apart and may introduce greater uncertainties in model results. EPA outlines three reasons for using a 36 km grid square size in its *Effectiveness Technical Support Document*. First, the larger grid size would account for mercury deposition that enters a watershed through groundwater

[4] *Methodology to Generate Deposition, Fish Tissue Methylmercury Concentrations, and Exposures for Determining Effectiveness of Utility Emission Controls (Effectiveness Technical Support Document)*. U.S. EPA, March 15, 2005.

inflow and runoff, as opposed to a smaller grid size that may only account for direct inputs to surface water. Second, in larger waterbodies where there is substantial fishing activity, the fish species consumed by humans are likely migratory and the accumulation of mercury in these fish will come from deposition over a larger area. Third, many anglers may catch fish from a variety of waterbodies in a watershed, thus a larger grid size would account for this fishing pattern.

Study Finds Different Rates of Atmospheric Chemical Reactions

The Mechanisms of Mercury Removal Study developed information on the rates of atmospheric chemical reactions involving mercury that is different than rates used by EPA in its CAMR hotspots analysis. The study was published in June 2005 after EPA issued CAMR. Rate constants, which quantify the speed or rate of chemical reactions, are the most important inputs affecting modeling results. The accuracy of rate constants can affect the accuracy of modeling results. Oxidation is an atmospheric process that makes mercury more reactive and is the most important reaction associated with mercury deposition. The mercury oxidation rate affects how quickly mercury is deposited and influences its properties and behavior. For example, oxidation makes elemental mercury more water soluble and more quickly deposited; if mercury emitted from a source comes out already oxidized, it can be immediately deposited near the source (depending on meteorological conditions and other factors).

Results of the Mechanisms of Mercury Removal Study regarding mercury reactions and associated rates suggest that emissions from global sources potentially account for less mercury deposition in the United States than previously believed. This means that the contribution of global sources to U.S. deposition may have been overestimated in EPA's analysis and the impact from domestic sources underestimated. According to the Agency scientist responsible for developing mercury capabilities in CMAQ, if the study's results about rate constants are accurate, then chemical formulations currently used in all other atmospheric simulation models, including CMAQ, could be incorrect (when modeling mercury deposition).

Uncertainties Noted with Methylation and Bioaccumulation

Assumptions about methylation and bioaccumulation directly impact the resulting predictions about mercury fish tissue concentrations after implementation of CAMR. Mercury methylation is a complex process that occurs in the environment when oxidized mercury is transformed into highly toxic methylmercury, which bioaccumulates (builds up) in fish tissue. Some of the important factors affecting methylation rates and bioaccumulation were not fully accounted for in EPA's analysis. Also, a lack of knowledge about some factors used in EPA's analysis is a source of uncertainty in EPA's conclusions about mercury fish tissue concentrations.

Methylation. Transformation of mercury to methylmercury occurs at varying speeds in different waterbodies, and EPA's analysis did not fully account for this variation. Methylation occurs when mercury enters waterbodies and bacteria transform it to methylmercury, a highly toxic and bioaccumulative form of mercury. Methylation of mercury occurs in waterbodies at highly variable speeds depending on various ecosystem-specific factors, including: the bacteria in the waterbody, the type of land surrounding the waterbody, the quantity of certain substances such as sulfate and carbon in the waterbody, and the pH (chemistry) of the waterbody. Thus, two adjacent waterbodies with equal mercury deposition can have different concentrations of mercury in fish.

EPA's analysis did not address individual differences between waterbodies, or the time it takes for different waterbodies to adjust to changes in atmospheric deposition. The modeling assumed that the environmental factors affecting the formation of methylmercury remain constant. EPA acknowledges that a lack of knowledge about methylation is "a major contributor to overall uncertainty" in its analysis; however, the effect of this uncertainty on the Agency's ability to inform mercury control policies is highly variable. An EPA official stated that variance in methylation rates was taken into account because actual methylmercury fish tissue measurements, which reflect varying methylation rates among different waterbodies where measurements were obtained, were used in the "utility-attributable" hotspot analysis. As explained in the next section, we found that concerns remain about these fish tissue measurements, which call into question how well they address methylation uncertainties.

Bioaccumulation. EPA's analysis did not fully account for the highly variable ways that mercury bioaccumulates in fish. When mercury deposition to a waterbody changes because of reductions in emissions, it can take time for those changes to be reflected in fish tissue methylmercury concentrations. Fish absorb methylmercury from their food and directly from water as it passes over their gills. To predict levels of methylmercury in fish tissue, CMAQ deposition results for a given area were input into a model that assumed a proportional relationship between declines in atmospheric mercury deposition and declines in mercury fish tissue concentrations. For example, a 50-percent decrease in mercury deposition rates was projected to lead to a 50-percent decrease in mercury concentrations in fish. However, drawing conclusions and making comparisons between different fish types is limited in that mercury bioaccumulates in highly variable ways among fish, both between species and within individual fish of a species. To establish a 2001 baseline estimate of methylmercury fish tissue concentrations, EPA used data from the National Listing of Fish Advisories and the National Lake Fish Tissue Survey:

> *For included locations, samples for the same species are averaged across all available years (post 1998), and then the highest averaged per species concentration is used to represent the methylmercury concentration for that*

sample location. For example, if there are two species at a location, walleye and pike, with three sampling dates for each species, we would first average over the three sample dates for each species, and then select walleye if the average for walleye is highest, or select pike if the average for pike is highest. . . . Assignment of the maximum average species concentration recognizes the greater risk to an individual consuming species with higher accumulation of mercury while respecting the fact that each sample for an individual species is only an estimate of the true mean concentration in that species.

According to EPA staff, the adequacy of current fish tissue data is sparse – it is patchy, non-standardized from State to State, and only identifies potential problems where data were actually collected. Regarding EPA's fish tissue data, an Agency official said, "The data does not support the conclusion that CAMR will not cause hotspots." In its *Effectiveness Technical Support Document*, EPA states that, among other limitations, the model it used to estimate changes in methylmercury fish tissue concentrations does not account for the time lag between a reduction in mercury deposition and a reduction in methylmercury concentrations in fish tissue. However, the document stated that EPA is unaware of any other tool for performing a national-scale assessment of the change in fish methylmercury concentrations resulting from reductions in atmospheric deposition of mercury.

Study Shows Significant Deposition from Local Sources

Results from the Steubenville Study,[5] a multiyear study in the Ohio River Valley, found that approximately 70 percent of mercury wet deposition at Steubenville, Ohio in 2003 and 2004 was attributable to local/regional coal combustion sources, predominantly from utility boilers.[6] The results of the Steubenville Study suggest that additional monitoring is necessary to ensure that EPA's CAMR analysis has properly estimated the contribution of local and regional mercury deposition. For example, while CMAQ results do not provide an estimate of mercury wet deposition for Steubenville specifically (due to its 36 km x 36 km grid cell area), it estimated for 2001 that 44 percent of the wet deposition in the grid cell containing Steubenville was from coal-fired utilities. Spatial and temporal differences[7] between the Steubenville Study and EPA's CAMR analysis do not allow for their results to be fully comparable; however, data from other monitoring sites further suggest that monitoring is needed to ensure that CMAQ

[5] A peer review of the Steubenville Study was completed in late December 2005 and it was submitted for publication in a scientific journal in February 2006.

[6] The Steubenville Study results have an uncertainty bound of approximately 15 percent. This uncertainty bound does not follow a normal distribution pattern but is positively skewed, i.e., the upper bound of the 95 percent confidence interval extends further from the estimate than the lower bound.

[7] The Steubenville Study wet deposition results are for 2003 and 2004 and (1) represent the wet deposition for a specific monitoring location; (2) include wet deposition for all coal-combustion sources; and (3) have quantified estimates of uncertainty. Conversely, the CMAQ results are for the year 2001 and (1) represent an estimate for a much larger area (i.e., a 36 km x 36 km grid cell); (2) represent deposition from coal-fired utilities only; and (3) do not quantify uncertainty.

has not underestimated wet deposition in some locations. An Agency scientist noted that:

> *. . .CMAQ runs conducted using 2001 emissions data for CAMR modeling showed that there are areas in the U.S. where domestic sources create large areas of enhanced deposition (e.g., up to 60% of wet mercury deposition in some areas originated from domestic coal combustion sources). The Steubenville measurements are consistent with these projections. As an example of uncertainties related to CMAQ . . . the University of Michigan has run a network of event-based mercury monitoring sites in the Midwest and Vermont and the 2001 CMAQ model runs systematically underestimate the deposition observed at these sites (in some cases by over a factor of 2).*

Senior Office of Air and Radiation officials told us that the Steubenville area is known to have higher-than-average deposition from coal-fired utilities, and that the preliminary monitoring results were not unexpected. OAQPS noted that for grid cells neighboring the Steubenville grid cell, the CMAQ model predicted that a higher percentage of mercury deposition was attributable to utility coal combustion (i.e., 57 to 71 percent). Preliminary results of the Steubenville Study were made available to Agency officials shortly after EPA's promulgation of CAMR and the *Revision of December 2000 Regulatory Finding* in March 2005, but were not available for consideration by the Agency during its promulgation of these rules. The Agency noted that they analyzed a number of scientific studies in developing CMAQ, but our evaluation did not consider all of the scientific evidence EPA used in developing CMAQ. As noted in Appendix A, we did not evaluate all the inputs and assumptions associated with EPA's mercury hotspots analysis. Additional limitations of our evaluation are listed in Appendix A.

Uncertainties Underscore Need for Mercury Monitoring Plan

In the preamble to the *Revision of December 2000 Regulatory Finding*, EPA stated that although it believed the likelihood of a "utility-attributable" hotspot occurring to be "remote," it intended to closely monitor the potential for hotspots, continue to advance the state of the science of mercury fate and transport, and take appropriate action if the possibility of a "utility-attributable" hotspot arose after implementation of CAMR. However, at the time we completed our field work, EPA had not yet developed a plan for monitoring hotspots. Given the uncertainties associated with the inputs to the CMAQ model and the results of recent studies as noted, it is important for EPA to have a plan to monitor mercury deposition. Mercury monitoring data could assist the Agency in determining "utility-attributable" hotspots, and in evaluating and improving the accuracy of its mercury fate and transport models. Without a mercury monitoring plan, "utility-attributable" hotspots could potentially occur after implementation of CAMR but be less likely to be identified due to a lack of deposition data or reliable modeling techniques to identify mercury sources.

Field measurement of mercury deposition could improve EPA's ability to conduct source apportionment studies to help to determine whether a hotspot was "utility-attributable." To assess whether CAMR results in "utility-attributable" hotspots, EPA must have mercury deposition data that enable it to identify the mercury source. Source-apportionment studies, such as that conducted by EPA in Steubenville, are designed to accomplish this task. Such studies estimate a source's contribution to mercury deposition and require the collection of deposition samples and measurements of trace elements in addition to mercury. Trace elements are elements that are co-emitted with mercury from particular sources, and help identify from which source(s) the deposited mercury originally came. For example, sulfur and selenium are trace elements associated with coal combustion. When these elements are in samples of deposited mercury, they indicate the mercury came from coal combustion sources. By employing a monitoring plan that incorporates more studies of this nature, EPA can better assess the impact that utilities have on mercury deposition and resulting fish tissue concentrations.

Mercury deposition data would also help EPA improve its current understanding of mercury fate and transport, and allow the Agency to validate and improve mercury deposition estimation models and techniques. Model performance can be assessed by comparing model predictions to actual field data. While mercury deposition data are available through the Mercury Deposition Network (MDN), these data have important limitations for model evaluation, particularly modeling designed to identify mercury hotspots:

- The MDN measures only wet deposition because there is no adequate field methodology currently available for dry deposition.

- The MDN does not generally provide deposition monitoring data for areas expected to be of greatest concern for deposition from local emissions sources. This is because MDN monitoring sites are generally located in rural locations that do not have local sources of emissions.

- There are large areas of the nation with few or no MDN monitoring sites.

- The MDN collects deposition samples on a weekly basis, so it does not accurately measure the impacts of individual events, such as rain or snowfall.

- The MDN sites do not collect trace element data, such as sulfur and selenium data for coal combustion, which is needed to conduct source apportionment modeling.

Due to the limitations associated with available data from the current mercury deposition monitoring network, EPA is currently unable to fully assess the accuracy of CMAQ's mercury deposition predictions against actual field

measurements. Agency officials told us that the EPA Office of Research and Development's National Exposure Research Laboratory was already implementing a research plan for mercury monitoring, but recent budget reductions have halted the program.

Conclusion

EPA has acknowledged uncertainties and limitations in its analysis of the potential for "utility-attributable" hotspots. The results from two studies – the Mechanisms of Mercury Removal Study and the Steubenville Study – illustrate uncertainties about some of the key assumptions used in CMAQ and the deposition results projected by the model. Further consideration of uncertainties could alter EPA's conclusions about the potential for "utility-attributable" mercury hotspots. EPA indicated it will closely monitor hotspots, continue to advance mercury science, and take appropriate actions if hotspots arose. To accomplish this, the Agency needs to establish a monitoring plan to conduct source-apportionment studies to measure the impact of CAMR and to assist in evaluating the accuracy of its model predictions against actual field data.

Recommendation

We recommend that the Acting Assistant Administrator for Air and Radiation:

2-1 Work with the Assistant Administrator for the Office of Research and Development to develop and implement a mercury monitoring plan, including milestones and responsible program offices for implementing each component of the plan, to: (1) assess the impact of CAMR, if adopted, on mercury deposition and fish tissue; and (2) evaluate and refine, as necessary, mercury estimation tools and models. This effort should consider the suitability of the Office of Research and Development's mercury research plan for addressing these objectives.

Agency Comments and OIG Evaluation

The Agency generally agreed with the recommendation in Chapter 2 of the report. However, the Agency expressed concern with our characterization of some scientific issues in the report and offered clarification on three specific issues. We accepted the Agency's technical clarifications and have made changes to the final report as appropriate. The Agency also provided us with additional concerns not specifically addressed in its written response to our draft report. We met with the Agency to discuss these concerns, and made changes to the final report as appropriate. In response to our recommendation, the Agency stated that the Office of Air and Radiation and Office of Research and Development will continue to work together to ensure that they are using the best possible information to assess the transport, transformation, deposition, and fate of mercury emissions in the United States. We support the Agency's commitment to

using the best possible information to assess the impact of mercury emissions in the United States, and continue to recommend the Agency develop a monitoring plan to better ensure that this happens. The Agency's formal written response is in Appendix C.

Chapter 3
EPA Needs to Clarify Conditions Under Which CAMR Performance Standards Can be Tightened

EPA does not clearly explain how the "utility-attributable" hotspot definition affects the Agency's ability to revise performance standards under CAMR. When CAMR is read in conjunction with the *Revision of December 2000 Regulatory Finding,* we believe the CAMR could be interpreted to preclude EPA from taking action to mitigate a mercury hotspot (such as tightening the cap or utilities' performance standards) unless it first determined that the hotspot was solely "utility-attributable." If this were the case, such a prerequisite could limit EPA's ability to reduce methylmercury fish tissue concentrations below acceptable levels, and thus address public health hazards that are being caused predominantly (but not "solely") by utilities. This could also impact EPA's ability to reduce the number of waterbodies with fish consumption advisories.

EPA Provides "Utility-Attributable" Hotspot Definition

In its *Revision of December 2000 Regulatory Finding,* EPA defined a "utility-attributable" hotspot[8] as:

> *". . . a waterbody that is a source of consumable fish with Methylmercury tissue concentrations, attributable solely to utilities, greater than the EPA's Methylmercury water quality criterion of 0.3 mg/kg."*

This definition only considers the contribution of one source (utilities) on environmental problems that could threaten human health, and would only consider a hotspot to be "utility-attributable" if the utility emissions alone caused methylmercury in fish tissue to exceed 0.3 mg/kg.

According to the preamble of the *Revision of December 2000 Regulatory Finding,* EPA adopted this definition based on its interpretation of Clean Air Act Section 112(n), which directed the Agency to ". . . study hazards to public health reasonably anticipated to occur as a result of emissions by electric utility steam generating units." EPA interpreted the language "as a result of" to mean that utility emissions must be the *sole* cause of a health hazard, and not just contribute to causing a hazard, to be regulated under Section 112. Using EPA's methylmercury water quality criterion of 0.3 mg/kg in fish tissue as the one

[8] EPA uses the terms "hotspot," "hot spot," "utility hot spot," and "utility-attributable hotspot" interchangeably throughout the *Revision of December 2000 Regulatory Finding* when referring to a waterbody that is a source of consumable fish with methylmercury tissue concentrations, attributable solely to utilities, greater than the EPA's methylmercury water quality criterion of 0.3 mg/kg.

measure for "hazards to public health," EPA adopted the "utility-attributable" hotspots definition to determine whether such utility hotspots would remain after implementation of the Clean Air Interstate Rule and CAMR. Based on the analysis described in Chapter 2 of this report, EPA stated that it did not believe that "utility-attributable" mercury hotspots would exist after implementing these rules, therefore supporting the Agency's decision that utilities did not need to be regulated under Section 112 of the Clean Air Act.

"Utility-Attributable" Definition Could be Interpreted to Limit EPA's Ability to Mitigate Hotspots

The "utility-attributable" definition could be interpreted to limit EPA's ability to address waterbodies with elevated levels of mercury unless utility emissions were the sole cause of the problem. This could in turn limit EPA's ability to reduce the number of waterbodies with fish consumption advisories where there is a health risk due to the combined impact of mercury from all sources, including air emissions.

As discussed in its December 1997 *Mercury Study Report to Congress*, EPA stated that there is "clearly" a need to address the combined impacts of mercury originating from all sources, including air emissions, wherever the combination of sources have been related to unacceptably high mercury levels in fish. Further, in its *December 2000 Finding,* EPA recognized concerns about the potential local impact of mercury trading programs and acknowledged that:

> *. . . approaches that involve economic incentives must be constructed in a way that assures that communities near the sources of emissions are adequately protected.*

Within CAMR and the *Revision of December 2000 Regulatory Finding*, EPA specifies several actions it might take to mitigate the effects of a hotspot in the event one should be identified. However, our analysis of the revision and CAMR suggests that the Agency may be precluded from taking any of those actions unless the hotspot first meets the criteria of a "utility-attributable" hotspot. EPA officials told us that this was not the intent of the rule, but agreed that the rule could be clearer.

CAMR and Revision Must be Read Together

Based on our reading of CAMR and the *Revision of December 2000 Regulatory Finding,* we conclude that the definition of a hotspot presented in the revision is intended to apply to CAMR. CAMR and the revision were issued on the same day and address the same subject matter. In addition, the preamble to the CAMR restates EPA's conclusion from the revision, but refers to it as part of "this action":

As stated elsewhere in this action EPA does not believe that utility-attributable hot spots will be an issue after implementation of CAIR [Clean Air Interstate Rule] and CAMR.

Because "utility-attributable" hotspots are not discussed "elsewhere" within CAMR, we conclude that "this action" refers to the other, closely related action published by EPA on the same day. This action, the *Revision of December 2000 Regulatory Finding*, defines "utility-attributable" hotspots and also explains that EPA may address hotspots under "other authorities under the CAA [Clean Air Act]," should they occur. However, the only mechanism to which EPA refers in order to addresses potential future hotspots – and the only mechanism presently promulgated – is CAMR. The revision cites the following ways it could address "utility-attributable" hotspots:

. . . if in the future we determine that utility-attributable hotspots exist and that those hotspots occur as the result of Hg emissions from coal-fired Utility Units, we may promulgate a tighter section 111 standard of performance, provided we determine the technology can achieve the contemplated reductions. We could revise the standard of performance by adjusting the cap-and-trade program to limit trading by high-emitting Utility Units. . . . Thus, although we cannot conclude today which statutory authority we would implement to address utility attributable hotspots because that determination necessarily hinges on the facts associated with the identified hotspots, we do conclude that were such a situation to occur, we believe that EPA has adequate authority to address any such situation that may arise in the future.

When read together, these regulatory actions suggest that a finding of a solely "utility-attributable" mercury hotspot is necessary to initiate Agency action to mitigate hotspots under CAMR. If this were the case, EPA would be precluded from requiring additional mercury reductions from the utility industry, even if it were determined that utilities were significantly contributing to a hotspot, if the utilities were not the sole cause of the hotspot. For example, if methylmercury fish tissue concentrations for a waterbody were at 0.32 mg/kg, EPA's water quality criterion of 0.3 mg/kg would be exceeded. If, in this hypothetical case, utility mercury emissions were causing 0.3 mg/kg or less of the total methylmercury, under the requirement as written, utilities would be excluded from any additional reductions to help mitigate the problem.

We discussed our interpretation with Office of Air and Radiation officials. These officials confirmed that the "utility-attributable" hotspot definition in the revision applies to the CAMR. However, these officials told us that this definition does not establish a criterion for when the Agency can adjust the performance standards under CAMR. They noted that under Section 111, performance standards are to be reviewed every 8 years, and can be adjusted for various reasons.

Conclusion

The two rules related to controlling mercury emissions from coal-fired utilities were issued on the same day and refer to and are consistent with each other. Thus, it appears that they are intended to be read together. Further, the "utility-attributable" definition in the *Revision of December 2000 Regulatory Finding* applies to the discussion of hotspots in CAMR, and this definition establishes a criterion for when the CAMR can be adjusted to address a potential health hazard. If this were the case, tighter performance standards for utilities contributing to a hotspot could not be promulgated unless it was first determined that the hotspot was solely "utility-attributable." Although not the intent of the rulemaking, EPA officials agreed that the rule could be clearer. We believe CAMR, if adopted, should be clarified to avoid any possible misinterpretation of how the "utility-attributable" definition affects EPA's ability to modify utility performance standards.

Recommendation

If EPA decides to adopt CAMR after the rule reconsideration process, to better ensure protection of public health and the environment, we recommend that the Acting Assistant Administrator for Air and Radiation:

3-1 Explain in CAMR that the "utility-attributable" hotspot definition found in the revision does not establish a prerequisite for making future changes to the performance standards under CAMR.

Agency Comments and OIG Evaluation

The Agency's response did not specifically address our analysis and conclusion that CAMR could be interpreted to use the "utility-attributable" hotspot definition as a prerequisite for future changes to CAMR. The Agency commented that, while information regarding "utility-attributable" hotspots would be relevant to future possible revisions to CAMR, such hotspots are not a prerequisite to the Agency making changes to performance standards under CAMR. We believe the Agency's intent should be made clear in the final rule. Accordingly, we revised our final report to recommend that EPA, to better ensure protection of public health and the environment, explain in the CAMR that the "utility-attributable" hotspot definition set forth in the revision is not a prerequisite for making changes to the CAMR. After submitting its formal written response to the draft report the Agency also suggested clarifying language to parts of Chapter 3. We accepted some of the suggestions and incorporated them into the final report. The Agency's formal written response is in Appendix C.

Details on Scope and Methodology

We conducted interviews with staff from the following EPA offices:

- Office of Air and Radiation, including its Office of Air Quality Planning and Standards and Office of Atmospheric Programs.
- Office of Research and Development, including its National Exposure Research Laboratory and National Center for Environmental Research.
- Office of Policy, Economics, and Innovation.
- Office of Water.

We also interviewed officials from the following external organizations: the National Oceanic and Atmospheric Administration, including its Air Research Laboratory; the Northeast States for Coordinated Air Use Management; and the Clean Air Task Force.

To understand the variables associated with mercury fate and transport modeling and, specifically, CMAQ, we reviewed and/or discussed with the above officials selected reports and studies, including:

- Mechanisms of Mercury Removal by O_3 and OH in the Atmosphere. Calvert Jack G.; Lindberg Steve E. *Atmospheric Environment*, Volume: 39, Number: 18, Page: 3355-3367, June 5, 2005.
- The National Oceanic and Atmospheric Administration's September 2005 (draft) report by Cohen, et al, *Report to Congress: Mercury Contamination in the Great Lakes.*
- EPA's *Regulatory Impact Analysis of the Final Clean Air Mercury Rule*, March 2005.
- EPA's *Mercury Study Report to Congress*, December 1997.
- A slide presentation on EPA's Steubenville, Ohio, study, *Preliminary Results from Steubenville Hg Deposition Source Apportionment Study*, April 27, 2005.
- The most recent peer review of CMAQ, *Final Report: Second Review of the CMAQ Model.*
- *Technical Support Document: Methodology Used to Generate Deposition, Fish Tissue Methylmercury Concentrations, and Exposure for Determining Effectiveness of Utility Emission Controls. Analysis of Mercury from Electricity Generating Units*, March 17, 2005 (revised).
- *Technical Support Document for the Final Clean Air Mercury Rule: Air Quality Modeling*, March 2005.
- *Emissions Inventory and Emissions Processing for the Clean Air Mercury Rule*, March 2005.

To gain an understanding of State and environmental groups' concerns related to EPA's analysis of potential "utility-attributable" hotspots under CAMR, we reviewed the following selected comments:

- The December 19, 2005 comments submitted *In Reconsideration of: Revision of December 2000 Regulatory Finding on the Emissions of Hazardous Air Pollutants From Electric Utility Steam Generating Units and the Removal of Coal- and Oil-Fired Electric Utility Steam Generating Units from the Section 112(c) List 70 Fed. Reg. 62200 (Oct. 28, 2005); and Standards of Performance for New and Existing Stationary Sources: Electric Utility Steam Generating Units 70 Fed. Reg. 62213 (Oct. 28, 2005). Comments Submitted by: The States of New Jersey, California, Connecticut, Delaware, Illinois, Maine, Massachusetts, Minnesota, New Hampshire, New Mexico, New York, Pennsylvania, Rhode Island, Vermont, and Wisconsin*, Docket No. OAR-2002-0056.

- The December 19, 2005 comments submitted regarding the *"Revision of December 2000 Regulatory Finding on the Emissions of Hazardous Air Pollutants From Electric Utility Steam Generating Units and the Removal of Coal- and Oil-Fired Electric Utility Steam Generating Units From the Section 112(c) List: Reconsideration," 70 Fed. Reg. 62,200 (October 28, 2005). Comments of: Clean Air Task Force, Izaak Walton League of America, Natural Resources Council of Maine, Ohio Environmental Council, U.S. Public Interest Research Group, Natural Resources Defense Council, Chesapeake Bay Foundation, Waterkeeper, Aroostook Band of Micmac Indians, Houlton Band of Maliseet Indians, Penobscot Indian Nation, The Passamaquoddy Tribe at Indian Township.*

To gain an understanding of EPA's definition of "utility-attributable" hotspots and the basis for that definition, we reviewed the following regulatory actions:

- *Regulatory Finding on the Emissions of Hazardous Air Pollutants From Electric Utility Steam Generating Units*, December 20, 2000.
- *Proposed National Emission Standards for Hazardous Air Pollutants; and, in the Alternative, Proposed Standards of Performance for New and Existing Stationary Sources: Electric Utility Stream Generating Units; Proposed Rule*, January 30, 2004.
- Final Rule – Preamble - *Standards of Performance for New and Existing Stationary Sources: Electric Utility Steam Generating Units*, March 15, 2005.
- Final Rule – Regulatory Text - *Standards of Performance for New and Existing Stationary Sources: Electric Utility Steam Generating Units*, March 15, 2005.
- Final Rule - *Revision of December 2000 Regulatory Finding on the Emissions of Hazardous Air Pollutants from Electric Utility Steam Generating Units and the Removal of Coal- and Oil-fired Electric Utility Steam Generating Units from the Section 112 (c) List*, March 15, 2005.
- *Reconsideration: Revision of December 2000 Regulatory Finding on the Emissions of Hazardous Air Pollutants from Electric Utility Steam Generating Units and the Removal of Coal- and Oil-fired Electric Utility Steam Generating Units from the Section 112 (c) List*, October 21, 2005.
- *Reconsideration: Standards of Performance for New and Existing Stationary Sources: Electric Utility Steam Generating Units*, October 21, 2005.

Prior Coverage

In a prior EPA OIG report, *Additional Analyses of Mercury Emissions Needed Before EPA Finalizes Rules for Coal-Fired Electric Utilities* (2005-P-00003), dated February 3, 2005, we cited concerns about EPA's limited assessment of the potential for mercury hotspots resulting from its (then proposed) cap-and-trade program under CAMR. In that report, we recommended that EPA further assess the risk of hotspots and, if necessary, identify how the Agency would reassess the hotspot issue. In response to our recommendation, EPA stated that it did not believe utility emissions would result in hotspots based on additional analyses it had performed, particularly after implementation of the Clean Air Interstate Rule and CAMR, but it would monitor the situation and take action if necessary. For this current review, we evaluated EPA's analysis of hotspots, its conclusion that there will be no "utility-attributable" hotspots after implementation of the Clean Air Interstate Rule and CAMR, and plans the Agency may have in place to continue to monitor the issue. Details on what we found, including recommendations, are in Chapters 2 and 3 of this current report.

Internal Controls

Government Auditing Standards require that auditors obtain an understanding of internal control significant to the audit objectives and consider whether specific internal control procedures have been properly designed and placed in operation. This evaluation was a limited-scope assessment of certain analyses pertaining to a rulemaking. Thus, we determined whether the Agency's hotspots analysis and conclusions were peer reviewed, and if the key model used in this analysis was separately peer reviewed. Peer review is a key internal control for ensuring the acceptability of scientific data and processes. We found that CMAQ, the main model used by EPA in its hotspots analysis, was peer reviewed; however, we found no evidence that the Agency's overall hotspots analysis, described in the document *Methodology to Generate Deposition, Fish Tissue Methylmercury Concentrations, and Exposures for Determining Effectiveness of Utility Emission Controls,* was peer reviewed. The Agency's *Ecosystem Scale Modeling for Mercury Benefits Analysis*, part of the Regulatory Impact Analysis for the CAMR, was peer reviewed. The benefits analysis was similar to the hotspots analysis, but it assessed the impact of CAMR on a national scale, as opposed to identifying localized hotspots or local-scale impacts.

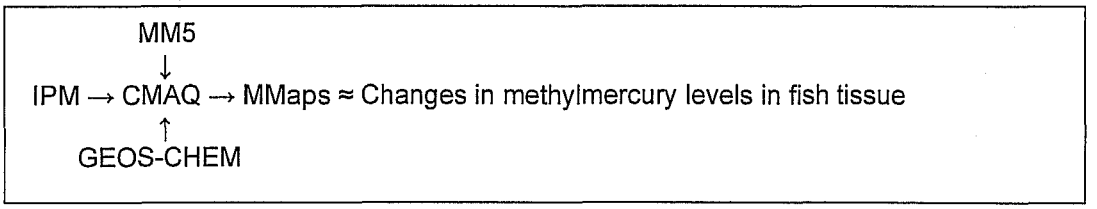
Limitations

Our work had several limitations. Specifically, we did not:

- Review every model that contributed to EPA's analysis of the potential for "utility-attributable" hotspots under CAMR.
- Evaluate all of the inputs and assumptions associated with EPA's mercury hotspots analysis.
- Evaluate the adequacy of EPA's water quality criterion to protect human health.

Models Used in CAMR Analysis

The following diagram depicts how data from each model were used in EPA's hotspot analysis. Details on each model follow the diagram.



Model	Purpose	Contribution to Hotspot Analysis
Integrated Planning Model (IPM)	• To analyze future cost and emissions impacts of proposed environmental regulations upon utilities.	Estimates mercury emissions from utilities after implementation of Clean Air Interstate Rule and CAMR.
Mesoscale Model (MM5)	• To provide meteorological information, such as wind, temperature, precipitation, and sea level pressure.	Simulates weather patterns, which affect where mercury deposits.
Goddard Earth Observing System-CHEMistry (GEOS-CHEM) Global Model	• To provide a global three-dimensional model of atmospheric chemistry driven by meteorology.	Uses global chemistry and transport information to provide global/background mercury concentrations.
Community Multiscale Air Quality (CMAQ) Model	• To estimate mercury deposition. • To simulate various chemical and physical processes thought to be important in the atmospheric transformation and distribution of mercury.	Estimates amount of mercury deposition occuring within 36 km^2 grid cells after implementation of Clean Air Interstate Rule and CAMR.
Mercury Maps (MMaps)	• To relate changes in mercury air deposition rates to changes in mercury fish tissue concentrations on a national scale.	Uses CMAQ deposition data to estimate fish tissue concentrations of methylmercury based on the assumption of a 1-to-1 ratio between reductions in air deposition and reductions in average methylmercury fish tissue concentrations.

Agency Response to Draft Report

Bill Roderick, Acting Inspector General
Office of the Inspector General
Office of Program Evaluation
1301 Constitution Ave. NW (2400 T)
EPA West Building
Washington, DC 20004

Dear Mr. Roderick:

Thank you for the opportunity to comment on the draft Office of the Inspector General (OIG) report entitled ***"Monitoring Needed to Assess Impact of EPA's Clean Air Mercury Rule on Potential Hotspots."*** In reviewing the draft report, we acknowledge your acceptance of the majority of the issues we identified in our earlier review. We have also recently supplied your office with additional written comments pertaining to the modeling analyses associated with the Steubenville project. We believe that the collective scientific and engineering expertise within EPA's Offices of Air and Radiation (OAR) and Research and Development (ORD) puts our offices in a unique position to assess the current state-of-the-science with respect to mercury transport, deposition, and fate, and its impact on the creation of utility-attributable hotspots.

We continue to have concerns about the portrayal of some scientific issues in the report, and note three areas where we would like to provide clarifying remarks. First, with respect to the potential changes in the atmospheric reaction rates within the Community Multiscale Air Quality (CMAQ) model (see pages 9 and 10), such changes would be made uniformly in **all** mercury transport/deposition models, not just CMAQ. Thus, the enhancements would create different results in any assessment using these numerical simulation technologies. Second, regarding our need to improve ambient monitoring (see page 13), the report should acknowledge that the Mercury Deposition Network (MDN) currently measures only wet deposition because there is no adequate field methodology available for dry deposition.

Finally, in terms of how EPA addressed the uncertainties in methylation and bioaccumulation rates between different fresh water bodies, our supporting health benefits assessment materials describe in great detail our complete understanding of these processes. You are correct to point out, and we clearly acknowledge in our documents, the uncertainties associated with mercury transport, deposition, and effects. At the same time, it should be acknowledged that the magnitude of uncertainties and their effect on our ability to inform mercury control policies is highly variable. We believe we have clearly explained the science and the uncertainties and provided a solid foundation for the Clean Air Mercury Rule (CAMR).

In your draft report, you recommend two specific follow-up actions for the Agency. Below we address each of these recommendations.

Recommendation 2-1: ***Work with the Assistant Administrator for the Office of Research and Development to develop and implement a mercury monitoring plan, including milestones and responsible program offices for implementing each component of the plan, to: (1) assess the impact of CAMR, if adopted, on mercury deposition and fish tissue, and, (2) evaluate and refine, as necessary, mercury estimation tools and models. This effort should consider the suitability of the Office of Research and Development's mercury research plan for addressing these objectives.***

EPA currently operates the MDN, which is located predominantly in the eastern U.S. and monitors only wet deposition. In the technical support documents supporting CAMR, EPA has continually highlighted the need for and the willingness to support additional ambient monitoring, including the development of dry deposition monitoring, to enhance our ability to assess the numerical accuracy of our sophisticated simulation tools – e.g., the CMAQ model. As you are aware, ORD has been heavily involved over the past decade in developing the CMAQ model, and is actively engaged in utilizing ambient data and the latest scientific information to update the model to reflect the best possible chemistry and physics. OAR and ORD will continue to work together to ensure that we are using the best possible information to assess the transport, transformation, deposition, and fate of mercury emissions in the U.S.

Recommendation 3-1: ***If EPA decides to adopt CAMR after the rule reconsideration process, we recommend that the Acting Assistant Administrator for Air and Radiation: Specifically explain what role the "utility-attributable" hotspot definition has in determining whether to make any future changes to the performance standards under CAMR.***

EPA has explained to your staff that while information regarding utility-attributable hotspots would be relevant to future possible revisions to CAMR, such hotspots are not a prerequisite. CAMR controls are based on the new source performance standards (NSPS) as set forth in section 111 of the Clean Air Act. To this end, the Agency is required by law to review and revise, as necessary, these limits every eight years. In conducting such a review,

we will analyze and evaluate the availability of new mercury control technologies installed since the previous review, and to the extent they provide additional cost-effective control, the Agency can move to change the existing NSPS limits. Additionally, the Agency continues to update its understanding of the science associated with mercury emissions, transport, transformation, and deposition, both from ambient data collection and monitoring and through continued enhancements to our analytical tool box. Thus, we feel that OAR and ORD are uniquely positioned to monitor this situation and provide the best possible solution for the protection of public health and the environment.

In closing, we direct the OIG staff to the numerous technical documents supporting the final CAMR, particularly the benefits assessment materials in which we outline in detail the variability associated with methylation and bioaccumulation rates in different water bodies. In these documents, EPA has demonstrated that the conclusions reached in the CAMR are based firmly in sound scientific principles, utilizing the best information available. If your staff have additional questions in researching these documents, our scientists, engineers, and modelers would be happy to assist them.

Sincerely,

William Wehrum
Acting Assistant Administrator
Office of Air and Radiation

George Gray
Assistant Administrator
Office of Research and Development

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