

**Summary Minutes of the United States Environmental Protection Agency (U.S. EPA)  
Science Advisory Board (SAB) Mercury Review Panel  
June 15-17, 2011**

Chartered SAB Members: See Roster<sup>1</sup>

Date and Time: June 15-17, 2011

Location: Marriott at Research Triangle Park, 4700 Guardian Drive, Durham, NC, 28803

Purpose: To peer review EPA's draft *Technical Support Document: National-Scale Mercury Risk Assessment Supporting the Appropriate and Necessary Finding for Coal and Oil-Fired Electric Generating Units* - March 2011.<sup>2</sup>

SAB Mercury Review Panel Participants:

Dr. Stephen M. Roberts, Chair	Dr. Leonard Levin
Dr. David T. Allen (6/15 &6/16 only)	Dr. C. Jerry Lin
Dr. Thomas Burbacher	Dr. Jana Milford (6/15 &6/16 only)
Dr. James Burch	Dr. M. Christopher Newland
Dr. Hillary Carpenter	Dr. Nicholas Ralston
Dr. Celia Chen	Dr. Stephen L. Rathbun
Dr. Miriam L. Diamond	Dr. Eric P. Smith
Dr. Charles T. Driscoll, Jr.	Dr. Alan Stern
Dr. Thomas Holsen	Dr. Edward Swain
Dr. James Hurley	Dr. Edwin van Wijngaarden
Dr. David Krabbenhoft (6/15 &6/16 only)	Dr. Robert Wright (6/15 &6/16 only)

SAB Staff Office Participants

Dr. Angela Nugent, Designated Federal Officer (DFO)  
Dr. Vanessa Vu, Director

Other Participants Identified on the Agenda

Ms. Lydia Wegman, EPA Office of Air Quality Planning and Standards (OAQPS),  
Dr. Zachary Pekar, OAQPS

Meeting Summary

The committee discussion at the meeting generally followed the issues and timing as presented in the agenda<sup>3</sup> with the exceptions noted below.

**June 15, 2011**

Convene Meeting

Dr. Angela Nugent, SAB DFO, convened the meeting and welcomed the group. She noted that there had been no requests for oral public comment and that two sets of written public comments had been received prior to the meeting.<sup>45</sup> Dr. Vanessa Vu noted that the purpose of the meeting was to peer review EPA's March 2011 draft documents entitled *Technical Support Document: National-Scale Mercury Risk Assessment Supporting the Appropriate and Necessary Finding for Coal and Oil-Fired Electric Generating Units*. She thanked the panel and the Agency for their preparations for the meeting and asked the panel to consider the public comments received through advisory process

Introduction of members, agenda review

Dr. Stephen Roberts, the SAB Panel Chair, asked members to introduce themselves. He reviewed the agenda and noted that the goal of the meeting was to develop a draft panel response to all charge questions requested by the Agency<sup>6</sup> by the conclusion of the meeting. The draft response would identify consensus or, where the panel had not reached consensus on a question, the range of panel views on that question. He reiterated the expectation that panel members take note of written public comments received.

Background and schedule for completion of the *Mercury Technical Support Document*

Ms. Lydia Wegman, OAQPS, provided an overview of the "Statutory and Regulatory Background Related to the Appropriate and Necessary Finding."<sup>7</sup> She noted that the draft review document provided technical support for a rulemaking to regulate coal and oil-fired utilities to reduce Hazardous Air Pollutants from electrical generating units (EGUs). The current draft supports the "appropriate and necessary" legal finding prerequisite for technology-based standards for EGUs. There are other technical documents supporting the rulemaking, including non-mercury case studies for other hazardous air pollutants and a nickel and chromium speciation methodology.

Introduction to the draft *Technical Support Document*

Dr. Zachary Pekar, OAQPS, provided a presentation entitled "Overview of the National-Scale Mercury Risk Assessment."<sup>8</sup> Following his presentation, panel members asked clarifying questions. In response, Dr. Pekar and Dr. Bryan Hubbell of OAQPS provided the following information:

- The target population is women of childbearing ages in watershed where subsistence fishing occurs. The draft document is intended as a "reasonable screening assessment" for that purpose. EPA was not able to obtain a population-weighted average for the target population, given available data.
- The analysis does not assume that subsistence fishers generally travel beyond their watershed to fish.

- EPA assumed interpolated deposition from CMAQ for watersheds using an area weighted average,
- EPA’s Regulatory Impact Analysis considered recreational anglers, in addition to the population of subsistence fishers discussed in the *Technical Support Document*, which EPA believes focused on the population with the highest exposures.
- Emissions inventories for EGUs are relatively high quality, because there is continuous emissions modeling available from EGUs. EPA has not assessed the data quantitatively, but there have been “qualitative discussions” of the quality of the data.
- EPA could compare uncertainties in EGU inventories to large inventory uncertainties, if the panel requested it.
- EPA assumed that there was potential for mercury maps to perform better with stationary waterbodies than moving waterbodies (i.e., lakes vs. streams), because fish could be migratory and deposition would be resident in lakes vs. streams.
- EPA held proportionality constant for each watershed.
- All percentile calculations were conducted in EXCEL and no special calculation was conducted with samples of size 1.
- EPA did not use deposition data to model fish tissue and instead relied on measured fish tissue because of methylation variability. In the future, it may be possible to generate estimates of likely fish concentrations, drawing on available information on land use and land cover that may consider methylation potential.
- Consumption rates for target groups of subsistence fishers came from regional studies.
- EPA confirmed that it ran the CMAQ model multiple times to get wet plus dry deposition for each grid scale plus a global model of the emissions inventory. EPA focused the analysis on the impact of the Clean Air Act, rather than what might be done by states or internationally, based on its interpretation of statute. Emissions calculations for the *Technical Support Document* may be different from calculations in the Regulatory Impact Analysis.
- EPA selected the 75<sup>th</sup> percentile to ensure that the “high end tail” of the distribution was included. The 75<sup>th</sup> percentile was chosen as a reasonable measure of larger fish.
- EPA chose the databases for fish tissue based on availability during the short time frame for completing the analysis. More state data might have been available if EPA had time to have identified and analyzed the data.
- EPA screen out watersheds for non-airborne sources of mercury by using Toxic Release Inventory (TRI) emissions by watershed with high non-airborne sources.
- EPA did not validate the proportionality assumptions of the Mercury Maps approach using real data, because it is hard to find studies that match all the assumptions.
- EPA did not use National Health and Nutrition Examination Survey (NHANES) data because NHANES does not include data on subsistence fishers.
- Many watersheds with fish tissue data were not included, likely because of the TRI screen.
- Fish tissue data came from state databases. State data did not provide uniform information on fish tissues.
- EPA would like to have generated full probabilistic uncertainty for each stage of the assessment, but it did not have available alternative inputs for models with confidence levels or the results of expert elicitation.

- In response to one panel member's observation that dry deposition varies from wet deposition estimates, Dr. Kirk Baker (OAQPS) stated that EPA did not have an evaluation of CMAQ performance related to dry deposition of mercury.
- EPA's court-ordered deadline requires that a final regulation be signed by November 16, 2011. This timetable will only allow minimal (1-2) runs for new emissions inventories
- EPA will check TRI screens for coal ash tailings as potential sources of fish concentration of mercury.
- Designation of a hazard quotient (HQ) as greater than one was a risk management decision. Exposures 1.5 times the reference dose (RfD) to get  $HQ > 1$ .
- EPA's base case inventory includes promulgated rules but not attainment strategies for State Implementation Strategies not approved, uncertainties about local controls, or global changes. EPA's focus is on clearly identifying the EGU fraction. The delta for the "denominator for total emissions does not matter so much."
- Natural emissions from forest fires are included in the CMAQ model. The model, however, does not re-suspend mercury that has been deposited.
- EPA acknowledged that a quadrant analysis that allows a comparison of the variability from fish tissues and variability in EGU depositions could be useful.

### Purpose and Scope of the Analysis

*Charge question 1: Please comment on the scientific credibility of the overall design of the mercury risk assessment as an approach to characterize human health exposure and risk associated with U.S. EGU mercury emissions (with a focus on those more highly exposed).*

Lead discussants identified before the meeting began the discussion with their preliminary comments. Dr. David Allen, the first lead discussant, reframed charge question 1 as "did you pick the right model, did you interpret model results correctly, was the integration with other models appropriate?" He stated that the approach examines maximally exposed individuals. The report is designed to identify populations at risks, not to estimate the size and magnitude of exposures. EPA used state-of-the-science air quality models. He noted that the level of documentation supporting the analysis should be expanded, but that the overall framework was scientifically credible. From an air quality modeling perspective, his special expertise, CMAQ can effectively handle deposition from the source categories of interest.

The second lead discussant, Dr. Hillary Carpenter, expressed the view that the proposed approach was credible and used standard risk assessment practices. It was appropriate to use the RfD and focus on the highest exposures to identify highly exposed populations. He noted the public health benefit of removing mercury from the food chain.

The third lead discussant, Dr. Jana Milford, supported the statements of Drs. Allen and Carpenter. In addition, she stated that the first section of the draft *Technical Support Document* should be revised to communicate the very limited focus of the analysis on a limited set of watersheds with data available to characterize high exposures, so that readers would not expect a nationally scoped risk assessment. Although the policy questions were broad, the design of the analysis is narrow. It should explain more effectively why the document excludes analysis of

coastal, fish-farmed, and commercially sourced fish. The document also needs to clarify more clearly the emissions reductions included as the analysis compares data from 2005 and 2016.

Dr. Eric Smith, the fourth lead discussant, expressed the view that the overall design was reasonable and credible, and succeeded in bringing together a variety of data collected for different purposes. He commended the Agency with for integrating data on fish consumption and air deposition and for using the RfD and HQ as a benchmark. The weakest link in the analysis, in his view, related to the use of Intelligence Quotient (IQ) methods and measures. EPA's use of percentiles in the draft document was acceptable. He expressed concern, however, over the large number of watersheds where the number of fish tissues sampled equals one. Most sample sizes are of size 1 and the median is 2. He generated the figures below

*Figures 1. Sample size plot for lakes and rivers using the Excel data provided to the panel. The results do not exactly match those in the report because there may be some slight differences in the data. There is clear evidence of a very high proportion of samples with only one fish (analysis provided by Eric Smith).*

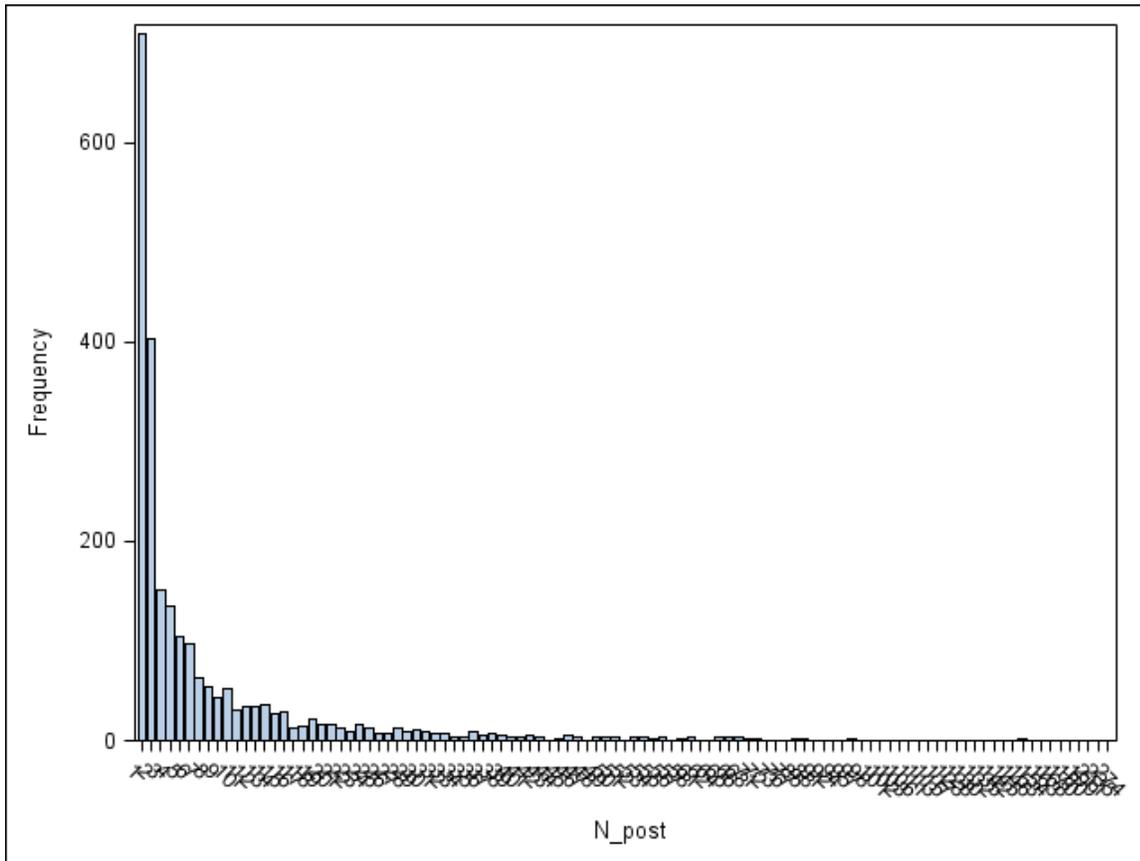
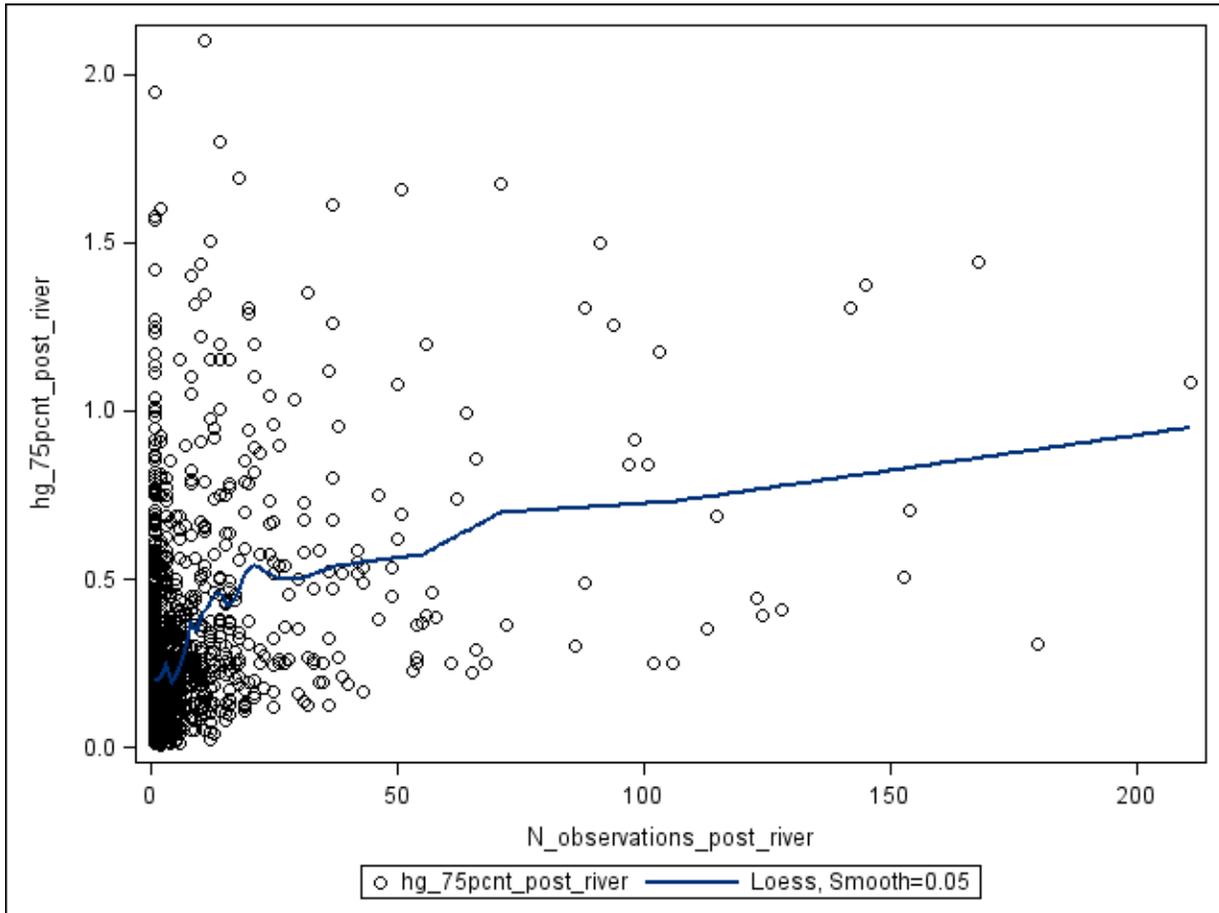


Figure 2: Comparison of Hg concentrations in fish as it relates to sample size in river and lakes combined. The estimate of the 75th percentile in the post period tends to increase with sample size. The fitted curve is based on a loess smoother with smoothing parameter 0.05. The curve is based on the values in the Excel file that was provided to the panel (analysis provided by Eric Smith).



The scatter plot suggests that the fish tissue dataset used by the Agency introduces a bias in the data, since as the number of observations increases, the 75% increases. EPA should develop another way to characterize the data and deal with the large number of watersheds where the sample size equals one.

Dr. Miriam Diamond, the fifth lead discussant, stated that the conceptual approach and simplifications in the document were reasonable. In her view, the weak links were emissions inventories for sources other than EGUs, the proportionality assumption for all waterbodies, and the assumption that present climate data will persist.

Other panel members also provided their comments.

- One member strongly suggested that EPA identify its sampling design as an uncertainty for the study.
- Another member noted that the Mercury Experiment to Assess Atmospheric Loadings in Canada and the US (METAALICUS) study results, not fully published, upholds the assumptions that mercury in fish tissue was proportional to mercury loadings in waterbodies.
- Panel members agreed that the background information presented by Dr. Pekar should be included in a revised *Technical Support Document*.
- EPA should provide additional information about consumption data for sport fishermen. Adding this group would expand the affected population and add uncertainty to the target population. Panelists also noted that it is not clear that adding this target group would expand the watersheds of concern.
- Panelists agreed that the document should communicate more clearly that the analytical output is watersheds where populations are at risk, not individuals at risk.
- A panelist noted that the document should communicate more clearly that a key issue is mercury in excess of selenium and the relationship of that ratio to risk.

In response to several panelists' comments that it would be desirable to indicate the numbers or proportions of populations in watersheds who were at risk, EPA representatives noted that their analysis is limited because they do not know the proportion of the target population that engages in subsistence fishing. The target group is difficult to study.

After the conclusion of the discussion, the chair summarized the panel's comments. The panel agreed that the approach was scientifically credible and used state-of-the-art approaches. The panel, however, had several concerns about the ways data were being used. The technical support document should be revised to explain the analytical approach more effectively. The document should state the desirability to express results not just in terms of watersheds, but in terms of individuals affected, but the lack of current ability to do so, given current lack of data and knowledge.

### Overview of Risk Metrics and the Risk Characterization Framework

*Charge question 2: Are there any additional critical health endpoint(s) besides IQ loss which could be quantitatively estimated with a reasonable degree of confidence to supplement the*

*mercury risk assessment (see section 1.2 of the Mercury Risk TSD for an overview of the risk metrics used in the risk assessment)?*

Dr. Thomas Burbacher, the first lead discussant, stated that the use of IQ was the weakest part of the risk assessment. The document overall provides a confused message about IQ and take focus away from the number of watersheds above the HQ. He stated that the draft report's comparison of mercury to lead concerning IQ was not appropriate.

Dr. Burbacher suggested other endpoints that could be used. He noted that data from the Faroe Island and New Zealand suggested that some of the subtest, such as the Boston Naming Test< that are components of the IQ metric have been found to be more sensitive to mercury than IQ overall.

Dr. M. Christopher Newland, the second lead discussant, agreed that other indicators can be used. Studies from Faroe Island have quantified delays associated with domain-specific tests, such as three-to-five month developmental delays. He also considered the use of IQ in the *Technical Support Document* as ambiguous. If it is meant to be a quantitative measure with a gradient, it is used in the report as a benchmark, "almost all or nothing measure." Drs. Burbacher and Newland agreed that there was no established level of developmental loss and, as a result, these alternative measures would be difficult to use in EPA's analysis.

Dr. Nicholas Ralston, the third lead reviewer, provided comments related to mercury and selenium that the panel wished to consider in the context of responding to charge question 11.

Dr. Alan Stern, the fourth lead reviewer, agreed with the characterization of problems using IQ measurements. He asked whether EPA intended to monetize neurotoxicological impacts based on the Technical Support Document. EPA representatives responded that they did not plan to use the document for this purpose.

Dr. Stern noted that the Grandjean 2007 report provides calculations of adverse impacts of methylmercury exposure in terms of the change in age related to those developmental impacts.

Other panel members provided their comments. One member noted that the van Wijngaarden 2006 paper provides 26 alternatives to IQ, but none of those offer add benefit to the use of the RfD and only potentially "opens up criticisms of the RfD."

Panel member agreed that some other potential endpoints were described in the literature but none provided a usable alternative for EPA's *Technical Support Document*.

*- Charge question 3: Please comment on the benchmark used for identifying a potentially significant public health impact in the context of interpreting the IQ loss risk metric (i.e., an IQ loss of 1 to 2 points or more representing a potential public health hazard). Is there any scientifically credible alternate decrement in IQ that should be considered as a benchmark to guide interpretation of the IQ risk estimates (see section 1.2 of the Mercury Risk TSD for additional detail on the benchmark used for interpreting the IQ loss estimates)?*

The same lead discussants addressed this question. They all agreed that IQ is a poor measure and should not be used. Although EPA cites a report to EPA from David Bellinger that makes strong case that a loss of one to two IQ points is a reasonable value, EPA has not made a strong case that use of IQ is appropriate for the *Technical Support Document*.

#### Specifying the spatial scale of watersheds

*- Charge question 4: Please comment on the spatial scale used in defining watersheds that formed the basis for risk estimates generated for the analysis (i.e., use of 12-digit hydrologic unit code classification). To what extent do HUC12 watersheds capture the appropriate level of spatial resolution in the relationship between changes in mercury deposition and changes in MeHg fish tissue levels? (see section 1.3 and Appendix A of the Mercury Risk TSD for additional detail on specifying the spatial scale of watersheds used in the analysis).*

Dr. James Hurley, the first lead reviewer, stated that the *Technical Support Document* use of a Hydrologic Unit Code (HUC)12 scale, which is more appropriate for watershed-level analysis and compatible with CMAQ. This scale, smaller than HUC10 scale used in EPA's previous mercury analyses, is also used in METAALICUS. He suggested that the report be revised to include diagrams explaining how CMAQ information is interpolated at the watershed level. He also suggested that the report include a table describing the distribution of rivers and lakes across watersheds and a clearer discussion of the links between fish samples and mercury deposition.

He noted that in the future, EPA might be able to use the Mercury Maps approach to better understand methylation and to design monitoring studies.

Dr. David Krabbenhoft, the second lead reviewer, noted that he had peer reviewed Mercury Maps and had criticized its use at the HUC8 scale. He found it valid, however, to use Mercury Maps approach at the HUC12 scale. At the smaller scale there is less landscape variability and less likely variation in fish type and fish tissue. Changes in deposition across a HUC12 watershed would be unlikely. Although there is still a possibility for "small pockets of lakes" within a single HUC12 to each have different characteristics, major differences across a HUC12 are unlikely.

Dr. Edward Swain, the third lead reviewer, agreed that use of HUC12s is quite appropriate, especially for analysis of EGU emissions.

Other panelists also provide comment. They noted that smaller hydrologic units had one major drawback; the smaller the unit, the smaller the number of fish likely to be sampled and there might be a bias towards smaller fish. A panelist noted that most of the databases used were developed for fish consumption advisories and were unlikely to "grab" small fish

The panel chair noted that the panel generally supported the HUC12 approach with the caveat that EPA should describe its possible impact on fish tissue statistics.

#### Characterizing measured fish tissue Hg concentrations

*- Charge question 5: Please comment on the extent to which the fish tissue data used as the basis for the risk assessment are appropriate and sufficient given the goals of the analysis. Please comment on the extent to which focusing on data from the period after 1999 increases confidence that the fish tissue data used are more likely to reflect more contemporaneous patterns of mercury deposition and less likely to reflect earlier patterns of mercury deposition. Are there any additional sources of fish tissue MeHg data that would be appropriate for inclusion in the risk assessment?*

Dr. Celia Chen, the first lead reviewer, stated that use of this kind of fish tissue data is appropriate and that the use of monitored fish tissue information is strength of the analysis. She listed some concerns that should be addressed related to the characterization of the data. She advised EPA to clearly identify the limitations of its small sample size and to describe the types of fish analyzed to the extent possible. She noted that some earlier data sets exist and could be used (Pennsylvania has data from 1997; the MercNet database), but that many data quality issues arise related to any potential use of these earlier data. She advised EPA to provide a better explanation of how fish data were culled and handled in revisions of the *Technical Support Document*.

Dr. Charles T. Driscoll, the second lead reviewer, commented that he has tried to extrapolate fish concentration data from land attributes and recognizes the difficulties currently with such an approach. Such modeling may be appropriate in the future to expand data sets. In general, he agreed with Dr. Chen that EPA's approach was reasonable. He encouraged EPA to make some additional effort to extract data for states with high EGU contributions; omitting discussion of fish tissue concentrations for Pennsylvania watersheds is a big gap.

Dr. Stephen L. Rathbun, the third lead reviewer, commented that the sample watersheds are likely to have a higher proportion of deposition than U.S. watersheds generally, since data come from fish tissue databases developed for fish consumption advisories. He recommended that EPA be consistent in characterizing its assessment as an analysis of watersheds with available data and not over generalizing.

Other panelists provided comments. Several emphasized the complexities of combining additional older datasets and the uncertain value of the added information. The panel agreed that since mercury responses in fish tissues change quickly, it is appropriate for EPA to focus on fish tissue data since 1999.

*- Charge question 6: Given the stated goal of estimating potential risks to highly exposed populations, please comment on the use of the 75th percentile fish tissue MeHg value (reflecting targeting of larger but not the largest fish for subsistence consumption) as the basis for estimating risk at each watershed. Are there scientifically credible alternatives to use of the 75th percentile in representing potential population exposures at the watershed level?*

Dr. James Burch, the first lead discussant, stated that the 75<sup>th</sup> percentile fish tissue value is reasonable and can be supported by published and unpublished studies on fish consumption. The panel had already discussed the limitations of the 75<sup>th</sup> percentile related to small sample size. In

his view, there is no reasonable alternative approach, since there is no national sample of fish tissue data that could be considered.

Dr. Robert Wright, the second lead discussant, expressed concern about the small number of fish tissue samples and possible distortions in the data introduced by considering a large number of samples of a single fish tissue as representing the 75<sup>th</sup> percentile.

Dr. Edwin van Wijngaarden, the third lead discussant, suggested that EPA provide information about two other percentiles (e.g., 60% and 90%) to give balance to its discussion of the 75<sup>th</sup> percentile. He also suggested that EPA conduct a sensitivity analysis limited to the watershed where there is a reasonable sample size.

Other panel members provided comment. Several members recommended against conducting a sensitivity analysis and instead advised EPA to describe its data limitations, providing a table showing a range of values. Members emphasized the importance of cataloguing potential biases, their direction, and magnitude, if possible. Regarding fish tissue data, biases may cancel out. The limited number of samples for many watersheds may point to collection of smaller fish and so the 75% estimate may be conservative, but if the data come from state fish advisory databases, the fish collected may be of a size and type people are likely to eat.

EPA representatives noted that it will be difficult to characterize the types and sizes of fish sampled because the data come from many different state databases.

The panel chair summarized the overall panel response. Where EPA has data to generate a 75<sup>th</sup> percentile, the number is reasonable. There is no more credible alternative. EPA should provide a clearer description of the nature of the fish tissue data available at the watershed level.

#### Defining subsistence fisher scenarios

*- Charge question 7: Please comment on the extent to which characterization of consumption rates and the potential location for fishing activity for high-end self-caught fish consuming populations modeled in the analysis are supported by the available study data cited in the Mercury Risk TSD. In addition, please comment on the extent to which consumption rates documented in Section 1.3 and in Appendix C of the Mercury Risk TSD provide appropriate representation of high-end fish consumption by the subsistence population scenarios used in modeling exposures and risk. Are there additional data on consumption behavior in subsistence populations active at inland freshwater water bodies within the continental U.S.?*

Dr. James Burch, the first lead discussant, stated that fish consumption rates described in the *Technical Support Document* are appropriate. The rates used are documented in Appendix C and are consistent with rates described in the literature and reasonable compared with consumption rates of high-end sports fishers. EPA's analysis adequately captures the limited existing literature and used it appropriately.

Dr. Robert Wright, the second lead discussant, agreed that the characterization of consumption rates was reasonable and that the table on page 81 was useful, thorough, and well done.

Dr. Edwin van Wijngaarden, the third lead discussant, stated that he was not aware of any other studies that should be included. He asked EPA to make several changes to the document. EPA should cite the Burger (2002) study, rather than Burger et al. Table C-1 should acknowledge the median intake was 11.6, not 39.

Other panel members provided comment. One member advised the Agency to characterize more fully the limits of studies available on subsistence fishers' consumption rates. EPA should provide more data on variations in seasonal fish consumption rates and on tribal consumption.

*- Charge question 8: Please comment on the approach used in the risk assessment of assuming that a high-end fish consuming population could be active at a watershed if the "source population" for that fishing population is associated with that watershed (e.g. at least 25 individuals of that population are present in a U.S. Census tract intersecting that watershed). Please identify any additional alternative approaches for identifying the potential for population exposures in watersheds and the strengths and limitations associated with these alternative approaches (additional detail on how EPA assessed where specific high-consuming fisher populations might be active is provided in section 1.3 and Appendix C of the Mercury Risk TSD).*

Dr. James Burch, the first lead discussant, noted that little information exists on subsistence fishing populations. He noted that EPA most likely did not exclude many census tracts because most census tracts contain at least 25 low-income individuals in EPA's population of interest and that EPA's approach was reasonable. He advised EPA to provide information about the number of census tracts excluded. An EPA representative commented that it lacked information about the prevalence of subsistence fishing and self-caught fish consumption within the populations of interest.

Dr. Robert Wright, the second lead discussant, agreed that the approach was reasonable and noted that census data are difficult to interpret because people do not identify their ethnicity in a standard way.

Dr. Edwin van Wijngaarden, the third lead discussant, also agreed that the approach was reasonable. He also suggested that EPA might focus attention on watersheds not only containing at least 25 individuals below a specific poverty level but also watersheds where a high proportion of the population is poor. Such watersheds may be locales where self-caught fish consumption is more prevalent.

#### Instructions before the panel recessed on June 15, 2011

The chair asked lead discussants to collaborate and develop draft written responses to the charge questions that incorporated the panel discussion during the public session. He asked panel members to begin each response with a concise answer to the charge question, followed by explanation and rationale.

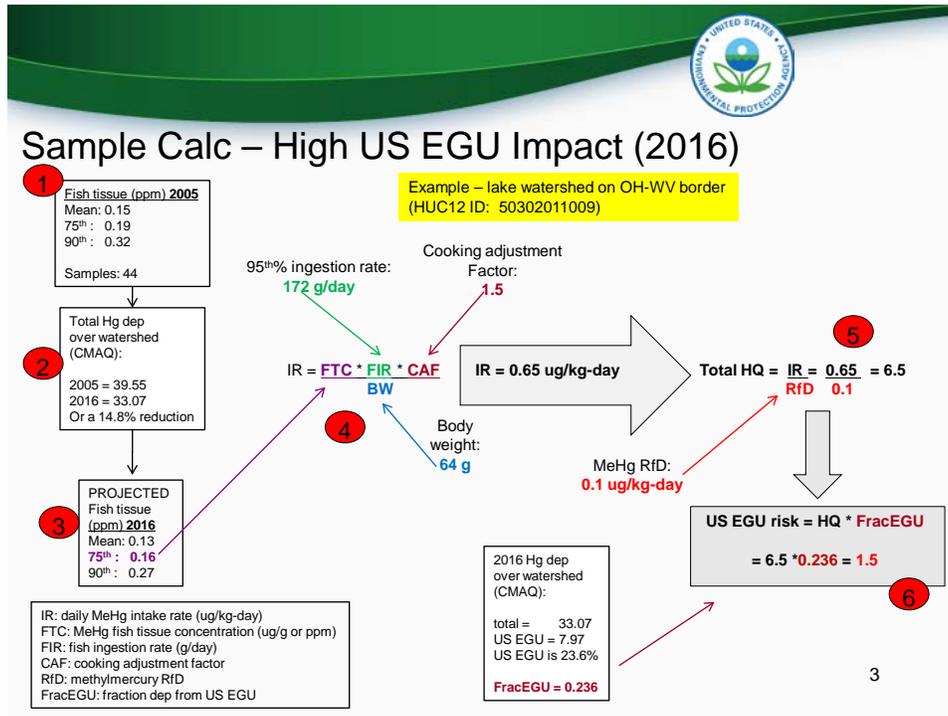
The meeting recessed at 5:00 p.m.

June 15, 2011

The DFO reconvened the meeting at 8:30 a.m.

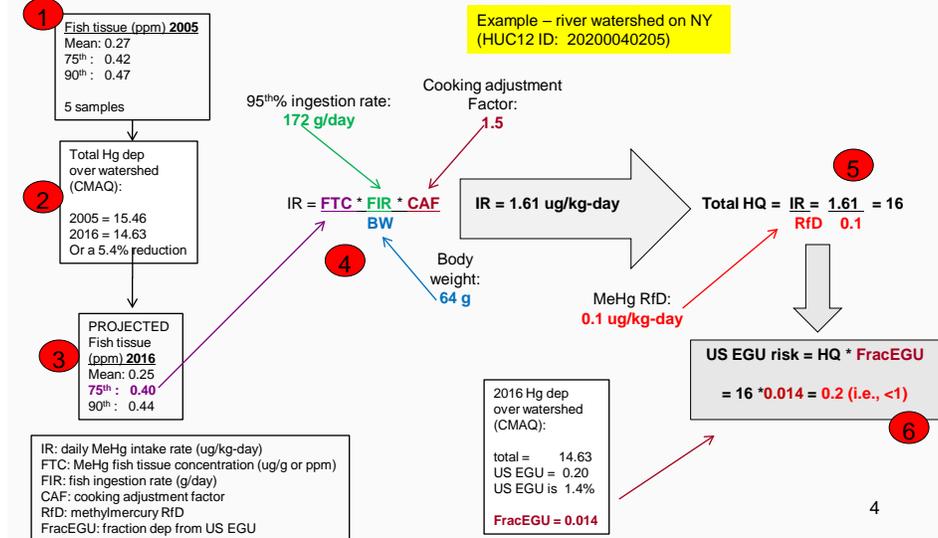
EPA presentation of an example risk calculation at the watershed level

The meeting departed from the agenda at the start of the day's session because the panel received a presentation, at their request, describing how EPA derived risk calculations at the watershed level. Dr. Zachary Pekar provided the two slides below and responded to panel members' questions.





## Sample Calc – Low US EGU Impact (2016)



Dr. Pekar and Dr. Bryan Hubbell made the following points in response to panel members' questions:

- EPA has used the cooking adjustment factor employed in the *Technical Support Document* in Superfund risk assessments and in the 2005 mercury analysis
- EPA used the consumption rate reported in the literature for each target population to develop the analysis for that population
- Zach – used consumption rate re: meal size...EPA will review the three different subsistence scenarios used and check that consumption rates are accurate and reflect available information about seasonality of consumption.
- EPA based its assumption of linear proportionality between mercury exposure and fish tissues on the Mercury Maps approach
- EPA used TRI to screen out watersheds with non-EGU sources contributing more than 25% of total mercury

After the presentation, panel members agreed that similar figures with a supporting narrative should be included in the *Technical Support Document*. The narrative should explain the source of data and the calculations involved in deriving 2016 fish tissue information. Members made several other points related to communication. One member advised EPA to use the term “hazard assessment” and “attributable hazard,” rather than “risk assessment” and “attributable risk,” because the document does not report risk results in terms of populations, as epidemiologists would expect. Another member recommended that EPA communicate more effectively the reductions of EGU emissions in terms of exposures reduced relative to the RfD. The panel also emphasized the important of communicating clearly that 2016 data represented projected fish tissue. Panel members also asked for column headings for Table 2-9 that are more accessible and understandable.

## Apportioning total MeHg exposure between total and U.S. EGU-attributable exposure

*- Charge question 9: Please comment on the draft risk assessment's characterization of the limitations and uncertainty associated with application of the Mercury Maps approach (including the assumption of proportionality between changes in mercury deposition over watersheds and associated changes in fish tissue MeHg levels) in the risk assessment. Please comment on how the output of CMAQ modeling has been integrated into the analysis to estimate changes in fish tissue MeHg levels and in the exposures and risks associated with the EGU-related fish tissue MeHg fraction (e.g., matching of spatial and temporal resolution between CMAQ modeling and HUC12 watersheds). Given the national scale of the analysis, are there recommended alternatives to the Mercury Maps approach that could have been used to link modeled estimates of mercury deposition to monitored MeHg fish tissue levels for all the watersheds evaluated? (additional detail on the Mercury Maps approach and its application in the risk assessment is presented in section 1.3 and Appendix E of the Mercury Risk TSD).*

Dr. Thomas Holsen, the first lead reviewer, stated that the Mercury Maps approach is an accepted peer-reviewed approach and the additional information from the METAALICUS study further supports the relationship between mercury exposure and fish tissues. The 12 km grid is a major improvement over the 36 km grid previously used, which missed many hot spots. The 12 km approach fits with field-based science. Although the state of Pennsylvania lacks data on fish tissue where large deposition is a major problem, he noted that he had no better suggestions for matching fish tissue with air deposition.

Dr. Leonard Levin, the second lead reviewer, noted that the Mercury Maps assumption was valid where all its criteria were met. If angler behavior changes, then the assumption may not be appropriate. It is important for EPA to use all existing literature to test these assumptions. He asked if EPA had considered using the steady state mercury-cycling model as an alternative to Mercury Maps. Dr. Levin also noted that the size of the cell was reasonable for wet and dry deposition analysis and mercury speciation. He asked if there was a potential mismatch of the distribution of divalent mercury by precipitation. He asked EPA to characterize more clearly the uncertainties associated with assessing current and future EGU emissions.

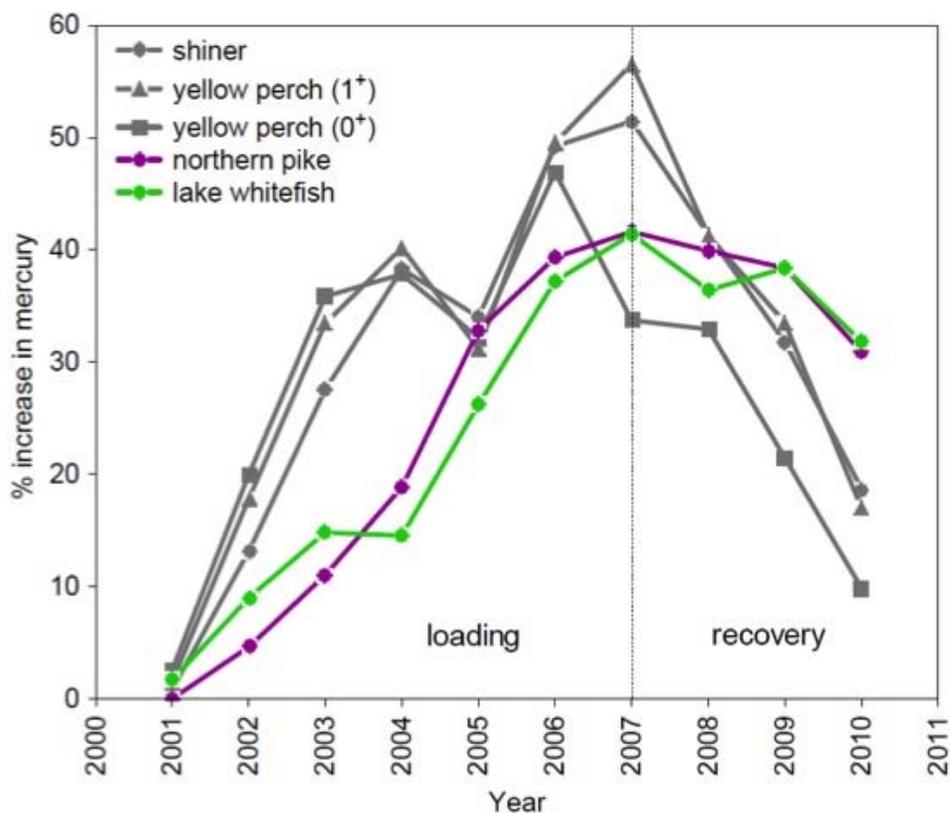
Dr. C. Jerry Lin, the third lead reviewer, noted that the report provides a good characterization of uncertainties and limitations of the data and modeling in qualitative terms. He recommended that the report provide a more complete report on the peer review of all component of the analysis and a quantitative assessment of uncertainty wherever possible. He also recommended that EPA devote more attention to discussion of hot spots that are not explained by the CMAQ modeling.

Other members of the Mercury Review Panel provided their comments. One member asked EPA to explain unusual patterns in the CMAQ data. She noted that CMAQ over predicted total wet deposition in the West, for example. She also noted that EPA's separate Air Quality Modeling Technical Support Document supporting the rulemaking had very limited performance data for mercury. Given the importance of emissions modeling for the *Technical Support*

Document: National-Scale Mercury Risk Assessment, CMAQ performance data should be more fully characterized.

Dr. Krabbenhoff provided field level data supporting the Mercury Maps assumption that, “all other things being equal,” proportionality should prevail. He reported briefly on the results of the METAALICUS study of an experimental lakes area that was dosed with isotopically labeled mercury. The report showed that mercury levels in fish varied directly with atmospheric dosages to the water body. He provided the following figure based on unpublished data gathered by the METAALICUS team.

### METAALICUS Fish Results: Loading and Recovery Phases



He noted that data from 2000-2004 had been published in the Harris et al. document cited in the *Technical Support Document* and that other published mesocosm-scale studies had shown proportionality and should be cited in the document. Other panel members supported the view that the METAALICUS analysis was representative of most water bodies.

The panel chair asked the lead discussants to summarize the panel’s response to question 9. They agreed that the Agency’s assumption of proportionality was well supported and the use of the Mercury Maps approach was solid. EPA had used a reasonable approach in screening out waterbodies where TRI emissions indicated significant deposition of mercury from other sources. EPA’s sensitivity analysis comparing effects on streams vs. lakes was appropriate. The

panel supported the use of HUC12 watersheds and shared a concern about lack of fish tissue data in Pennsylvania.

*- Charge question 10: Please comment on the EPA's approach of excluding watersheds with significant non-air loadings of mercury as a method to reduce uncertainty associated with application of the Mercury Maps approach. Are there additional criteria that should be considered in including or excluding watersheds?*

Dr. Thomas Holsen, the first lead discussant, supported EPA's approach. He commented that the approach was not "perfect" and might be improved by a sensitivity analysis excluding urban areas.

Dr. Leonard Levin, the second lead reviewer, agreed that the TRI approach was generally good. He suggested that EPA might also consider excluding watersheds affected by sanitary sewer runoff, but he agreed that people often ignore fish advisories that warn them away from fishing in contaminated areas.

Dr. C. Jerry Lin, the third lead reviewer, also agreed with EPA's approach. He asked other panelists whether EPA should consider excluding waterbodies with short retention times.

Other panel members provided comment. One member argued against excluding waterbodies with short retention times. EPA's reliance on empirical data identifies accumulation of mercury. Mercury bioaccumulation in fish tissue is measured and appropriately linked to waterbodies where the fish were caught.

Other members emphasized the importance of revising the document to provide more information on the watersheds excluded in the analysis and the criteria used to screen out watersheds at each step of the analysis.

#### Estimating risk including HQ and IQ loss

*- Charge question 11: Please comment on the specification of the concentration-response function used in modeling IQ loss. Please comment on whether EPA, as part of uncertainty characterization, should consider alternative concentration-response functions in addition to the model used in the risk assessment. Please comment on the extent to which available data and methods support a quantitative treatment of the potential masking effect of fish nutrients (e.g. omega-3 fatty acids and selenium) on the adverse neurological effects associated with mercury exposure, including IQ loss. (detail on the concentration-response function used in modeling IQ loss can be found in section 1.3 of the Mercury Risk TSD).*

Dr. Thomas Burbacher, the first lead discussant, noted that the concentration response function is derived from the Axelrad 2007 paper, as explained on page 25 of the *Technical Support Document*. Ingestion levels are converted to maternal hair level of mercury and neurotoxic effects as described in the Seychelles study. He stated that there are no other concentration-response functions for IQ that currently are ready to be used. He recommended, however, against the use of IQ because it was not the most sensitive outcome to consider.

He noted that there are ways to change the concentration-response function by taking into account the beneficial effects of fish nutrients and selenium. This research, however, is not sufficiently advanced to provide adequate support for EPA's *Technical Support Document*. He recommended that EPA strengthen its qualitative discussion of the uncertainties related to the beneficial effects of fish nutrients and selenium.

Dr. M. Christopher Newland, the second lead reviewer, stated that the animal literature suggests an important nonlinearity between neurotoxic effects and exposure to mercury and fish nutrients. If EPA does not provide a discussion of the masking effects of these nutrients, it could underestimate the potential impacts of mercury. It is important, however, to pay attention to critical periods for neurotoxicity. Although selenium shows a protective effect for adult mercury toxicity, it does not confer protection for developmental exposures.

Dr. Nicholas Ralston, the third lead reviewer, noted that for freshwater fish, masking effects from fish nutrients is most relevant to larger fish and that research on the cellular level has revealed the importance of selenium's role in protecting against mercury toxicity at the cellular level. He emphasized the extraordinary sensitivity of the fetus to mercury toxicity and the need to consider the ratio of mercury to selenium in assessing toxic effects.

Dr. Alan Stern, the fourth lead reviewer, stated that the only alternative to the use of IQ was to consider developmental delays, but that the literature was not yet sufficiently developed to use in the *Technical Support Document*. In regard to the beneficial effects of fish nutrients and selenium, he stated that there was insufficient literature to support the view that omega 3 fatty acids and selenium consistently provides protection from adverse mercury effects.

Other panel members provided comment. One member emphasized the lack of clear epidemiology literature on selenium-mercury interactions. Another member agreed and stated that EPA should acknowledge the Seychelles study on this point. He also noted that Appendix table F-2 should be corrected to show that outlier data were derived from the New Zealand study, rather than the Seychelles study and strengthen the narrative discussion of the epidemiology data in the body of the report.

Panel members agreed that EPA should not highlight IQ findings in the main body of the report, including the report's risk characterization framework and summary, because IQ is not a particularly good endpoint for methyl mercury. EPA should revise the document to develop a new appendix discussing its efforts to characterize IQ effects as one of several possible endpoints for future analysis, including developmental delays and the Boston Learning Test.

#### Discussion of key sources of uncertainty and variability

- *Charge question 12: Please comment on the degree to which key sources of uncertainty and variability associated with the risk assessment have been identified and the degree to which they are sufficiently characterized.*

Dr. David Allen, the first lead reviewer, noted that Appendix F provided a useful summary of variability related to spatial data, fish tissue, watersheds, and human response to mercury concentrations. He suggested that EPA also include additional sources of variability, such as

- Body weight for different target populations
- Cooking weight adjustment
- Year of meteorology vs. inter-annual changes
- Fishing patterns
- Ecosystem structure (re: Mercury Maps assumption of “all other things being equal”)
- Inter-annual changes in global CMAQ boundary conditions
- Potential alternative futures scenarios
- Overall emissions inventory
- Performance evaluation of CMAQ
- Size of the grid size chosen and the pros and cons of choosing larger and smaller grid sizes

Because the *Technical Support Document* is a screening-level analysis and provides sensitivity analyses for a few key sources of variability, there is no need for an overall quantitative uncertainty analysis.

Dr. Hillary Carpenter, the second lead reviewer, agreed that an overall quantitative uncertainty analysis was not needed for this screening-level study. He called for strengthening the discussion of the variability and uncertainties associated with the fish tissue database and identification of the biases associated with those uncertainties.

Dr. Miriam Diamond, the third lead reviewer, agreed with the previous two speakers. She made additional suggestions for topics to be included in Appendix F:

- Uncertainty of the TRI inventory
- Uncertainty of the non-TRI air inventory
- Excluded waters
- Impact of socio-economic status on vulnerability to mercury toxicity.

Dr. Jana Milford, the fourth lead reviewer, called for EPA to:

- better characterize CMAQ performance
- better characterize the representativeness of watersheds included in the study.
- discuss in more detail: the potential for fish tissue sampling bias
- better discuss the potential for the masking and beneficial effects of fish nutrients and provide additional citations; and
- discuss the exclusion of sport fishers.

The lead reviewers agreed that the *Technical Support Document* should be strengthened by better characterization of variabilities and uncertainties. EPA should include quantitative information, where available and identify the likely direction of bias.

Panel members agreed with the lead reviewers' comment and added the following suggestions:

- Discussion of seasonality and fish consumption

- EPA should describe its conclusion regarding the 99<sup>th</sup> percentile more fully and indicate this conclusion has high uncertainty

### Discussion of analytical results

- *Charge question 13: Please comment on the draft Mercury Risk TSD's discussion of analytical results for each component of the analysis. For each of the components below, please comment on the extent to which EPA's observations are supported by the analytical results presented and whether there is a sufficient characterization of uncertainty, variability, and data limitations, taking into account the models and data used.*

- *Charge question 13a - Mercury deposition from U.S. EGUs*

The lead reviewers agreed that it was difficult to tell the extent to which EPA's observations were supported by the analysis. Dr. Thomas Holsen, the first lead reviewer, noted that it was difficult to understand the 2016 scenario, as presented. Dr. Leonard Levin, the second lead reviewer, noted that there was insufficient description in the document on the modeling framework, inventory, and data specification. He called for more description of the one percent of watersheds that show risks of U.S. mercury emissions sufficient to exceed the risk criteria. Dr. C. Jerry Lin, the third lead reviewer, recommended more description of the CMAQ model runs, outputs, and uncertainty. He suggested that EPA provide information on the upper and lower bounds to give the reader sense of uncertainty.

Other panel members provided additional comment. One panelist noted that CMAQ deposition maps in the *Technical Support Document* look quite different from other deposition maps, especially for hot spots. He called on EPA to diagnose these differences. One example is Texas. Where mapping wet and dry deposition may allow quick testing of EPA hypothesis that hot spots may be related to precipitation patterns in CMAQ

- *Charge question 13b - Fish tissue methyl mercury concentrations*

Dr. Celia Chen, the first lead reviewer, recommended that EPA strengthen its discussion of analytical results related to fish data by presenting the kinds of fish collected and size of fish collected by watershed, because the scarce amount of fish tissue data makes it difficult to understand the size distribution of fish at different percentiles. Dr. Charles Driscoll, the second lead reviewer, agreed and called for a clearer description of fish tissue sampling for rivers and lakes. Dr. Stephen Rathbun, the third lead reviewer, advised EPA to better explain how the 2005 and 2016 data were derived. He noted that because of the sampling design, the top 10 percentile reflects bias from state databases. One lead reviewer had difficulty understanding how EPA's conclusions were supported by its data analysis because of problems with presentation of the fish tissue information. Other reviewers found that conclusions were supported by the analytical results.

Other panelists provided the following additional comments:

- Maps should include Alaska and Hawaii and also include western states

- EPA should take care that the *Technical Support Document* does not communicate that the “top 10% percentile” refers to population estimates, rather than watersheds where fish tissue data are available.
- Many but not all panelists recommended removing figures because they did not clearly support the analysis.

- *Charge question 13c - Patterns of Hg deposition with Hg fish tissue data*

Dr. James Hurley, the first lead reviewer, recommended a qualitative explanation of figures 2.15 and 2.16 and recommended that figure 2.17 be moved near the beginning of the document. Figure 2-17 is important to include early in the report because it illustrates that watershed characteristics influence fish tissue concentrations. The special relationship between watersheds and fish tissue provides a rationale for the analytical approach used by the Agency. He considered figure 2-18 an effective way to summarize patterns of mercury deposition compared to fish tissue data.

Dr. David Krabbenhoft, the second lead reviewer, suggested that EPA also discuss natural organic matter and wetlands in this section. He recommended that EPA revise the section to make the link between analytical results and observations more clear. Dr. Edward Swain, the third lead reviewer, stated that figures 2-15 and 2-16 and the related explanatory footnote made difficult to understand. He advised EPA to clarify the text in the important footnote and move it to the body of the text. He noted that figure 2-17 needed a clearer legend and clearer explanation. The document overall needs a better term for “75% fish tissue concentration.”

Other panel members made the following additional comments:

- Tables sometimes switch between mean and median and should be consistent.
- Figures 2-15 and 2-16 should show more clearly the areas where the “blue” waterbodies (waterbodies included in the analysis) and the “red” waterbodies (waterbodies with fish tissue analysis) overlap. The present mapping protocol obscures the presentation of different data layers.

- *Charge question 13d - Percentile risk estimates*

Dr. Hillary Carpenter, the first lead reviewer, recommended that EPA strengthen its discussion of variability in this section.

Dr. Jana Milford, the second lead reviewer, expressed concern that different estimates for high-end female consumers in different ethnic groups were difficult to understand. She recommended that EPA revise the text to discuss these differences and add an appendix that addresses localized effects of gold mines in South Carolina.

Dr. Eric Smith, the second lead reviewer, commended EPA for the clarity of this section. He found the use of percentile estimates valuable and liked EPA’s discussion of uncertainty. He thought the observations were well supported by the analytical results and variability and confidence were well characterized.

*- Charge question 13e - Number and frequency of watersheds with populations potentially at risk due to U.S. EGU mercury emissions*

Dr. James Burch, the first lead reviewer, suggested that EPA provide figures illustrating deposition on excluded watersheds, similar to figures 2.15 and 2.16. Information on the number of watersheds with no fish data will be needed to support the fourth bullet on page 63. He also suggested that discussion of sports fishers would enhance the discussion of populations potentially at risk. Drs. Robert Wright and Edwin van Wijngaarden, the other lead reviewers, stated that they had no concerns about this section and thought the analytical results supported EPA's observations. Dr. Wijngaarden suggested that EPA include in this section a sentence or two about actual impacts from the exposures identified.

Other panelists agreed. One mentioned that EPA should consistently change the language stating "less than 1% of waterbodies" to "less than 1% of fish-sampled watersheds" to communicate the scope and findings of the study more clearly.

*- Agency charge question 14: Please comment on the degree to which the final summary of key observations in Section 2.8 is supported by the analytical results presented. In addition, please comment on the degree to which the level of confidence and precision in the overall analysis is sufficient to support use of the risk characterization framework described on page 18.*

The panel found Agency charge question 14 unclear and decided to divide it into two charge questions:

*Question 14*

*Does section 2.8 respond to the goals of the study and does it encapsulate the critical issues and the significant results of the analysis?*

*Question 15*

*Despite the uncertainties identified, is there sufficient confidence in the analysis for it to determine whether mercury emissions from U.S. EGUs represent a potential public health hazard for the group of fish consumers likely to experience the highest risk attributable to U.S. EGU?*

In regard to new charge question 14, Dr. David Allen, the first lead reviewer, stated that Section 2.8 does summarize the critical issues and significant results of the analysis. Indeed, each one of these findings was extracted from an earlier section of the report and will need to be updated as the report is revised.

Dr. Hillary Carpenter, the second lead reviewer, recommended that text be revised to reflect EPA's decision regarding IQ. If IQ decrements are not included as a critical result, discussion should be removed. EPA should add a discussion of the importance of the use of measured fish tissue data because of the difficulty modeling fish tissue from watershed conditions. Section 2-8 should also be revised to clearly communicate that the analysis focuses on watersheds at risk, rather than population estimates.

Dr. Miriam Diamond, the third lead reviewer, recommended that EPA revise section 2.8 so that it clearly addresses the policy-relevant questions on page 13 of the *Technical Support Document*. Section 2-8 should be short and focused. It should emphasize the importance of the proportionality assumption. If mercury decreases from EGUs, mercury in fish tissues will decrease, and mercury risks from material fish consumption will decline.

Dr. Eric Smith, the fourth lead reviewer, commented that the paragraph on IQ in section 2.8 was difficult to understand. He advised EPA to reframe the reference to “99<sup>th</sup> % watershed” and “99<sup>th</sup> percentile watershed” in the first two bullets on page 63 as a range of values, because of uncertainties associated with the 99<sup>th</sup> percentile. He also suggested that EPA take care in communicating its results as “national-level” results because the limitations of the available data. He also advised EPA to change the language in the second bullet on page 64 and use a more precise term than “a significant majority of those watersheds.”

Dr. Jana Milford, the fifth lead reviewer, stated that the analysis addressed the objective in a credible manner. She suggested however that EPA revise the document to indicate that it was unlikely that all reductions will happen by 2016 and suggested that the first bullet be revised to reflect this uncertainty.

After panel discussion, the chair summarized the panel’s general response to the new charge question 14 as follows. The fundamental conclusions and the analytical choices in the study are reasonable and appropriate. The analysis has uncertainties that cut different ways. There is a significant public health hazard associated with EGU emissions of mercury supported by EPA’s screening level assessment.

In regard to the new charge question 15, the panel members agreed on the following response: “Notwithstanding the uncertainties inherent in this analysis, the TSD, subject to the recommendations of the panel, makes an objective, reasonable and credible determination of the potential for a public health hazard from mercury emitted from U.S. EGUs.”

#### Other issues

The panel identified and discussed other topics that did not relate directly to the charge questions, for possible inclusion in the report:

- Appendix G is not necessary. It should be deleted and source data brought into the main body of the report, along with additional source characterization.
- The report might be better characterized as a “hazard assessment” rather than as a “risk assessment,” because the report does not report population risks.
- EPA should provide more extended discussion that some types of susceptible populations, such as source fishermen, may not be included in the analysis.
- The introduction should briefly describe potential risks not included in the analysis. It should highlight that the focus on public health does not include discussion of ecological risk.

- The panel’s draft report should commend the Agency for its efforts to conduct an innovative, cross-media analysis addressing air deposition to waterbodies.

Instructions to the panel

The chair asked the lead discussants to prepare draft text that would capture the overall panel’s response to the charge questions assigned to their group. He asked them to send draft text to the DFO by 11 p.m.

The meeting recessed for the day at 5:00 p.m.

**June 17, 2010**

The meeting reconvened at 8:30 p.m.

Panel discussion of draft responses

The DFO distributed a compilation of draft responses developed by panel members on June 16, 2011.<sup>910</sup> The panel discussed the draft responses and the discussions were documented in a “track-change” version of the document.<sup>11</sup>

Summary and next steps

The panel chair asked lead discussants to complete revisions to the draft text based on the “track-change” version of the document, which the DFO distributed immediately after the meeting

The chair and DFO thanked panel members for their participation and the Designated Federal Officer adjourned the meeting at 3:15 p.m.

Respectfully Submitted:

Certified as True:

*/Signed/*

*/Signed/*

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Dr. Angela Nugent  
SAB DFO

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Dr. Stephen M. Roberts  
Chair, SAB Mercury Review Panel

## **Appendix A**

### **Members of the Public Participating in the Meeting or Who Requested Teleconference Access Information**

Kirk Baker, EPA  
Charlotte Bertrand, EPA  
Amanda Curry Brown, EPA  
Greg Carter, ICF, International  
Matthew Davis, EPA  
Stan Durkee, EPA  
Maria Hegstad, Inside EPA  
Mary Houyoux, EPA  
John J. Jansen, Southern Company  
Allison Jenkins, Texas Commission on Environmental Quality  
Amy Lanson, EPA  
Tom Perry, National Mining  
Cathy Rimer, EPA  
Mary Ross, EPA  
Greg Schaefer, Arch Col, Inc.  
Rita Schoeny, EPA  
Madeline Strum, EPA  
Avun Varghese, ICF International

## Materials Cited

The following meeting materials are available on the SAB Web site, <http://www.epa.gov/sab>, at the page for the [June 15-17, 2011](#) meeting: <http://yosemite.epa.gov/sab/sabproduct.nsf/a84bfee16cc358ad85256ccd006b0b4b/4a60092a413f56608525783f0050f148!OpenDocument&Date=2011-06-15>

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<sup>1</sup> Roster of the SAB Mercury Review Panel

<sup>2</sup> *Technical Support Document: National-Scale Mercury Risk Assessment Supporting the Appropriate and Necessary Finding for Coal and Oil-Fired Electric Generating Units - March 2011 Draft*

<sup>3</sup> Agenda

<sup>4</sup> Comments from Willie Soon

<sup>5</sup> Email from Juan Ramirez, June 14, 2011

<sup>6</sup> Charge for Mercury Risk Assessment

<sup>7</sup> Statutory and Regulatory Background Related to the Appropriate and Necessary Finding, Presentation by Lydia Wegman.

<sup>8</sup> Overview of the National-Scale Mercury Risk Assessment by Zachary Pekar

<sup>9</sup> Draft initial response to charge questions for discussion on June 16, 2011.

<sup>10</sup> Preliminary draft response to charge question 13

<sup>11</sup> Track-change version of draft panel responses to charge questions - reflecting discussions on June 17, 2011