ILLINOIS POLLUTION CONTROL BOARD
June 16, 2006

IN THE MATTER OF	)
	)
PROPOSED NEW 35 ILL ADM. CODE 225 CONTROL OF EMISSIONS FROM LARGE COMBUSTION SOURCES (MERCURY)	) R06-25) (Rulemaking - Air))

TESTIMONY OF DR. GERALD KEELER
PART II

BEFORE MARIE E. TIPSORD
HEARING OFFICER

The testimony of Dr. Gerald Keeler, a witness called in the rulemaking proceeding before the Illinois Pollution Control Board taken on June 16, 2006, at 9:00 a.m., at the offices of the Environmental Protection Agency, Springfield, Illinois, before Holly A. Schmid, Notary Public and Certified Shorthand Reporter, CSR No. 084-98-254587 for the State of Illinois.

A P P E A R A N C E S

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MADAM HEARING OFFICER: Good morning, everyone. Welcome back. This is day five, and we're making some good progress.

My name is Maria Tipsord. I'm the hearing officer in this proceeding in No. RO6-25. My opening will be fairly truncated, since I don't see any new faces.

I just want to introduce the panel to you today. Board member Dr. G. Tanner Girard; Board Member Anand Rao; the far right Nicholas Melas. To my far left, Tom Johnson, also a board member. Our technical unit today is represented by Anand Rao. Tim Fox is with us again today, and Matt Reed is joining us today with the board staff.

Before we go back to Dr. Keeler's testimony, Mr. Rieser, I believe you were going to have some exhibits for me this morning.

MR. RIESER: Why, yes, I do. We have copies of the preliminary results of Steubenville. I'm giving one to Mr. Harley, right off the bat, "The Preliminary Results for Steubenville Mercury Deposition Source Apportionment Study" from Tim Opelt, April 27, 2005. I don't recall what number you have that at.

MADAM HEARING OFFICER: We're going to

mark that as Exhibit 29, if there's no objection. Seeing none, that will be Exhibit 29.

(Exhibit 29 was admitted.)

MR. RIESER: Then the second one is "The Ambient Measurements to Support Coal Combustion Emission Research" October 21, Beijing, China presented by Matthew S. Landis, 2005. Again, we are presenting a copy to Mr. Harley. We'll mark that as Exhibit No. 30, if there's no objection. Seeing none, we will mark that as Exhibit No. 30.

(Exhibit 30 was admitted.)

MS. BASSI: What was 29?

MADAM HEARING OFFICER: 29 is the preliminary results. And "The Ambient Measurement" is the title page on the second one. That will be Exhibit 30. Thirty is the Beijing study; 29 is the U.S. EPA preliminary. Have we got the exhibits straightened out? Has everybody got 29 and 30? I believe we are ready to start with Question No. 10 for Dr. Keeler.

DR. KEELER: Question No. 10: "In using the source-receptor approach to determine the source of wet deposition mercury, is it accurate that you determine the source by analyzing for other constituents associated with those sources? A, does

that analysis demonstrate the proximity of those sources? B: Does this analysis differentiate among different types of coal used?" I assume you're asking source receptor modeling approach not -- in using the source-receptor approach.

MR. RIESER: Correct.

DR. KEELER: If you're referring to the multivarious statistical analysis approach, it does not demonstrate the proximity of the sources, so the answer to A is no. If you're asking about the combined hybrid receptor modeling approach, the answer is yes, so just to differentiate --

MR. RIESER CONTINUES:

Q. Just for the record I note that the term source-receptor study is the one that you used in your testimony. For example, in this second paragraph of the conclusion, we talked about, on page 5, that says, "Source receptor studies have recently been completed that indicate the coal-fired utilities contributed, approximately, 70 percent of the mercury," so it wasn't a term I made up. It was something that I thought I took directly from your testimony.

A. Right. All the methods that we use are looking for source-receptor relationships, and I was

just asking a clarifying question. That's all. It's a correct use of the term.

Q. Thank you.

DR. KEELER: Question No. 11 -- just so it's clear, B, the answer was no. "In your testimony, you state that coal combustion was clearly dominant, in terms of explaining the mercury deposition, approximately, 70 percent. What is the basis for this figure?" Do you want me to answer this again?

MR. RIESER: Yes, please.

DR. KEELER: This was the average of the results of the PMF and the Unmixed models.

MR. RIESER CONTINUES:

Q. Of the two years, correct?

A. For the two years.

Q. 2003 and 2004?

A. Right, for the two-year combined analysis.

Q. There were differences in meteorology between the two years, were there not?

A. Yes, there was. I said the deposition was quite different between the two years.

Q. And in 2004, if I recall your testimony, was dominated by four major precipitation events. Is that correct?

A. Actually, I don't recall saying four, but if that's what I said.

Q. I think you said "several" I'm sorry, but it was dominated by several large precipitation events?

A. Yes, that's correct.

Q. And in what way was it dominated by those events?

A. Those were very large deposition totals relative to the total amount for the entire year.

Q. And what does that mean with respect to your findings, if any?

A. Well, in one respect what it means is that for a model, such as a deterministic model, if a missed accurately calculating the deposition for that one event, it will significantly alter their source-receptor relationship and the ultimate approportionment of whatever came from whatever source.

Q. I'm sorry. What does its mean for the findings of the receptor study, the one you performed?

A. Not much. I mean, it's just another example. I was highlighting the fact that it can have a few single events that can lead to very large deposition, and it's important in a sense of if one is trying to compare the results of a CMAQ or TEAM, or that

type of a model to a receptor modeling that those single events are very, very important, in terms of the overall deposition to that location for the entire year, and so not accurately predicting them is a major error, so that was the purpose in my presentations and in my comment.

Q. Does it also suggest that source-receptor done in a year with -- let me ask this, did you consider -- and I do see in your testimony it's "a few large precipitation events," I'm sorry. Is it your belief that these large precipitation events were unusual with the relationship to the typical weather in Steubenville?

A. They are not unusual in the sense that we see these large events, typically at every site that we measure. The sites in Michigan, the sites in Vermont, the sites in Florida, we'll see a couple of very large events that contribute a fairly large percentage of the total deposition in all the sites that we make measurements at.

Q. Is it accurate that several of these precipitation events you observed in Steubenville were results of hurricanes that came up from the Gulf of Mexico?

A. Two of the events were the result of cyclones that came up from the Gulf. They were the

remnants of hurricanes and provided very large amounts of precipitation.

Q. Had you done the study in 2004, and only had the 2004 data, would that have skewed the data higher than the usual data that you would see for Steubenville because of the large precipitation events?

A. No.

Q. In what way would it not?

A. It turns out that, for those large precipitation events, the source-receptor model underestimated the total deposition for those events, and in fact, underestimates them quite a bit. Extreme events in statistical analyses tend to be smoothed out, so those couple big events, in terms of the deposition -- they were over a microgram per square meter per event -- were underestimated, and therefore, would not have overestimated or given more of an emphasis to those events.

Q. But you stated in your testimony that, at least, one of those events added 8 percent of the total mass of mercury to the amount of mercury observed for the year 2004.

A. That's correct.

Q. And you don't consider that a significant

additional amount based on that one storm?

A. No. The point of my testimony was that it does -- 8 percent is a significant additional amount, but you asked the question whether that had a significant impact on the results of our source-receptor modeling, and I said no.

Q. I understand. I see where the four event comes from. I'm sorry, Madam Hearing Officer. Which was the Beijing?

MADAM HEARING OFFICER: The Beijing study is 30?

MR. RIESER CONTINUES:

Q. Thank you. If you turn to Exhibit 30, there is an "EPA PMF Estimated, versus Measured Mercury Deposition."

A. Yes, I see that.

Q. And it's a graph comparing mercury deposition in events, and there are four peaks, at least, four large peaks that are larger than the other peaks in that graph.

A. Correct.

Q. Do those represent the significant precipitation events that you discussed?

A. Those are, yes.

Q. So would you agree that, in order for the source-receptor -- excuse me -- receptor modeling to -- strike that. Let's go on to the next question.

DR. KEELER: "What range of values is represented by this approximate value?" An approximate, that is. I'm sorry. What did I say?

MR. RIESER: I thought I heard you say an approximate.

DR. KEELER: "An approximate" it says. I'm sorry, if I mumbled my words. The PMF and Unmixed numbers, if I said I think PMF came out to be, approximately, 70, might have been 69, and Unmix was 74, and so that's where the number of, approximately, 70. That wasn't meant to be a mathematically-rounded number, by any means. It was supposed to be an approximation.

MR. RIESER CONTINUES:

Q. I asked this, I suppose, indeed, but is there a plus or minus range associated with that?

A. Yeah. As I said yesterday, I believe the uncertainty, if you do it the same way for both of the models, is around 15 percent.

Q. Thank you.

DR. KEELER: The question is asking, "What is the purpose of expressing this as an

approximate value?" For the purpose of simplicity, and I have already answered what level of uncertainty to place on this figure, which is the 15 percent. Question 12: "You state that `a meteorological analysis corroborates that a substantial amount of the mercury deposition found at the Steubenville site was due to local and regional sources."

MR. RIESER CONTINUES:

Q. Let me stop you. You use the term "corroborate." What findings do you have, aside from the meteorologic, that indicate a substantial amount of mercury was due to local and regional sources?

A. Well, if one takes the emission inventories for the region for mercury, and looks at the amount of mercury and other constituents that are there, one can then see that the largest contributor in the emissions inventory in that region is actually coal-fired utilities, so again, that's what I'm saying is we, again, find that this matches up with what the EPA emission inventory tells us.

Q. The emissions inventory is of emissions, not deposition, correct?

A. It is emissions inventory. It's the actual amount of emissions estimated from the source.

Q. So the emissions inventory doesn't, in and of itself, tell you what the deposition is, does it?

A. No, it does not, unless you use a deterministic model to model from emissions to deposition?

Q. As I understand it, you did not use a deterministic model?

A. No, I did not.

Q. And so in what way did you arrive at the finding through your study that a substantial amount of mercury deposition found at the Steubenville site was due to local and regional sources?

A. When one does a source-receptor modeling, one will often take the data, do the analysis, determine an estimate of what a local source contributions and regional source contributions are and then use the local emissions inventory to what we call -- it's not a validation. It's a comparison to the results that you find. It doesn't make sense, in terms of what was emitted in the region, to what you actually predicted. This is a very common practice. It's done in a lot of receptor modeling results. For example, if you estimate that diesel emissions are an important emissions are important and go to an area, and there are no diesel

trucks estimated to have emissions in that area, then you find your results very unsatisfying.

Q. What is it about the emissions inventory that allows you to make a qualitative statement with respect to the deposition in the area, as you say, it's a substantial amount that was due to local and regional sources?

A. Are you asking me about the emissions inventory?

Q. I'm asking you what about the emissions inventory allows you to make the statement that a substantial amount of mercury deposition found at the Steubenville site was due to local and regional sources?

A. We have observational evidence that shows us that, when we have high concentrations of reactive mercury in the atmosphere, we would expect that to be removed fairly close by precipitating systems. Taking this understanding of the processes, one can then take and use that understanding when looking at, okay, here are emissions that are, to a large fraction, greater than 50 percent as estimated by the utilities to a common form of reactive mercury. When one goes and looks at when and where the precipitation fell, one can then make an estimate that this mercury would have been

removed through wet deposition in that area.

Q. How do you know what the amount of reactive gaseous mercury is emitted by the sources around Steubenville?

A. It's in the emissions inventory.

Q. The amount of reactive gaseous mercury is in the inventory?

A. That's right. They provide an estimate of the percentage of reactive mercury, particulate mercury and elemental mercury that's emitted from each source.

Q. Did you do anything to -- the emissions inventory is from 1999. Is that correct?

A. That's correct.

Q. Did you do anything to evaluate whether that emissions inventory was still accurate as of the time you did your study?

A. We only have the data that is presented to us, so the answer would be no. There was no follow-up. We can only use the information that is provided to us, so the same information that all the modelers use.

Q. Could you have taken steps to -- strike that. Put it this way, yesterday, when I asked you about the sources that were nearby, you said that you didn't know what they were, and you directed us to the

EPA map.

A. I don't think that's what I said, that I didn't know what they were. You asked me how many, specifically, and how much power was produced by the plants, and I believe I answered I didn't have that number in front of me.

Q. Did you have --

A. I know exactly where the sources are, not just the coal-fired utility, but all of the other sources in the vicinity.

Q. Did you have that number in front of you when you performed your study?

A. We combine all the analysis tools that we have including the emissions inventories, the maps showing the locations of all the sites, how much of the mercury is emitted from all those, and trying to understand the results of our modeling, yes.

Q. Now, of course, we are limited in that we don't actually have a copy of your study, but were there maps showing the locations of the power plants, the coal used, and then megawattage included as part or your study?

A. The publication has a map showing all the locations of the coal-fired utilities based on the 1990

information that was provided -- 1999, excuse me. I misspoke. And I would have to go back and remember if in the manuscript version that we submitted, whether it had anything showing the actual amount of mercury that was emitted from each stack. I don't recall that, but it does show, geographically, where the plants were located.

Q. So your report identifies specific power plants as contributing to the mercury levels that you observed in Steubenville. Is that correct?

A. No. As I mentioned yesterday, the receptor modeling approach does not allow you to identify a particular power plant. It identifies source contributions from coal combustion.

Q. Then what was the point of including a map of certain power plants in your study?

A. It's very important when you're publishing any type of paper in international journals to show people the location of where you are studying and the major emissions sources in that vicinity. This is common practice in the scientific literature.

Q. So the point was just to show the location. Did you have other features, such as items of historical interest in Steubenville?

A. This was a scientific peer-reviewed literature paper. It's not a historical overview of the area of Steubenville.

Q. I'm trying to understand why, if the point of a receptor study, such as the one you performed, is that it's not, A, can't use it to identify specific sources, and B, it's not important to know what those sources are, I'm trying to understand why you would identify specific sources within the study, itself.

A. Again, you have misinterpreted and misquoted what I said. A, I did not say it was not important to know are the individual sources are. B, I didn't say that individual sources are not important, and I've been working in Eastern Ohio, Western Pennsylvania air shed understanding the sources of, not just mercury, but other compounds for over 20 years. I have driven that area myself more hours than I can tell you. I have spent an enormous amount of time on the grown. I have actually gone around and photographed the sources. Identified that, in fact, they were in the locations that were given because, in the early days, we were given locations for plants that actually didn't coincide with where the plants were located, so we actually went and verified that they were there, so I

have a long historical context, in terms of the research I have been doing in that area. I published my first source receptor paper on aerosols and their sources in the Southwestern Pennsylvania area in 1986, so this is not something that is new to me, and I think, from over 20 years worth of scientific experience, I believe I have a good sense for what information is important to provide in a scientific peer-reviewed paper and what's not, and so I'm not sure why you keep saying I'm referring to these things as being unimportant.

Q. Well, in your testimony, on page four, in the paragraph that begins, "Multivariant statistical receptor models have been successfully used to apportion sources of mercury deposited in South Florida and elsewhere." What you say after that in the next sentence is, "These techniques have the advantage of not requiring prior measurements of source profiles or emission inventories." Similarly, in your report, which is attached as Exhibit B, and I believe it's on page 18, again, in a paragraph that begins with the statement, "Regarding multivariant statistical receptor models," there's a sentence right before the end of the paragraph that says, "Again, both techniques referring to statistical techniques such as Unmix and deposit matrix

factorization, both techniques have the advantage of not requiring prior measurements and source profiles or emission inventories." So since you identify an important, positive point that it doesn't require -- the studies you performed don't require emissions inventories, I'm having trouble understanding what role they have to play in the findings that you make, and obviously, I'm hampered that I don't have the actual report in front of me.

A. I will try to say it again in a different way, so perhaps it's more clear. Receptor modeling allows you to estimate the source contributions by source category for the pollutants that you're looking at. It does not identify the specific stack or source, a specific company that emitted the pollutant. You asked the question about corroboration, and this is how we got into discussing emissions and emissions inventories, what we call "source reconciliation." If one does a receptor modeling study, one that comes to mind is one Glenn Kass did in the early 70's looking at the sources in the Los Angeles Basin. He was looking at the source of L and L carbon (phonetic) and basically, did a receptor modeling very similar to what we done in this study, and estimated the contributions to L and L

carbon and then went, as a corroborating piece of information, took the inventory that estimated, from a source perspective, how much carbon came from all the sources in LA to see if he could get an approximate balance. What goes up, has to come down. If you estimate an overabundance of material that you can't corroborate with observations or with emissions estimates, then it gives you some idea that the emissions are not correct or that there are other sources contributing that perhaps the emission inventory didn't conclude, so this is a standard practice in the field, but it does not require -- receptor modeling does not require the use of emissions data.

Q. Did you quantify the amount of mercury deposition that you expected to find in Steubenville based on the emissions inventory?

A. No, sir.

Q. In what way did the review of the emissions inventory, then, corroborate the finding that a substantial amount of mercury deposition found at the Steubenville site was due to local and regional sources?

MADAM HEARING OFFICER: With all due respect, I think that's where this all started. I think he answered that question in the beginning.

MR. RIESER: Well, I'm really limited here because I don't think he did answer the question. He said he looked at the inventory and that supported the finding that a substantial amount of mercury deposition found at the Steubenville site was due to local and regional studies because that finding is corroborated by other information I have to assume that's a finding, and again, I don't have the report in front of me.

MADAM HEARING OFFICER: You have made that point several times this morning, as well.

MR. RIESER: Right, but the point being says he looked at the emissions inventory. We don't know what plants he looked at. We don't know what particular things he found. We don't know whether this was a qualitative or quantitative finding of his.

MADAM HEARING OFFICER: I understand that, but he has also repeatedly stated that the receptor modeling does not look at individual plants. It looks at a source category. Am I characterizing that correctly?

DR. KEELER: Correct.

MR. MATOESIAN: Yes, and he's answered that several times, category of sources you can trace

back to.

MR. RIESER: Thank you.

DR. KEELER: Just for the record, I did state that we use the emissions inventory from the 1999 modeling that EPA did, the same inventory that was used in the CAMR Rule, and we looked at all the emissions for the entire Midwest, and actually, for all the entire Eastern United States, so --

MR. RIESER:

Q. What I would like, then, is a list of the plants that Dr. Keeler identified as being the plants that he looked at the inventory for to identify the amount of mercury that corroborated this finding.

A. It's the entire list that's in the CAMR Rule, so if you want the entire listing, you can get that on the EPA website.

MADAM HEARING OFFICER: Once again, Dr. Keeler, when you start telling us to get stuff, that means the Agency needs to provide it to us, if you have not already. We need that as an exhibit.

MR. RIESER CONTINUES:

Q. I'm sorry, the entire list of all power plants in the country?

A. That's the list we used and we looked at

the plants east of the Mississippi.

Q. Did you look at a specific range of plants for this study, all the plants in the Mississippi --

A. We did not look at specific plants, as I said earlier. We looked at the region.

Q. Well, I'm --

A. We didn't identify -- we did not identify individual plant contributions that are in the receptor modeling, or in terms of trying to understand the contribution of a particular plant. That's not in the scope of the work that we did.

MR. RIESER: I don't think it's unfair to ask what plants, to get a list of the plants.

MADAM HEARING OFFICER: I have already asked them.

MR. RIESER: I'm hearing "region" and "list." I'm not hearing, "I looked at these plants," and I'm assuming there is a list.

MR. MATOESIAN: He stated this --

MR. RIESER: I'm not done talking. I'm assuming there is a list of plants that he looked at because he describes, "We looked at these RGM's, and we calculated the RGM's with the" -- blah, blah blah, and that's what we need to corroborate, the meteorological

findings, so I would like a list of those plants.

MR. MATOESIAN: I believe you directed us to provide that and as he stated, it was a list of plants east of the Mississippi, I believe.

DR. KEELER: Right.

MS. BASSI CONTINUES:

Q. Sorry to jump into this fray, but please correct me if I'm wrong, and that's my question. I thought, at one point, you said that, in your manuscript, or in your published data, or some place, there was a map on which you identified the plants that were in the region or in the vicinity or in the local area, or however you defined it, but it sounded to me as if you were saying that there were certain power plants, perhaps, other types of sources that were on a map around the Steubenville area that is plotted on a map that you have identified as dots on a map. Is that correct?

A. That's correct. In the submitted version of the paper we submitted, a figure, which had a copy -- I mean had a spot showing the location of the Steubenville site, and then had within -- I would say it showed the greater Steubenville area, including most of Ohio, half of Pennsylvania, down to the south of it, up

to the north. It didn't include a large area. It was really meant to show where Steubenville is, but it did include a point showing a major source of mercury from the `99 inventory plotted on that.

Q. Then somehow that got expanded to the entire emissions inventory used in the CAMR?

A. Because there are two different questions. One was asking a question about figures, and one was asking what we look at when we look at the emissions, and I was trying to be clear about that.

Q. So when you looked at the emissions to corroborate your findings from your study, you were looking at more than just what was plotted on your map. Is that correct?

A. That is correct.

MR. ZABEL CONTINUES:

Q. Maybe this is obvious, but it seems to me we have been dancing around the question of why we can't get a copy of the draft report.

A. It's not a report. It's a manuscript that was submitted to a scientific journal that's in the review process. We've already been given reviews, and we're in the process of finalizing that paper. The paper will be provided to everyone, once the paper is

sent for publication. One other thing that is very difficult today, especially when doing environmental research, is to maintain the integrity of the scientific research publication process, and one of the reasons why we didn't want to make presentations and do briefings in front of the EPA, until we had our final analysis was because these results, then, get misinterpreted. People that don't do scientific research often don't understand the process that science is -- you learn as you go. You make corrections and improvements to the scientific research that you are doing, and that, at times, if you don't have the data that you would like at hand, you get that data, and people provide new data. You submit your information and you refine your analysis, and if versions of publications are going around prior to you actually submitting it to the peer-reviewed literature, then the whole process becomes -- basically, the integrity of the process disappears.

Q. I'm sorry. My question wasn't answered.

A. I'm saying that this hearing has come at a time where the paper has not come out in press, yet, so that's the reason why the paper hasn't been provided.

Q. I perfectly understand that. I want to know is there some legal reason why we cannot have that

document as it exists today? They are asking this Board to rely on what you're saying is in that paper. We have no chance to judge that. If I were in litigation, I could get it in Discovery. I could order it produced. They want this Board to rely on what Dr. Keeler is telling us. I have no reason to think he's not telling us the truth, but I can't check it. I don't know of a legal reason -- if there is one, counsel can tell me -- why we can't have copy of that draft.

MADAM HEARING OFFICER: I actually believe that yesterday Dr. Keeler invoked intellectual property.

MR. ZABEL: Then he can have it under confidentiality. We won't publish it. That's not the point.

DR. KEELER: I'm not sure how to answer you. I just know that I know that, in terms of the scientific peer review process, this is not appropriate and --

DR. GIRARD: Could I ask a question. You say it's been reviewed. Have you already submitted the revised paper to the journal?

DR. KEELER: No, we have not. It's -- right now it's under going, again, another level of

review at the Agency, so it's not a finalized document, yet, and that's the main reason why -- if I hadn't submitted the final version, I would have no problem with sharing that, but again, this is -- it's one of these thing that it's just not done this way.

MR. RAO: And based on the comments you have received from this peer-review committee, does it change your results or conclusions in any way?

DR. KEELER: No, it does not.

MS. MOORE: Is the peer view committee looking at it now within the EPA?

DR. KEELER: Yes. It's an internal review.

MS. MOORE: Given the fact that your findings are U.S. EPA excuse me -- are a little different than the direction that the U.S. EPA has thought to go in regard to mercury, don't you think there would be some chance that the release of this paper might be held for some period of time for further and further and further peer review?

DR. KEELER: I don't believe they, legally, can hold up the publication. I'm the one that has to then make a determination that, okay, we are not going to wait anymore, so we have a deadline of July 1

to return the final version of the paper to the Journal, and so that's the drop dead deadline for all of their discussions and review, no matter what, in my mind.

MS. MOORE: So July 1 it would actually be available?

DR. KEELER: That should be -- that's correct. It should be available around the July 1 time frame.

MS. MOORE: It would be pretty clear to you then if there were some other reason they didn't want to release it, not that that kind of thing would ever happen.

MS. BASSI: Certainly not in Illinois.

DR. KEELER: I think that's correct.

MR. ZABEL CONTINUES:

Q. Is my understanding correct, Doctor, that's the version you would be willing to release, the July 1 version?

A. The version that we will submit as a final version to the Journal will be the one I'm happy to share.

Q. Then I guess my only inquiry would be whether we can have Dr. Keeler back after our experts have had a chance to study that.

A. It all depends on when.

MR. RIESER: It would be my suggestion, frankly, that, if it's going to be released by July 1, it would be my suggestion we just halt the cross-examination here --

MADAM HEARING OFFICER: We're not going to halt the cross-examination because, if it doesn't happen July 1, and we're right here arguing about whether or not the Steubenville study is going to be issued. We're -- we'll continue on.

Here's what I'm going to do. I'm going to direct the Agency to provide a copy of the Steubenville report no later than July 5. If it can't be available by July 5, then I will be willing to hear motions at that point.

MR. ZABEL: I will have a motion at that point, Madam Hearing Officer.

MADAM HEARING OFFICER: I just want to put it off, in case we can get to --

MR. ZABEL: I will reserve my motion, until the end of the Fourth of July holiday.

DR. KEELER: Can I just make one point? I'm not going to be in town -- I'm actually going to be in the field, until about July 10, so I'm not

going to be dealing with this at all. I told you July 1, just so that you would know that that's when we have to do it, but I'm not going to be in town to be able to do anything in regards to this, until I get back on about July 10. I think I get back to town late on July 9, so putting a date of July 5 is not going to work for me. I'm just telling you. I have other commitments that I have made previously. This hearing got postponed from May, to now, and I had to cancel two different trips that I had planned for June in order to be here this week, and I can't cancel any more in the future because it involves field work, and I have contracts that are obligating me to be in the field.

MR. RIESER: We're just asking for the report, not you.

DR. KEELER: But if EPA responds back to me with whatever the final comments and all that kind of stuff very late in the game -- I'm hoping I get it before that, so I can get this taken care of, but if they get it back to me June 30 or something like that, I'm going to have a really hard time in dealing with that. I don't know what will happen. That's out of my hands.

MR. ZABEL: Madam Hearing Officer, I

will make my motion, regardless. I understand his difficulty. I'm giving up most of Father's Day with my children because of this hearing on Monday, so I'm sympathetic doctor, but at some point, we need the evidence in the record, and if it isn't there, I will make my motion.

DR. GIRARD: One problem we have got is that we have already got partial -- we have partial information in the record now, which you already said is not final. It seems to me that really need to talk with your attorneys to see if it is possible to put a draft copy, as it is now, in the record. There's no way it's going to be released for publication. We take trade secrets all the time in cases, so you need to talk with your attorneys. I think it would short circuit some of this questions by three or four hours, if you could simply look at what methods were used, and a lot of these questions go to procedures. They don't go to results at all. So I think you need to go talk with your attorneys.

(At which point, a break was taken.)

MADAM HEARING OFFICER: Back on the record.

MR. MATOESIAN: In response to the

question of -- on the question of Dr. Keeler's report, we're going to have to talk to the U.S. EPA about whether it can be released and what portion, so we cannot today commit to the July 5 date. We are going to reach out to them, and hopefully, get an answer by early next week, Monday, perhaps Tuesday. Then give you a more definitive answer then. That's the best we can do at this point.

MADAM HEARING OFFICER: Mr. Zabel.

MR. ZABEL: May I add to my request then that we also, if we receive anything, receive the 200 pages or thereabouts of commentary that Dr. Keeler indicated he received from U.S. EPA? You are going to be talking to U.S. EPA, so you might as well talk to them about both.

MR. MATOESIAN: We will bring that issue up, as well, to them.

MR. RIESER: One other item, which I asked for yesterday, was if the LADCO presentation could be provided and I think Dr. Keeler said he would look for it.

DR. KEELER: It's being photocopied as we speak I believe.

MR. RIESER: Great. Thank you.

MADAM HEARING OFFICER: At this point, then, we will move on with the cross-examination of Dr. Keeler, and we will address issues considering the availability or unavailability of the Steubenville study published report at a later date.

MR. RIESER: I think we are on 12-A.

DR. KEELER: 12-A: "In your testimony, how do you define "local" and "regional" sources?" I believe I answered that previously. We had an extended discussion about that yesterday, so that's been answered. B: "Are the sources described in this state limited to coal-burning sources?" No, they are not.

DR. RIESER CONTINUES:

Q. What other sources are?

A. I believe I answered this yesterday, as well. Iron and steel production, municipal waste incineration, refining, metals production I think were the sources that I mentioned yesterday. C: "Is the deposition" --

Q. I'm sorry --

A. "Limited to wet deposition?"

Q. I'm sorry, one question on that. In identifying where the sources -- were the sources you

identified as a result of the receptor sampling and modeling or as a result of the review of the emissions inventory?

A. Only the receptor modeling.

Q. Thank you.

DR. KEELER: C, "Is the deposition described here limited to wet deposition?" The source apportionment results receptor modeling performed were only including the wet deposition?

MR. HARLEY CONTINUES:

Q. Dr. Keeler, mindful of the fact that the source apportionment was based on wet deposition, on days when it didn't rain, when there was only dry deposition, do you have an opinion about how that might have effected the results of the work that you did at Steubenville?

A. As part of this overall project, we will be looking at, both, wet and dry deposition. Again, this was the first paper that we attempted to get into the scientific journal, the wet deposition took precedence. The dry deposition work is ongoing, and it's going to be based on the extensive on-site meteorological measurements, as well as the reactive gaseous mercury, particulate mercury, and elemental

mercury measurements that we're actually making on site. We have, at this time, not modelled the deposition using the ambient data. However, based on our past projects, we would assume -- not one would assume. The dry deposition component should be a significant additional loading of mercury to this ecosystem. In our studies in Detroit, where we were in areas with similar source contributions, or similar source densities, the portions of dry deposition was -- well, the dry deposition that was about half of the overall deposition that we saw at the site at Steubenville was different in terms of the mix of sources than Detroit is, so we expect to see some different contributions, and so forth, but dry deposition is half the story we believe, and in an area with lots of sources, dry deposition could dominate the local deposition to this area.

Q. To be clear, that would be added to what you have already presented in your testimony about deposition through precipitation?

A. Yeah. The wet deposition -- just to be clear, the wet deposition that we modelled and think that 70 percent of which is coming from coal-fired utilities, is only about half of the total deposition, so mercury enters the waterbody by wet deposition, and

then there is a whole other amount of mercury that enters through mercury that's in the air, basically, interacting with the surface and falling to that surface, so at this point, we haven't really apportioned half of the total deposition, which is again, part of the goal, but that's further down the road.

Q. Based on previous work that you have done, would you reasonably expect that the utility contribution to dry deposition would be present in the same proportion as it is for wet deposition?

A. The importance of wet, versus dry, can vary from one spot to another, but based on, again, past experience, I would expect that the sources that are within the 50-mile radius of Steubenville will have a major importance, in terms of the dry deposition and influence in the ambient levels of mercury in the air at Steubenville.

CROSS EXAMINATION BY MR. HARRINGTON:

Q. I don't believe you answered the question as to whether utilities would have the same impact on dry as wet deposition. Could you comment on that further, please?

A. I can't give you a quantitative answer to be specific on that. I would expect them to be a

significant contributor to the dry deposition. I cannot, because I have not done that analysis, give you a quantitative number what percentage of dry deposition to coal-fired power plants is.

Q. Do things such as steel mills, metal working refineries have potentially and proportionate greater impact on dry deposition?

A. We're talking about dry deposition of mercury, right?

Q. Dry deposition of mercury in Steubenville. Keep it within the context of --

A. Again, local sources, if they are closer to the site and have different forms of mercury that they are emitting, would have a different contribution than coal-fired utilities would, yes.

Q. Thank you.

MR. RIESER CONTINUES:

Q. And during the 2003-2004 sampling, did you measure dry deposition in Steubenville?

A. We did not measure continuously for the 2003-2004 time period a direct measurement of dry deposition that's analogous to what we did for wet deposition. What we have done and what we plan to do to provide that estimate is to use ambient concentrations

of mercury that have been measured, so we have continuous measurements of reactive gaseous mercury, elemental mercury, particulate mercury that are performed on an hourly time basis together with the onsite meteorological data, and we will model the dry deposition quantity to the surface at the Steubenville site. As part of intensive periods, we have direct measurements of mercury of dry deposition using surrogate surfaces, and other techniques, which all of these techniques have uncertainties, so we compare those measurements together with models to come up with a best estimate for dry deposition of mercury in Steubenville, but again, that analysis is not completed.

MR. HARLEY CONTINUES:

Q. In talking about the conduct of your ongoing research, you testified yesterday that you have assembled, but not compiled data for wet deposition for the year 2005. Is that correct?

A. The database is not finalized. We haven't compiled all of the trace element data and mercury data and ion data at this point.

Q. Based on your firsthand review of the data as it now exists, do you have an opinion as to whether or not the information from 2005 is consistent with what

you saw in 2004, 2003, or is it just too early?

A. We haven't done any source apportionment modeling on the 2005 data at all because the data is not completed. The total amount of mercury deposition in Steubenville in 2005 which is the data that is done I don't have the exact number in front of me, but it's greater than the average. It's more than 2003, and I think less than 2004, so it's in the same vicinity.

MR. BONEBRAKE CONTINUES:

Q. Is the relative proportion of different species of mercury deposited different in wet deposition, as opposed to dry deposition?

A. The answer to that question -- I'm going to try to simplify it. The reactive gaseous mercury forms and the particulate mercury forms are the ones that will most readily go into precipitation. When we analyze our samples for our precipitation samples for these species we see a very wide range in how much reactive particulate is there and part of that is because the reactions occur in the precipitation sample, itself, giving us somewhat an uncertain answer as to how much particulate was there, in the first place. Reactive mercury is also going to dominate the dry deposition because of its properties. It has a very

high deposition velocity, and so similar to wet deposition, reactive mercury is going to dominate in wet deposition, and also going to dominate in dry deposition, so in the absence of precipitation, you would expect do see a fairly rapid depreciation of the reactive mercury to the surface similarly as if it was going into cloud water, so I would expect reactive mercury to dominate, both, the wet and the dry. The one part, the dry deposition, that is less well understood, and is not included in the models, and the models that I have reviewed in the current literature is the uptake of elemental mercury by force canopies and into the plant materials. This form of mercury and this deposition loss is something that's not characterized well, but it's a significant amount of mercury on an annual basis. It can be as much as three times the wet deposition to a forested ecosystem. It's not a simple answer.

Q. The deposition -- the mercury uptake in the forest canopy that you just mentioned, would you anticipate that that ultimately ends up in the environment, and if so, what portion of the environment, aside from the trees, themselves?

A. Well, what we've quantified thus far is the mercury that's taken up in deciduous leaves and

confer needles and so forth in the forest canopy. That material, at least, for the deciduous trees -- every fall, that material drops from the trees and falls to the forest floor, so mercury gets bound up in the organic matter and that material is bound to decompose like the other plant material and start working through the process of weathering and so forth, go into the soils, and some of it will run off, depending on the ecosystem structure, so it's a delayed signal, in terms of deposition to the forest canopy uptake through the growing season, deposition and then a slow process where it will then slowly make its way to the ecosystem.

MR. ZABEL CONTINUES:

Q. Just for my benefit, Doctor, you mentioned in discussing dry deposition the use of surrogate surfaces. Explain to me what that is or what that means.

A. Sure. One of difficulties in making measurements of the deposition of any pollutant, whether it's mercury or sulfur or any pollutant that's in the atmosphere, is that the surface of the earth is complex. Trees present a very complex surface in an urban area, buildings and roads and sidewalks, all those surfaces are very complex, in terms of the surface area, the

composition, how they move, how the wind and meteorology influences those, and so we can't make a replicate of a building and stick it up and then somehow wash the building down to get how much pollutant was deposited into that building, so we come up with a surrogate, something what we hope will mimic the surface, so we use a variety of different surfaces, and when we do this, we try to provide surfaces that have properties that won't artificially enhance the deposition, so there are other dynamic surfaces. Sometimes we will use a water surface if we are trying to look at and estimate the amount of mercury that's deposited into the Great Lakes, for example. If we're trying to assimilate the deposition to a specific type of surface, we would put that material on a small aerodynamic surface and actually measure how much deposits to that, and then to verify that we're getting reasonable results, we actually then use models to estimate how much mercury deposited to that small surface, and then use an understanding of the landscape and some of the information that we can get from a remote sense to tell us about how the landscapes change and the proportion of different types of trees and vegetation and plants and so forth to come up with a larger estimate of the deposition.

Q. So in doing that, you use multiple surrogates, I take it, for different types of surfaces?

A. We use more than one type of surrogate surface, that's correct.

MADAM HEARING OFFICER: Anything else? Moving on to D, I believe.

DR. KEELER: D: "What meteorological analysis was performed to demonstrate this statement?" We used a combination of meteorological analysis tools to perform the meteorological interpretation for this project. This included detailed plotting analysis of surface and upper air meteorological maps, backward air mass trajectories, NEX-RAD precipitation data sets, together with statistical techniques, such as cluster analysis to institute meteorological influences on the deposition.

MR. RIESER CONTINUES:

Q. If you look at Exhibit 29, which is the Beijing, China, Landis Report, there are -- there's a page after the page we looked at before called "Hy-split Back Trajectories."

A. Yes. That's what I was referring to in my statement.

Q. So these are two examples of the back

trajectory?

MADAM HEARING OFFICER: Point of clarification, the Beijing study is Exhibit 30. 29 is the preliminary results. That's right. 30 is the Beijing study.

MR. RIESER CONTINUES:

Q. I had two identical exhibits. Sorry about that. Exhibit 30. Doctor, you're there. "Hy-split Back Trajectories."

A. Yes.

Q. So these are examples of the type of work that you would do?

A. These are examples of one of the tools that I listed there. These are the -- as I said, the backward air mass trajectories.

Q. What information do using these as examples -- what information do these provide to you?

A. If you look at these plots, these plots, basically, the trajectories are calculated to correspond to the maximum hour of the precipitation for a couple of the precipitation results we received in Steubenville, and these black lines represent the center of probability of mass that air would have had thought going backwards from Steubenville and where the air mass

would have come from moving backwards in time and I think it's six-hour increments, and that's what those little stars are.

Q. The stars are six-hour increments?

A. I believe so, yes. That's going back 72 hours. These are three-day back trajectories.

Q. Then there are graphs below these that are on the side that says "HPA." Would you tell us what these rep?

A. Yes. The bottom plots HPA is a unit of pressure, and so this gives us a vertical slice looking up in the atmosphere of the height that the air mass was predicted to be at, so again, if you start at Steubenville, or to the right, looking at the first here moving backwards in time, it shows that our site was at the surface, and then the air mass actually came moving backwards in time, and went up into the atmosphere a little bit into the higher into the mix layer and then up as it went backwards and slowly came down again.

Q. Did these examples -- again, do these also represent the difficulty in identifying the proximity of regional source because the three days' time travelled put you pretty far away from Steubenville? Can you be more specific about the difficulties you had to -- why

do you select three days? Let me ask that.

A. For the purposes of this demonstration, three days was selected because, when you start going back further, you actually have missing data in the data streams, and you wind up actually having the model condition calculate very often, so we use three days because, as part of that the original analysis we did back in the late 80's looking at some of the utility acid precipitation data, we found that three days represented some synoptic meteorological conditions very well, and that going further -- actually, the uncertainty in the trajectory calculation was back much more than three days which was so great to make them unreliable.

Q. Looking up, again, at the specific question of 12, "Meteorologic analysis corroborates that a substantial amount of the mercury deposition found at the Steubenville site was due to local and regional sources," would the local and regional sources be sources that contribute mercury emissions to the atmosphere or all along the lines of these back trajectories?

A. The line here, again, is meant to represent the most probable path, so as you move

backwards in time, the path that actually the air mass could have taken actually grows wider, so if you were to take and draw an increasing, like, wedge of air moving backwards in time, it actually encompasses a larger area than what's shown by just this line. This is just a representation, and so what we do then is to use this as a guide, and then take the surface and upper air meteorological maps together with the NEX-RAD to help this in terms of guiding us in terms of the timing for how quickly the air mass has moved, where the precipitation fell along this trajectory, and what sources could have fallen into this kind of large area that surrounds this line that you see here, and so you put that all together and together with the known source locations to be able to then say, "Here's the sphere that we think has contributed to the deposition at that point."

Q. When you -- tell us what "NEX-RAD" is, I'm sorry.

A. NEX-RAD is the weather radar that you see presented on the television. It's the nice way to show the storms for Springfield, show the nice, heavy thunderstorms that come through in different colors, so it's next-generation radar is what it stands for.

Q. So going back to your description of this you describe sort of a -- since I'm used to ground water what I will call an inverse plume where it spreads out from the back and focuses in at the front end. Is that an apt description?

A. I'm not a ground water person, but plume is okay.

Q. So back to that question, would it be in the way you did the study that all of the sources that you identify within this area, looking at this first map on the left, which starts at, essentially, the Rio Grand, all the sources within that area leading up to Steubenville would be included in your analysis of the mercury emissions that fall at Steubenville?

A. We will utilize going as far back as the trajectory would tell us for the three days. We actually look at the meteorological numbers for the entire country when we are doing this, but we would look at and investigate any potential influences that would occur along that entire path.

Q. So when you talk about local -- we had an extended discussion yesterday I understand about local and regional sources and things like that, and you were -- again, correct me if I'm mistaken -- but you were

concerned that the local and regional as the proximity issue was problematic because, in your mind, it really wasn't meteorologic?

A. That's correct.

Q. The meteorology that's described in this first plot, the one on the left on this Exhibit 30, would suggest that the mercury that's being contributed into Steubenville that you measured came from sources along this line and then spread out as far as the data shows that the air mass moved. Is that correct?

A. I believe what you're trying to convey is correct.

Q. Is it, again, looking at this map, is it the assumption that you're going back three days because that's an understanding of what's useful data? Is that the way to say that? After three days it gets mushy?

A. Yes.

Q. It doesn't really tell you anything. Do you have any assumption, and I asked this yesterday, but there is a good graphical representation of it. Do you have any assumptions that any amount of mercury comes into this back end that you have got at the Rio Grand in looking at how much mercury is being deposited in Steubenville?

A. Again, let me see if I understand what you're asking me. This line, or whatever, that goes back toward the Rio Grand here, we don't add up emissions along that line or suggest that emissions are -- that's not included in our analysis. There are no assumptions in terms of the analysis. What we would do is we would take and look at the entire upwind history of this precipitation event. One tool to look at where the air mass came from would be this line, and along this line we would look at things, such as did it rain? What was the precipitation rate moving backwards i time along this line, and what we found is that, by using precipitation, you can look to see whether the probability that the pollutant would be removed is greater in times when precipitation along these back trajectories is high or not, so we look at the storms, and in this case, this one that's for May 8, it turned out that the air mass actually wasn't moving very fast. If you look at those stars there, there are a few stars very close to Steubenville, so the air mass was not moving very fast. In fact, those first four or five stars there reflect the meteorological situation at the time, which basically, had a storm which stalled out in that area, so the storm was a big storm. Things didn't

move very quickly and the precipitation would have been washing out all of the reactive mercury, and all of the other very reactive pollutants from the atmosphere and cleaning things up for a very long time, so that the air masses that could have contributed to the loading that was occurring through that storm couldn't come from very far, and so this is how we do that type of analysis, and one can take and model that specific storm and compare that against using observations because there are no assumptions in the observations. It's meteorological data that we have and we don't look at a line underneath the map. We actually look at the whole area, and we, basically, say, from this, we know that we had a very slow-moving air mass that took a long time for it to actually go anywhere, so we are talking about emissions that were in the vicinity of the Steubenville area. The ones that were coming from Southern Ohio that were -- the emissions sources were, basically, emitting up into that area, and then that storm was staying there, and it was precipitating out for an extended period of time, so that the air mass, by the time it got up towards, Steubenville had already been washed out. The air that was in that storm had already had a great deal of removal and cleansing, just to put it in simple terms,

so the highest probability of where the air masses that fed the clouds could have come from had to have been in that general vicinity. Again, I'm saying Southern Ohio, Northern Kentucky, that general area, based on the service meteorological data our on site, data as well as using this as a tool. When you start talking about meteorological analysis and showing maps and so forth, everyone turns off and goes to sleep in your talk, but when you show a trajectory plot, people get the idea that the air started down somewhere in Texas and that's the path that it took before it got to Ohio, so it's simplification for presentation purposes, but by no means is it what we use as the definitive answer because there's very complex three-dimensional flows that occur in the atmosphere, and one has to take those into account, as well, when one is looking at what potential source areas could have contributed.

Q. So that description is what tells you that the mercury deposited in Steubenville came from the specific area you described, Southern Ohio, Kentucky, and not from, say, Houston, which is more or less passed -- is that correct?

A. Yes, in simple terms.

Q. In doing that analysis, do you have to

take into account the atmospheric chemistry in transformations of mercury in the atmosphere?

A. We do rely on our understanding of the reactivity of mercury and the chemistry of mercury in order to be able to look at what distance scales we think things could take place on. However, there are no assumptions made. We use what our best available understanding is based on, both, our observation data that we have taken, both, at Steubenville and at our Michigan sites, together with what is published in the literature.

Q. And is that understanding -- you use the term "understanding." Is that correct?

A. I believe that's what I said, yes.

Q. Is that understanding different than the atmospheric transformation of mercury which are described in the deterministic models?

A. That would depend upon the specific deterministic model. This gets to the whole question that I raised yesterday about the uncertainties in the models.

Q. Let's use CMAQ to narrow it down?

A. CMAQ -- the version of CMAQ that EPA uses has a very simplistic atmospheric chemistry for mercury.

There are lots of issues in that chemistry. It does not include all the relevant reactions that we understand today. It doesn't include the most up-to-date reaction rates, so I would say no. We rely upon more than that.

Q. And have you published or is there another paper published paper that you rely on that identifies the atmospheric transformation reactions that you rely on in doing your work?

A. We have papers. We have a paper that we have submitted to -- see, we have a paper that we submitted to a peer-reviewed scientific journal that details some of our deterministic modeling, which is not at all what was done here, but that's not really relevant to the situation, but it incorporates some of the mercury chemistry that we rely on. I mean, some of these chemical reactions and updating the atmospheric chemistry happened very rapidly. I was just in Russia at a mercury meeting a long-range transport mercury meeting in Moscow and learned of some new reactions that had just come out, so we rely upon, both, what our colleagues tell us at meetings, as well as what the peer-reviewed literature has. I don't write down, and I don't have, like, a publication where I have listed all the atmospheric chemistry that I rely on. I rely on

what's in the peer-reviewed literature.

Q. I guess what the bottom line of what I'm trying to get at is what Sheldon would say is, is there a way that we can see how you describe the atmospheric transformation reactions? I assume there is some type of mathematical equation or part of your model or something that another person can look at and apply in a similar setting and test.

A. We don't use chemical reactions in our modeling. I stated yesterday that the receptor modeling does not use chemical reactions. We only used observed information.

Q. Then I completely misunderstood because I thought you said that, in evaluating where mercury came from, you made certain judgments, decisions about the atmospheric chemistry that mercury undergoes.

A. What we use as our understanding that reactive mercury is removed very easily with precipitation, which we have published and have observations that show this, and that elemental mercury is not removed as rapid, so again, this is based on observation of published work, and in understanding the information, we have an idea of how long reactive mercury would last in the atmosphere based on almost

instantaneous removal in precipitating systems. That's the atmosphere chemistry that I'm referring to is that there are different chemical properties of mercury forms that may get removed at different time scales.

Q. Do you have a numeric rate that you use to evaluate the removal of reactive gaseous mercury?

A. No, sir.

Q. When you say it's rapidly removed, what's the quantification of rapidly?

A. Well, we have hourly data, and you will see within an hour time frame a very rapid, so within an hour time frame, we see a significant -- more than 50 percent -- removal of the mercury within one hour of the onset of precipitation.

Q. When you talking about that data, what you're talking about is the data at your wet deposition sampling locations, correct?

A. That's correct.

Q. So the storm begins at five o'clock. At 5:15, you have a sample that's got a lot of mercury in it. At 6:15, there's no mercury, just --

A. The reactive mercury would have dropped, that's right.

Q. And what does that -- but is it correct

that you use that data to make decisions as to how much reactive gaseous mercury is in the air mass that's moving into Steubenville?

A. No. There's no assumption there.

Q. So how do you know how much mercury is in the air mass that's moving into Steubenville or where it's from?

A. We have on-site measurements of the reactive mercury at the site. There's no assumption. That is my point.

Q. What does it tell you -- what does that data tell you about -- well, step back. That's why you're not in position to identify the proximity of the sources based on the samples that you do at Steubenville, correct?

A. We have not done a detailed source apportionment of the ambient mercury at Steubenville, yet. What we have done at this point is look to see specific episodes when we have high reactive and particulate mercury to see what the meteorological conditions were like and where the air was coming from based on on-site meteorological measurements, as well as other meteorological data, such as the trajectories, to see if there is a strong association, so whether we see

repeated pattern of things like high sulfur dioxide, high reactive mercury, high nitrous oxide, high CO, whatever the on-site measurements we have, high particulates, and then we analyze the particulates for there elemental composition, as well, so we can look for the same tracers in the air as we see in the precipitation, and that analysis has not been completed, yet, because we collect four samples a day. That would collect them for -- well, we're on our third year now, and it's thousands of samples that we are in the process of analyzing, so that analysis and information will come. We do see strong relationships that winds that flow from the south, southwest with higher mercury levels and higher S02 (phonetic) concentrations that are indicative of transport from fossil-fuel-burning plants from coal-burning plants.

Q. What tells you that those are fossil burning plants, again, looking at this first map as an example in Kentucky, Ohio River Valley and not Houston?

A. Well, we have an idea of the location of where the fossil-fuel-burning facilities are, where all the sources are, and then we can look along that swath that we think where the air could have possibly come from, and we look at the inventory to tell us what the

possible sources could have been. It's an aid, not as a quantitative tool.

Q. Then you have to make -- then you have to evaluate whether precipitation events have washed out mercury that could come from other sources along that line. Is that correct?

A. That's right. It's something I have been working on for more than 20 years, so in my best expert judgment, I have done this for multiple pollutants, including mercury, and I feel like I have a very good handle on this situation, and on this type of analysis.

Q. If there was an example where there was an air mass moving into Steubenville, and there was no rain fall events going on along the line back to Texas, what would the results of Steubenville look like?

A. You know, I would have to go and look to see if we had those type of events in order for me to be able to predict because you can draw the same line moving from Steubenville to Texas, and depending upon the winds, how strong the winds were, and at all those segments, what the atmosphere was like, the stability of the atmosphere along the trajectory, the temperature profile, all these different meteorological parameters would affect disbursion, the chemistry, the transport,

and the dry deposition that occurred along that trajectory. One of the things that, if one was to take and estimate how much mercury you would expect left in an air mass that was submitted to Texas, by the time it got to Steubenville, one can take and estimate how much you would have expected to have loss from dry deposition, how much you might expected to have lost from chemical reactions, and just by the air mass being deluded as you got there and when you get that far back in time, there's very small contribution that you would see in Steubenville from sources way back in Texas, but that's a general comment. I would have to look at specific information to give you a quantitative answer.

Q. In doing that estimate that you just described, one of the factors would be the atmosphere transformation that mercury undergoes --

A. Yes.

Q. -- during that time of travel?

A. Yes, sir.

MR. HARLEY CONTINUES:

Q. The May 8 event that you described on your hy-split trajectory, is that one of the days during that year where there was an event that precipitation led to a significant deposition of mercury in Steubenville?

A. Yeah. That was one of the four largest events depositing. Again, I think I've given a figure of maybe the four largest or the several largest, as much as 8 percent of the annual total, so these are significant events that occurred at this site.

Q. In the two-year period of 2003, 2004, how many total mercury rains have there been on Steubenville comparable to the event on May 8 where we have hyperloading of mercury on Steubenville?

A. Gee, I don't have that in front of me. My memory is that we had in the two-year period about eight events that were greater than .6 micrograms per meter squared I believe, which that's a big event. And then a couple that were greater than one, and again, if you are looking at 10 to 20 micrograms per square meter at a year at a site, if you get more than one in one rain event, that's a significant contribution in that one day.

Q. There was one other question I had. The CMAQ model, you gave some reasons why the CMAQ model is it not as precise as the receptor-based approach that you used in Steubenville. One question I had about the CMAQ model is you said the CMAQ model underestimated mercury loading in Steubenville by comparison to the

results of the work that you have done. Is that correct?

A. Yeah. Just to qualify, the CMAQ for 2001 is where they calculated that 43 percent was coming from coal-fired utility boilers. Our data is from 2003, 2004, we did have the opportunity to compare our Michigan network sites for the 2001 year, together with our estimated for Vermont, and the CMAQ model underestimated the deposition that we measured at our Michigan sites and at the Vermont site for 2001. It was off by a factor of two at one site, as I recall, so it grossly underestimated the total deposition at our sites that we had measuring in 2001. The way you phrased it, "CMAQ being less precise" I think the way I would rather phrase it is that these type of models are more uncertain, that there are more parameters and processes that are poorly defined in these models, which make their uncertainties greater and the conclusions drawn from those models much greater than I would say that they are from the receptor modeling. That's a correct statement.

Q. Is the CMAQ model a model which accounts for, both, wet and dry deposition of mercury?

A. Yes, it does.

Q. And is it fair to characterize your testimony as indicating that, in the Steubenville situation, your modeling of wet deposition alone was greater than the CMAQ model of, both, wet and dry deposition at that site?

A. My memory tells me that CMAQ actually estimated a greater dry deposition at Steubenville than it did for wet deposition for the 2001 year, so no, our wet deposition wasn't greater than the CMAQ's total. I believe the CMAQ total was around 30 micrograms per square meter, or 34. It's hard to tell from the modeling because they do it in colors with ranges, but that, again, I'm just going from my memory of what Russ Bullock presented, but I believe that that's true, that the dry deposition was greater in this area than the wet deposition was. Using the CMAQ model, not from our observations.

MR. BONEBRAKE CONTINUES:

Q. On the May 8 back trajectory, a line, is that, essentially, indicative of a wind direction from the southwest?

A. Yeah. The line that starts at Steubenville or the line that starts at the site there on the border of Pennsylvania and Ohio, if you follow

that backwards towards the bottom of the left page that is trying to illustrate the most likely path that an air mass took before it got to Steubenville.

Q. In this particular case, through Texas and Louisiana, the air mass was moving from the southwest and northeast?

A. That's correct, southwest.

Q. Yesterday we talked a little about wind directions in Illinois. My understanding from your testimony was that, in the winter season in Illinois, the wind direction is frequently from the northwest. Is that correct?

A. Yeah. The Great Lakes region, as a whole, has a higher frequency of winds from the north, northwest during the wintertime as a result of synoptic meteorological conditions.

Q. And during the summer months, are winds in the state of Illinois most typically from the southwest?

A. From the data I looked at for O'Hare, it appears as if the south is the dominant winds with south, southwest being one of the more frequent wind directions, but knowing that westerly winds are also the dominant wind areas during the summer.

Q. Would O'Hare's -- would the direction of

wind at O'Hare be impacted by Lake Michigan?

A. Yes.

Q. So would the data from O'Hare, in your view, be representative of the rest of the state of Illinois?

A. No. If you look at wind measurements made in Southern Illinois, you see a slight variation in that overall pattern. You might have slightly more winds from the south than you would at O'Hare, so the winds will change slightly. The dominant wind direction still is going to be west with a southerly component being strongest.

Q. With respect to the northwest portion of the state of Illinois, would you expect, then, that during the winter months the predominant wind direction would be from the northwest and then the summer months it would be from the southwest?

A. South, southwest. From what I have seen for -- and again, I haven't looked at a climatological average, but that's about right.

Q. What would you view, Dr. Keeler, to be the states which contain upwind sources of mercury with respect to the state of Illinois?

A. Again, taking what you said in terms of

the dominant wind directions, you would have the states of Missouri, Iowa, and farther to the west would be upwind of Illinois, and then the states to the south, Kentucky, Tennessee, Louisiana, Alabama.

Q. Would Texas also be in that list?

A. Texas would be in that list, as well.

Q. One other question for you, Dr. Keeler. You mentioned in response to a question from Mr. Harley that you had done, as I understand it, a comparison of CMAQ predictions to Michigan deposition data that you had available to you. Is that correct?

A. Yes.

Q. Is that comparison in a published article?

A. No, it's not.

Q. Is that comparison publicly available?

A. You know, is it in Dr. Landis' briefing?

MADAM HEARING OFFICER: Exhibit 30, Beijing Exhibit 30, yes.

DR. KEELER: It says, "Comparison of CMAQ Model Versus" --

Q. Back toward the end of the document.

MADAM HEARING OFFICER: Yeah, two-thirds back he said. "Comparison of CMAQ Model versus UMAQL Measured Mercury Wet Deposition Testimony."

MR. BONEBRAKE CONTINUES:

Q. Is that correct, Dr. Keeler, that's the page you're on?

A. Yes, and refers to the left column to Dexter, Michigan.

Q. Helston, Michigan?

A. That's correct.

Q. Both, the CMAQ predictions and the deposition data that you were using in the comparison were both from 2001?

A. Yes, sir. These numbers were provided to Dr. Landis I believe by Russ Bullock of U.S. EPA, and these are the actual data that went into the CAMR modeling.

Q. Is there a discussion of this comparison in the study that's been at issue today in terms of what --

A. No. This is an additional analysis. The Michigan site data is not included in the Ohio paper.

Q. Other than what's in this particular page, has the comparison or the bases of the comparison otherwise been made publicly available?

A. All of the Michigan data for 2001 is in peer-reviewed publications and the CMAQ model results

are in the public docket that was filed by IEPA.

Q. So --

A. So it's all public.

Q. From your perspective, then, someone could take the publicly-available information in those documents and repeat the comparison?

A. Yes, sir.

MR. ZABEL CONTINUES:

Q. Earlier I think you said, in doing the corroboration using a Michigan inventory, you looked at sources east of the Mississippi. Is that correct?.

A. I said that was the area that we focused on, yes.

Q. You didn't use, for a particular corroboration, also sources east of the Mississippi?

A. Again, for trying to speak generally to be inclusive of all the work that we did for a particular event, we would use our understanding of the meteorologic and transport for a particular period, such as the May 8 period, where we would focus on those sources, and sources that were to the southwest, for example, in the most highest probable transport area, so we wouldn't be then taking out the list of sources from Minnesota and Wisconsin at that time to look at -- in

order to think about the May 8 event. On another day where the flow came from those directions, we would look at another set of sources that would help us interpret that specific day. We didn't limit our analysis to a number of sources. We had the entire -- plotted all of the sources plotted in 1999 EPA database together with a list of all those sources and the estimated fraction of mercury emitted from each source in each fraction as a tool to guide us in terms of our interpretation.

Q. That was sort of the point of my question, and the May 8 is a good example. There's some subset of sources east of the Mississippi you would have used in looking at emission inventories for them?

A. Again, we would have focused on the sources in the states which we thought had a probability of contributing on a specific day for a specific event.

Q. Just to make this perfectly clear to me, there are coal-fired plants in Tampa Bay in Florida. They would not have been included, would they, in your May 8 analysis?

A. I would say that I did not look at Tampa Bay power plants on interpretation of the May 8.

Q. On that May 8 one, both, Louisiana and Texas I believe are west of the Mississippi, were they

not?

A. That would be a geographically-correct answer.

Q. And in fact, Minnesota -- for instance, if you're looking in the other direction, although I understand Minnesota has a dispute on which side of the Mississippi they are in, at least, part of it is west of the Mississippi, is it not?

A. Yes, it is. In my use of east of the Mississippi and west of the Mississippi, I was trying to give a general division line, but as I mentioned earlier, I was not trying to distinguish an absolute line of demarcation for any of the analysis.

Q. Well, then in the May 8 case, would you have looked at cases in Louisiana and Texas?

A. We would have looked at sources along that trajectory, yes, or in that area that would be indicated by that air mass trajectory, yes.

Q. In answer to one of the questions I understand that cone gets wider the far away from Steubenville you get?

A. That's right. So sources all the way up from Kansas to Atlanta, Atlanta area, Georgia would also have been considered in looking in the backward upwind

path.

Q. Most of Texas, I take it, at that point?

A. Yes.

Q. Thank you.

MADAM HEARING OFFICER: Anything further? I believe 12-E --

MR. RIESER CONTINUES:

Q. This will actually address some of the questions, but since Mr. Harley brought up the comparison of CMAQ and the receptor modeling, it's correct, isn't it, that CMAQ in your type of receptors study are designed to achieve two different results. Is that correct? It's designed for two different purposes. Is that correct?

A. How a model is used is defined by the user and so in my case, which I can attest to, we were using receptor models to calculate how much mercury was deposited via wet deposition from the major source categories for the period of 2003-2004. So that apportionment to source categories was our objective, and that's where we did the modeling. Why EPA did the CMAQ modeling for 2001? As I understand, it was to estimate the contributions from all the major sources to the deposition of mercury across the entire United

States, so by definition, it has a broader purpose, and was not looking at one site. It was not looking at just wet deposition. It looked at wet, dry, and ambient, so yes, they have -- they have different purposes, but to say CMAQ model has one purpose and the type modeling we did had only one purpose, it really depends on what the user was using that model for.

Q. The CMAQ model, among its utilities, is that it can be used for predictions. Isn't that correct?

A. Yes, sir.

Q. So you can use it to decide what would happen, as an example reflected in Exhibit 30, "Utility zero out," of what mercury deposition would look like if there were no utility emissions?

A. Yeah. I believe, like you said, in Exhibit 30, I believe that map included a couple special plots. Maybe I'm wrong.

Q. You're correct. There is a CMAQ simulated total mercury deposition for 2001 and underneath it says, "Utility zero out," and prior to that, there's a base case CMAQ simulated total mercury for 2001 base case, so as we said, you can use CMAQ to, as an example, take out all of the utility emissions and see what

things look like?

A. Correct.

Q. Can you use your model to do that?

A. The receptor model, by definition, does not have a predictive capability.

Q. So if I -- well, let me ask you, if you assumed that the coal-fired power plants, within a 50 kilometer range of Steubenville, ceased to operate, would you have any conclusion as to what that would do to the mercury deposition in Steubenville?

A. Based on our work, what I would say is that if the coal-fired utilities, regardless of location, stopped emitting, so they were zeroed out, we would see close to a 70 percent reduction in the mercury deposition that we measured at Steubenville.

Q. Could that conclusion, in making that statement, what you were referring to are not the coal-fired utilities within a 50 kilometer distance from Steubenville, but all coal-fired utilities in the United States?

A. We -- again, based on our analysis, our meteorological analysis, we will consider sources that were beyond regional, so very long range sources, so ones that are the western part of the United States

would contribute very little to that total and part of that is backed up by just looking at the deposition data that's in the Western United States, which is very low. It's for around four micrograms per square meter, so I would say that it's the sources in the eastern United States coal-fired utilities in the Eastern United States which are contributing that 70 percent, and if those were reduced, we would see that commensurate drop in the mercury deposition at that site for those years that we modelled.

Q. But you wouldn't be able to use your receptor model to determine what would happen at Steubenville if, for example, all the power plants in the state of Ohio reduced mercury emissions by 70 percent?

A. No. The model is not capable of predicting calculations.

MADAM HEARING OFFICER: Are we ready, then -- I believe we have answered 12-E and I think perhaps 12-F already. In the discussion we had this morning, E is, "Does the analysis differentiate between sources located at different distances?" and we have had substantial discussion about --

MR. RIESER: Correct, yes.

MADAM HEARING OFFICER: F is, "Have you quantified the substantial amount as used in this statement?"

MR. RIESER: I was looking at the wrong number, yes, correct.

MADAM HEARING OFFICER: And we answered 13-A and B yesterday, so 13-C.

DR. KEELER: I actually believe I answered this one as well. "Are they fired with bituminous or sub-bituminous coal?" Again, in the complete listing of the emissions sources and the EPA inventory, it lists the type of coal burned. I believe there is a mix of plants that burn, both, bituminous and sub-bituminous. Some are all sub-bituminous and some are -- a few that are bituminous, so there's a combination. D: "Does the chemical profile of bituminous as opposed to sub-bituminous affect the amount and type of mercury emitted by a coal-burning generating unit?" Again, I believe I answered this yesterday in saying that I'm not an expert on control, and so perhaps, an expert for the State will provide -- later will talk about how various control will affect the emissions, but clearly, the type of coal burned will have an influence on the type of type and form of

mercury, in respect to whether it's reactive mercury or gaseous mercury or particulate mercury and we talked about the importance of chlorine and fly ash content and iron and others things in the coal that would cause those differences. E: "Would you expect a different result at Steubenville if the surrounding units burned sub-bituminous coal?" I don't have the ability to provide an answer to that question. I don't understand exactly what you are asking. I assume that the power plants in the area are not -- from an inventory, some do burn sub-bituminous coal, so I'm not sure if you are asking me if all the plants in the Steubenville area burn sub-bituminous but I see --

Q. I am asking, if all the power plants surrounding Steubenville burn sub-bituminous coal, would you expect a different result?

A. Again, I guess I'm not prepared to answer that question. I think I would have to have more understanding of how changing to a different coal type for the various types of controls that are used in that area would affect speciation and I'm not prepared to answer that.

MADAM HEARING OFFICER: And I believe you have answered 13-F, as well, whether airborne

sources of mercury are located within 50 miles.

DR. KEELER: So G: "In what way, if any, are the conditions at Steubenville analogous to the conditions in Illinois?"

MR. RIESER: To be honest, there was some movement in that answer, so if we get too repetitive, cut us off, but I would like to go through this because I heard two different things, to be honest.

MR. KIM: Could you clarify what you mean because Dr. Keeler did describe the distinctions in terms of meteorological conditions and so forth and I recall him going into something about topography. Were you wanting something beyond that, something different?

MR. RIESER: What we're looking for is whether the findings with respect to Steubenville are analogous to Illinois, and some of that discussion has to do with things that were discussed and things weren't discussed. I heard, on the one side, Steubenville was typical, but in some ways, it's obviously atypical due to the amount of power plants that are around, so I think we need to walk through each of the features and talk about them.

MR. KIM: There again, I'm just for my sake just trying to get it clear. You said, "What we

want to know is whether the finding at Steubenville are analogous to Illinois." When you say the findings at Steubenville are analogous, you have to be comparing that to some findings in Illinois, I assume, so are you referring to something specific, or are you saying can the findings in Steubenville be transferred to Illinois?

MR. RIESER: I'm assuming this testimony he has presented had some meaning to the Board as far as what the study means and the decisions they should make with respect to Illinois, so I do think we have to decide how applicable these findings are to Illinois.

MR. KIM: I agree. The only reason I'm saying that is he's already provided testimony that he believed the findings could be applied, not only to Illinois, but to other locales, once you take individual variances into account. With this question on its own is read, it seems like you are referring to something specific, some kind of fact-specific situation or --

MR. RIESER: I'm happy to break it down if the question, itself, is not clear. I'm happy to break it down and go through each of the issues that I had in mind and maybe that will take care.

MR. KIM: Let's do that.

MR. AYRES: I thought we had a discussion that went for, at least, a half an hour.

MR. KIM: I think, if you break it down, my guess is some of that stuff has already been answered, but if you want to break it down, that's fine.

MR. AYRES: There was a discussion that was very fact specific, and then we talked about the transferability of the learning, if you will, from Steubenville. Do you recall that?

MR. RIESER: I recall that and my problem is my recollection is -- my recollection is that the answer wasn't clear. There are, obviously, some informational issues that are portable and Steubenville was a very specific place that has the conditions that are represented because of conditions that are specific to Steubenville.

MR. KIM: Sure.

MR. RIESER: Seriously, I think we could have got through this pretty quickly.

MR. KIM: I wanted to be clear.

MR. RIESER CONTINUES:

Q. I honestly don't mean to belabor the point, but I just don't think it was clear on the record. Let me ask, Steubenville is in a river valley.

Is that correct?

A. The city of Steubenville has part of its boundaries that fall in the Ohio River Valley, that's correct.

Q. Was the sampling location in the part of Steubenville that was in the River Valley?

A. You get down to, I think, definitions. I think, technically, that whole area is in the Ohio River Valley, but just to be clear, in terms of topography, the site was not down on the river in the valley. It was actually up on top of the area that then flattens out going to the west in Ohio, so it was not down in the valley where local sources would have inundated the data that we were getting. It was actually up on top, and I think, like, 400 feet above the river, to be clear.

Q. Is the meteorology of the Ohio River Valley, as you have described it, different than the meteorology one would typically see in Springfield, Illinois?

MR. KIM: I think this has been answered. I think he went through an extended discussion about meteorological distinctions between Steubenville and other parts of any other part of the country. I think his specific testimony was you are not

going to find that replicated anywhere, but Steubenville.

MR. RIESER CONTINUES:

Q. Is that your testimony?

A. I think what I said yesterday was that the conditions at Steubenville, in terms of the overall source-receptor relationships, which meteorology is a part of, are specific, to a point, and that those would be unique to Steubenville. The question is whether the conditions in Steubenville make it anomalous, or somehow unique where the results would not be transferable to somewhere else in Ohio, somewhere else in the Great Lakes or in Illinois and I would suggest that the conditions are not unique or anomalous to make them so they are not usable or transferable to conditions that we would have in Illinois.

Q. What are the conditions that are not anomalous?

A. The weather in Ohio, just as it is in Indiana, Illinois, Michigan, Minnesota, Wisconsin, are all controlled by synoptic meteorology, which is the large scale movement of the highest and low pressure systems across the Great Lakes, so unlike some places where they have some dominant feature, such as Bermuda

high, which may dominate the weather in a certain location, that might make it different than another one. The Great Lakes, themselves, are dominated by synoptic meteorological transport, and therefore, as long as you're taking into account the specific meteorology that occurs at that spot, it's not going to be all that much different. The controlling factors are not that much different for Illinois than Ohio.

Q. Do the presence of a large number of power plants surrounding Steubenville, does that factor make it anomalous to other locations?

A. Again, I think I said this before, but I believe that the high density of power plants in the Steubenville area is a prime reason why power plants are a prime contributor to the extremely high deposition that we see there. However, in another place which would have a similar density, I believe you would see a similar result.

Q. So to see a similar result, you would need a similar density of power plants?

A. You could get similar amounts of deposition different ways, but if you want to ensure that you saw elevated, like, 70 percent contribution of the power plants, you would need to have a significant

emissions, upwind emissions, in the local vicinity. Again, the upwind vicinity, to be clear, of the receptor model or the receptor site.

Q. When you use "upwind vicinity" in that sentence, what, specifically, do you mean?

A. The greater region.

Q. What is "the greater region"?

A. The local and regional area surrounding the receptor.

Q. The local and regional areas we defined --

A. Previously.

MR. ZABEL CONTINUES:

Q. Dr. Keeler, what is the closest coal-fired power plant to your monitoring site?

A. I believe it's the Samis plant located about seven kilometers north of the Steubenville location.

Q. Is the Samis plant on the river?

A. Yes, sir.

Q. What's the height of the stacks of the Samis plant? Do you know?

A. It's fairly tall. I could look it up, if you would like me to, but my guess is it's 400 or 500 feet.

Q. But it's on the river?

A. Yes.

Q. So it's 400 feet lower than your monitoring site?

A. The base of the plant is 400 feet lower, and because it's seven miles up the river, I actually don't know if it's the top of the topographic change, which would make it more than 400 feet.

Q. Seven miles or seven kilometers? There is a slight difference.

A. I believe it's seven miles.

Q. Was there any conversation of plume impact from the Samis plant?

A. We actually looked for plume impact on the Samis plant in out ambient data. We have not modelled specific events, but we believe that we see, again, plume impacts at our site. We haven't definitively looked and said, "This is the Samis plant," but we do see indications of a coal-fired utility to the north of our site impacting the levels of mercury in SO2 and other things that we have seen there.

Q. North of the plant would not be on the river, I take it? I'm not familiar with the geography. I'm just asking.

A. Yes, it is.

Q. So it would be lower than the monitoring site, as well?

A. The height of the stack might be comparable in height to the elevation of the monitoring station.

Q. How far away is that plant?

A. I'm sorry?

Q. You said same as the north?

A. Yes.

Q. I thought you identified the second plant.

A. No.

Q. We were just talking about Samis?

A. That's correct.

MADAM HEARING OFFICER: Question H, then.

DR. KEELER: "Is this high density of coal-fired units reflected in the CMAQ modeling performed by U.S. EPA?" Again, basing my answer completely on the figure that you can see in the Exhibit 30, the one we were just referring to, the base case, I would say yes. Question I: "Is it reflected in the TEAM modeling performed by AER?" My answer is I don't have a recollection of seeing that output. I may have

seen it. I just don't recall whether it was reflected or not.

Q. Was it part of the literature that you reviewed and you talked about reviewing model an --

A. I have read several papers in the peer-reviewed literature that described and talked about TEAM model and so forth. I just don't recall seeing or visually cueing in on some area that had a specific impact from a specific source type.

MADAM HEARING OFFICER: Mr. Rieser, I believe that you asked earlier I got the answers to J and K on the comparison of the Steubenville research with the CMAQ.

MR. RIESER CONTINUES:

Q. That's correct, but I have one follow-up on that, which is sort of the opposite. Do you know what steps the U.S. EPA has taken to compare the results of CMAQ to your work in Steubenville and what their findings were?

A. Only, again, what you can see presented in Landis presentation, that is the only thing I'm aware of.

Q. Are you aware of the response to significant public comments received in response to the

revision of the December, 2000, regulatory findings on the emissions of hazardous air pollutants from the utility, electric utility, steam generating units, and the removal of coal- and oil-fired -- the reconsideration technical support document that came out?

A. I got an E-mail as an announcement from someone saying that this report came out. I have not had a chance to, either, down load it, or read any of the pages.

Q. So you haven't read the response that says the results of the Steubenville, Ohio, receptor modeling study corrected by EPA, ORD, Office of Research and Development, that Dr. Landis -- are consistent with those entangled by the CMAQ modeling?

A. Okay.

Q. You have read that?

A. No, I have not.

Q. So you haven't had a chance to review why they say that and determine a response?

A. No. I have not downloaded that report or read any portion of it.

Q. Thank you.

MADAM HEARING OFFICER: L.

DR. KEELER: May I make a follow-up comment? I think it's important to know that my modeling half compares to my measurement half. The idea of a good comparison is a different definition, and so in the EPA case, without having read what they actually say, they might view a 43 percent contribution based on the 2001 year to be fairly similar to a 70, plus or minus, a 14 or 15 percent contribution from the receptor modeling, so just to know how they interpret "good" and the words that you used for that. I know that they are trying to put the best fit on that as they can.

MADAM HEARING OFFICER: Mr. Rieser, what exactly were you reading from?

MR. RIESER: I was reading from the Technical Support Document, which is attached to the reconsideration of the CAMR, mercury CAMR that the EPA announced on June 9 of 2006. It was in the Federal Register on that date, which would be 71 Fed Reg. 33388 through 333402. I'm not sure if that's -- I have just been advised that this is the Federal Register for the actual reconsideration discussion, which actually contains a little bit of this in there. The response to comments which I read is not in the Federal Register. It's on the U.S. EPA website, so I will be happy to

provide a copy to you.

MADAM HEARING OFFICER: Thank you very much. For the record, obviously, since this isn't the federal register it's a public document and obviously, we, at the Board, look at the Federal Register, but for purposes of the record, it's probably best if we also put the Federal Register reconsideration of CAMR in the record at the same time. Do you have a clean copy of that?

MR. RIESER: I have clean copies of either one, so if I may, if I could bring some copies Monday --

MADAM HEARING OFFICER: That would be great. Thank you.

DR. KEELER: Are we -- K is gone. "What steps have you taken to compare the results of your Steubenville work with the EPRI TEAM deposition models, which was included in the CAMR docket?" Again, this was not the scope of work, nor the scientific objective of the project that I performed, so it was not done. Obviously, M is not applicable. That finishes Ameren's questions.

MR. KIM: I asked for a short break because when we might have neglected to send him the

four questions that were presented by Prairie State and I think he confirmed that he hadn't seem them, and I think some of them may have been answered, but I want to make sure that we get all the questions answered.

MADAM HEARING OFFICER: I think Question No. 1, "Have the details of Steubenville model been made publicly available?" That's similar to the Ameren -- quite a bit of discussion. Second, "You state that 70 percent of the mercury wet deposition in Steubenville comes from coal-fired power plants. How far have you traced back power plant plumes to reach that conclusion?" Hundreds of miles, and we also discussed that today.

DR. KEELER: Much longer than that.

MADAM HEARING OFFICER: So I think question No. 3 you might want to elaborate.

DR. KEELER: "Have you modeled what wet mercury deposition is predicted in Steubenville after implementation of CAMR? I actually just answered this question to some extent. Our model does not have predictive capability, so we are not able to do that. So the rest of the question is not applicable and 4: "Would you expect coal-fired power plants to contribute 70 percent of the mercury to wet deposition at every

location this the United States?" One of the things I think would be worthwhile just pointing out -- the answer is no, and one of the things that's worth pointing out is when you hear these estimates of 8 to 10 percent of the mercury deposition in United States is from U.S. sources it's kind of a small number. They are talking about the entire land area of the United States. Every one single square area and most of the coal-fired utilities are in the Eastern United States, the eastern one-third of the United States, and you would not expect to see 70 percent contribution to Southern New Mexico, so obviously, you would not expect that. Continuing with that question, if not, what is the contribution of the Illinois coal-fired power plants to mercury wet deposition in Illinois?" I'm not sure exactly how the questions are connected, but again, I don't have a quantitative estimate for that to answer that question.

MADAM HEARING OFFICER: Anything further?

MR. RIESER: Just to note for the record that Mr. Bonebrake advised me that he had, in a fit of preparation, actually brought copies of the reconsideration for the federal register, and so we will present those now. Giving the first copy to Mr. Harley.

MADAM HEARING OFFICER: I will mark this. This is the actual Federal Register from June 9, 2006. It's the reconsideration. It's not the comments. We will mark this as Exhibit 31, if there's no objection. Seeing none, it's Exhibit 31.

(Exhibit No. 31 was admitted.)

MR. FORCADE CONTINUES:

Q. Yes. If I could, I would like to ask a Steubenville question. If I could, I would like to direct your attention to three documents in the record and sort of lay a frame work for the questions. The first one is Ms. Willhite's testimony on page 3. Why don't you grab that. In particular, in that document on the middle paragraph contribution from point sources, there was a sentence, "It was determined that the total of all waste water discharges to receiving rivers and streams in Illinois provide an average annual loading of 45 pounds of mercury." Do you see that?

A. I do.

Q. The second would be --

MADAM HEARING OFFICER: For the record, Ms. Willhite's testimony is Exhibit No. 8.

MR. FORCADE CONTINUES:

Q. Would be the Technical Support Document at

pages 68 and 69. On the bottom of 68 and top of 69 in the reference to total mercury loading from MPTS sources, and the third one would be your prepared testimony at page five, the last paragraph, in which you talk about the importance of coal-fired power plants to the loading of mercury in large lakes and many down inland lake which is have been identified as impaired waters. The distinction I'm trying to suggest here is we have talked a great deal about deposition, but we have not particularly identified as much background information on loading to the lakes and streams, and I would like to ask a few questions, if I could, to explore that.

First, would you say that past and present loading to lakes and streams, particularly impaired streams, is important in determining the amount of mercury available for methylation?

A. Yes. It is important, and I would like to add that some of the more recent research that had been performed through the halogen project (phonetic) and other work which has been published by Cindy Gilmore suggests that it's the mercury that's recently deposited from the atmosphere that is the most important in terms of cycling and methylation and contamination of the

ecosystem.

Q. I'm still trying to restrict right now my questions to the loading to streams. You, again, mentioned deposition.

A. Because deposition is the primary input to most streams.

Q. You're running a bit of ahead, if you wouldn't mind. Would you identify what you would consider to be the sources of loading of mercury to impaired lakes and streams?

A. Well, there's tributary inputs that load. There's nonpoint sources from agricultural and animal feed lots. All of the runoff from industry sites, basically, runoff from the land into tributaries and then direct discharges from point sources into either tributaries or inputs to those lakes and streams.

Q. Have you done any studies to try and evaluate those specific forms of loadings and quantify them?

A. Anywhere?

Q. Yeah. Let's start with anywhere.

A. Yes.

Q. Could you tell me what studies you have done?

A. We did a rather large study in the city of Detroit trying to -- not trying, with the objective to quantify the importance of atmospheric deposition and the goal of trying to identify the most significant sources of mercury and PCB's to the receiving waters that feed into the city of Detroit's waste water treatment facility.

Q. I'm sorry. Was that loading to the sewers and waste water treatment facility?

A. Yes. In other words, we worked with the city of Detroit's waste water -- the water and sewer department to quantify how much mercury was coming into the head of their waste water treatment plant from all of their network, which is a fairly large network of homes, industry, combined storm sewer overflows and so forth, and then to look at how much mercury they then discharged, and part of this was wrapped around their MPDS permit looking at how much affluent mercury they put out and what forms, and how far of this was related to atmosphere I think deposition.

Q. So you have done studies on the amount of and source of mercury entering into a public-owned treatment work?

A. Yes.

Q. Have you done similar studies for a stream or lake?

A. We have not done an exhaustive study in trying to estimate the inputs to a specific tributary. We have done some monitoring in the state of Michigan trying to look at kind of upstream-downstream relationships for mercury on rivers in Michigan, but again, those were not meant to be exhaustive, in terms of, specifically, quantifying the runoff from agriculture, versus industrial discharge. It was just trying to see if we could find an influence of an urban area on a specific river or tributary.

Q. Could you identify the number or name of those studies for me, so I can ask some questions on them?

A. The one was -- I don't know what the initial name was, but it was something like "Mercury Levels in Michigan Rivers and Surface Waters" done with the Michigan DEQ in the 90's. I actually don't remember the exact year, sometime in the 90's, though, and then the other study we did was something mercury PCB's and cadminium (phonetic) in affluent -- at the city of Detroit's waste water treatment plant, something like that.

Q. The second one you mentioned, would that be the POTW study you discussed earlier or was that a third?

A. No. That's the same one.

Q. So excluding the publicly-owned treatment works, as far as streams lakes and rivers are concerned, you have one study which was the 1990 Michigan study. Is that correct?

A. Where we look, specifically, at streams and rivers.

Q. The loading of mercury to streams and rivers.

A. Again, as I mentioned, it wasn't a study looking at -- it was looking at levels of mercury kind of upstream and downstream of different urban areas or towns, so that would be my only experience.

Q. Regarding the 1990 -- do you want to call it study or do you have another term?

A. Which one are you referring to?

Q. The 1990 Michigan --

A. Michigan study. That's fine. When you are asking me that, you are not asking me to talk about the Lake Michigan Mass Balance Study.

Q. No. I'm asking you what you have done to

evaluate the mercury loading to streams and rivers.

A. That's not my main focus area, in terms of research.

Q. I understand, so the 1990 Michigan study was the only one that you can point to, specifically. Is that correct?

A. I guess, yes.

Q. Could you describe in detail what you did in that study?

A. We made measurements of -- well, I should say the Michigan DEQ took water samples using the systems that we developed to measure total and dissolved mercury and other metals in a series of rivers, and I believe maybe lakes and across the lake and in situations where they could make a measurement, and say, upstream of Ann Arbor and downstream of Ann Arbor in the Huron River, for example, to see if there's an influence of the runoff and inputs of metals and mercury into the stream related to that area, so it was a way to get some survey data across the state.

Q. When you say the Michigan Department of Environmental Quality samples, these were water quality samples?

A. Water quality, only.

Q. Water quality, only. Do you have an idea of, approximately, how many sites were studied or samples were taken?

A. I don't recall the total numbers. It was in the hundreds.

Q. Was it a large geographic area or was it a single stream segment?

A. I know that it encompassed the entire lower peninsula.

Q. Of Michigan?

A. Yes.

Q. That would be a big study, then.

A. Yes, sir.

Q. What was your function, then, to take the analytical results from Michigan DEQ and evaluate them in some way?

A. No. Our lab that was doing that provided the sampling equipment and did all the analytical determinations of mercury and metal concentrations in the samples collected and provided them with the recorded findings. Because that's outside my typical area of research, I didn't spend any time evaluating the data, other than for the quality of the information that was collected.

Q. Did you draw any conclusions from the data or was your evaluation simply, "Here's the analytical results"?

A. As you had described, "Here's the analytical results."

Q. So you performed no evaluation of the sources or impacts or --

A. No, sir.

Q. Have you done any evaluations of the loading of mercury to stream segments, other than this that would be relevant to determining the amount of mercury coming into the lakes and streams?

A. I think I have said that my expertise is not in tributary or aquatic science. It's in atmospheric science, so I have not performed input analysis.

Q. Do you have any method or are you aware of any additional reports that have been done which evaluate the amount of loading to specific stream segments of mercury comparing, for example, air deposition, versus upstream water deposition?

A. Well, there was an extensive amount of work down by the University of Wisconsin and the USGS, as part of the Lake Michigan Mass Balance study in

looking to -- I don't know how many tributaries into Lake Michigan, and I know they have done an exhaustive amount of work for Lake Superior for exactly that same purpose for mercury and trace elements, and I have seen presentations, and I know there's, at least, a few publications in the peer-reviewed literature on that.

Q. The analytical results that you conducted for the Michigan study, those are water quality evaluations for mercury water analysis for mercury content?

A. Yeah. They were analysis of liquid samples that were taken from surface bodies of water.

Q. When were those done?

A. I said I believe it's in the mid 90's. I don't recall the exact date.

Q. Do you happen to recall what analytical method you used to test the mercury?

A. Sure. I used coal vapor atomic fluorescence for the mercury and I used ion-coupled masstometry (phonetic) for the trace element analysis.

Q. So would that be Method 1631, Provision E of the mercury analysis?

A. That protocol came out after, but our protocol is almost identical. I mean, we did not follow

their protocol. We have our own protocol that has been subjected to Agency peer review, and proved quality assurance, quality control plans that we use in all of our work.

Q. What was your method detection limit?

A. For that study, I would have to go back. I don't recall the detection limits for the 40-some elements that we did.

Q. I'm sorry, restricting my evaluation here to mercury.

A. Again, I don't recall, but it was for that -- we determine a method detection limit for every study we do, based on the actual data, which is defined as seven times the standard deviation of repeated analysis of a low standard, and I don't remember the exact number. It's -- I believe it's around a tenth of a nanogram per liter, could be lower than that.

Q. Prior to the 1990 Michigan study, did you do other evaluations of mercury concentrations in water?

A. I did determinations of mercury in cloud water and fog water, yes.

Q. What time period would that be in?

A. Late 80's.

Q. Did you use the functional equivalent of

1631 for those tests, too?

A. No. We used a much more elaborate and exhaustive technique that requires a nuclear reactor. I did this work at the Institute of Technology while I was visiting scientists there.

Q. Prior to 1990, if you did not have access to a nuclear reactor, would you not have commonly used Method 245 or a similar method for determining mercury content in waters?

A. I'm not sure I can answer that question. I'm not 100 percent certain I know what "Method 245" is, and I know that -- well, I'm not sure I can answer that question.

Q. If you had conducted a water analysis for mercury prior to the 1990's, and prior to the implementation of your test protocol, do you know, approximately, what the method detection limit would have been available for those prior test methods?

A. If you are talking about research methods or are you talking about those that would have been used by states or EPA? I mean --

Q. States and EPA and facilities subject to mercury testing.

A. You are asking me to give you a historical

account of the analytical techniques through the 80's?

Q. That would be one way of getting to my question, but another way would be to say is it your understanding that Method 1631 is described as being, approximately, 250 times more sensitive than the prior testing protocols for mercury with significant increase in lowering of the method detection limit?

A. I don't know the numerical number, but from the early 1980's, the methods that were used such as atomic absorption and coal vapor atomic absorption have detection limits that were much higher, so they were unable to see the small quantities of mercury that we can see, starting in the late 80's. For some reason, they were already beginning to use those low-level techniques in the early 80's. Nick Bloom and Bill Fitzgerald and his students at the University of Connecticut had these techniques at their disposal. The widespread use of those were regulatory, and other monitoring purposes did not happen in the 80's.

Q. I believe it would be 1990 would be I think the first -- do you happen to recall when the first version of Method 1631 came out or its equivalent, which uses the nanogram detection limit?

A. I don't know the exact date because I

restarted using something that was similar before that method and it actually worked its way through the system.

Q. Would you believe it would be common, prior to that time, for the detection limit to have been about one part per billion or slightly less for most of the common analytical procedure in use by states and dischargers?

A. Well, my understanding, again -- and I can't say this is for most or I can't put a quantitative number on it, but I would say that most places that were doing fish contaminant work and so forth had, at least, a detection limit of 150 parts per trillion maximum before they moved to coal vapor atomic fluorescence and some of the other techniques, so it was quite a bit higher than the .1. I mean, that's a thousand fold different than I just quoted you 150 parts per trillion versus the .1 that we are able to do now.

Q. But that was for --

A. Total mercury.

Q. Tissue evaluation?

A. Mercury analysis. Are you asking me for surface water?

Q. All my questions relate to mercury testing

for surface water.

A. I don't know the exact number to give you, but your basic premise is correct, that detention limits were very high and could have been approaching a part per billion prior to the advent of the work that Fitzgerald and his students did in the early 80's.

Q. If you were to evaluate the loading to a stream, as you mention on page five of your testimony, how would you determine the components, other than air deposition?

A. Again, this is outside my area of expertise, but I did participate in the Lake Michigan Mass Balance study and from working collaboratively with the University of Wisconsin and the USGS and people who did that work, as I understand it, they make measurements of the hydrograph, the flow of water coming in from all the major tributaries they think are important, and then try to take samples for mercury using approved clean techniques to then ascertain what the amount of mercury coming in along at different flows from that tributary, and then sum those numbers up, so they are a flow-proportioned calculation of how much mercury would enter into the body of water that you are interested in and studying. That's, more or less, what

they did for all the tributaries for Lake Michigan. In doing that, you come up with a total mass that entered Lake Michigan from the Sheboygan River, and you do that for every single one of them, so it requires an enormous amount of work and a lot of monitoring.

Q. If you were to evaluate, for example, an impaired lake or stream in Illinois in an attempt to determine the amount of air deposition in loading to that stream and compare it to the loading from other sources, what would you do for the air deposition portion to determine loading of that stream?

A. You are asking me, personally, what I would do?

Q. Yes.

A. If it was a specific stream that I was interested in, I first have to evaluate how long that stream was, whether I felt that one monitoring location would represent what would be coming into that stream if it was extremely long, 20 miles long, or if it's something longer than that, I would evaluate what point sources were contributing to that stream, and then look at the land use types around that stream, and then make a determination whether I needed to put one or two deposition where I would collect the amount of

precipitation that fell and I gauge it, so I would have a number of rain gauges and so forth along there, so I could get an accurate description of the amount of precipitation that fell into the stream and maybe even put multiple gauges on that stream, so I could get the flow of that stream, so I could have a good idea of then the mass of whatever contaminant I was looking into the stream, but it would be very stream specific, and it would require some analysis of the situation and on-site recognizance and so forth.

Q. If you were to complete such a study and determine what you felt was an appropriate level of loading from air deposition, that would simply be one component of the loading to that particular stream segment, wouldn't it?

A. Yes, sir.

Q. And there would be another section at which would be the water component, sediment component. Those other components would all contribute to the total loading?

A. I didn't say explicit, but clearly, you would have to make repeated measurements of the stream, the water body of interest, both, the liquid sample, as well as the sediments, anything else you think could

have contributed to the loading or movement of the contaminant through that stream.

Q. There would be no way that you could possibly determine the relative proportion of the air loading to that stream segment without knowing the other components of contribution, would there?

A. If I was an engineering firm who was requested to make a determination of the importance of runoff, atmospheric deposition and so forth, I would use my best expert judgment and use what data was available to estimate the importance of these. In many cases you don't have the actual measurements, so you have to use expert judgment, and use whatever available measurements are there to give an estimate for that. In the best of all worlds, I would like to have measurements. I'm a very measurement-greedy person. I like to have measurements for all those things that I said, so I can be certain of my conclusion. However, in making a best estimate judgment, one would use the available data that you had and put some air bars on how precise or imprecise you would be able to estimate the various inputs.

Q. Directing your attention to page three of Ms. Willhite's testimony and page 69 of the Technical

Support Document, in which it suggests that the average MPDS has loading to Illinois streams was 45 pounds and then comparing that to 7,022 pounds per year of mercury emissions, that evaluation wouldn't give you any way of determining for an impaired stream what portion was coming from air deposition and what portion was coming from other sources, would it?

A. Those two facts by themselves do not allow you to calculate the specific proportion coming from the atmosphere, versus what was coming from the tributary to a specific stream.

Q. Would a portion of the reason be because it talks about emissions to the atmosphere, rather than amount loaded to the Illinois streams from air deposition?

A. I think that's one source of uncertainty, yes.

Q. There would be no evaluation in the sentence that you see there about other contributing sources, such as sediment movement, nonpoint runoff, combined sewer overflows, types like that?

A. I'm sorry. I don't know where you are referring to.

Q. The reference to the 40 pounds of MPDS

loading compared to the 7,022 pounds of air emissions, it makes no reference to any contribution coming from surface runoff from sedimentation moving downstream or other sources, does it?

A. I don't see any listed here.

Q. And would you consider that to be one possible input to the stream loading for an impaired water?

A. Yes. There is one potential input to a potentially impaired water, yeah.

Q. Would you have any information that would allow you to draw a rough conclusion of the amount of stream loading to a particular stream segment that would come from air deposition, versus other sources, generally?

A. I wasn't asked to look at this or address that, and that's not, again, in my typical line of research. If I was asked to do something like that, I may be able to put that information together, but I did not do that, and this is the first time I have actually thought able calculating something like that. I mean, we have looked at this issue, in terms of looking at one of the things we found on the Lake Michigan Mass Balance Study was there a fairly large amount of the input to

tributaries that they couldn't account for by looking at runoff from agricultural areas or runoff from surfaces and so forth, which we did a rough calculation and determined that most of those was probably from atmospheric, so it was the mercury that was in the rain that fell to the ground, and then wound up running off into the tributary. It was in the soluble phase, and so forth, but that kind of gets at what you're asking me here, but I have not addressed that question, specifically, in this case.

Q. Right, but what you're talking about there is mercury entering in the equatous (phonetic) phase. Is that correct? You're not talking about --

A. Yeah. The river has water in it and the rain fell and fed and goes as a liquid into the river, yeah.

Q. So for the evaluations that you were doing in Michigan, and for the discussion you just had, would you use filtered samples to determine the mercury content?

A. If I wanted to understand the mechanism and the physiochemical transport from various fields and so forth, I would take a total sample and definitely filter it, so I could look at the total and dissolved

phase, yes.

Q. And historically --

MADAM HEARING OFFICER: I apologize for interrupting, but are you going to be able to wrap this up? I don't want to cut you short, but it's 10 after 12, and we've been back at for a couple hours, so if it's going to take another 20 minutes or so we might want to go ahead and take a break, but if it's only going to take a couple -- it's up to you.

MR. FORCADE: I'm not sure whether it's going to take me five or 15. I'm not sure.

MADAM HEARING OFFICER: Let's go ahead and go to lunch because we have been back at it for a couple of hours.

MR. FORCADE: That's fine. I just don't know.

(At which time, the proceedings were adjourned for a lunch break.)

MADAM HEARING OFFICER: I believe Mr. Forcade was asking Dr. Keeler some questions. Let's go back.

MR. FORCADE CONTINUES:

Q. We had a lengthy discussion at lunch about the co-benefits discussion about the co-benefits of

concluding the testimony as early as possible on a Friday afternoon, so I may be able to conclude with one or two more questions. Dr. Keeler, if I'm not characterizing this correctly, please let me know, but I believe that you've made attempts to identify the source of mercury deposition by what is, essentially, a fingerprinting to identify the source categories. Is that a paraphrase?

A. No. That's correct.

Q. Have you done anything to try and identify the mercury present in fish in a similar manner?

A. I, personally, have not.

Q. That's it.

MR. HARRINGTON CONTINUES:

Q. One question. The City of Detroit Study that you did concerning BOTW's, do you know whether there was any effort to characterize, either bypasses or combined sewer overflows during that study and their impact on receiving waters.

A. Our study was focused completely on quantifying the importance of atmospheric deposition on PCB's, mercury to the waters that hit the head of the plant, and we didn't really look at issues of bypass or combined sewer overflows. We made measurements in the

system, but we did not look at those issues.

Q. Was there significant measurable mercury in the influence of the BOTW's?

A. We measure mercury in every sample we collect, and yes, there was measurable mercury. Again, our detection limits are a tenth of a part per trillion, so you see mercury in the drinking water you have in front of you. It's probably not of any concern.

Q. To put another way, mercury is everywhere in the natural environment, correct?

A. Yes.

Q. Do you recall what the levels of mercury were in the influence of publicly-owned treatment works?

A. The influence concentrations varied from 100 to 400 nanograms per liter.

Q. Thank you.

MR. FORCADE CONTINUES:

Q. Dr. Keeler, you just mentioned in response to Mr. Harrington's question that you found mercury in many locations. Would you expect, at that level of detection, that you would find mercury in many MBTS discharges (phonetic)?

A. I believe I would see mercury at least in the trace quantities in the part per trillion level in

all discharges.

Q. Thank you.

MR. BONEBRAKE CONTINUES:

Q. Just one other follow-up, do you recall the eruption of Mt. St. Helens around 1980?

A. I remember it very well, yes.

Q. Was that eruption a significant source of mercury air emissions?

A. Volcanoes are thought to be one of the prime natural sources that put mercury into the earth's atmosphere.

Q. Has there been any estimate of the amount of mercury emitted into the air that resulted from that eruption?

A. It's possible someone did a calculation. I'm not aware of that that number.

Q. Have you ever seen a comparison of that number, whatever it may be, to mercury emissions from electric-generating units?

A. Again, I don't recall Mt. St. Helens, in specific. I know that people have looked at volcanic emissions from Italian volcanoes and a couple of others around the world, but I don't recall Mt. St. Helens, specifically, but it's a pretty large number. If

volcanoes were going off continuously all the time or every year, it would certainly change the global budget of mercury in the atmosphere. Mt. St. Helens, if you remember, gave us very beautiful sunsets and put a lot of ash and sulfuric acid up in the stratosphere, so it shot -- not only did it put a huge ash over a small area, but it also shot a lot of stuff up into high levels in the atmosphere, so it definitely was seen everywhere.

Q. In fact, the mercury that went up high levels of atmosphere, would that suggest what mercury would have been dropping onto the ground or into the waters for a significant period of time after the eruption?

A. Whatever came out of the volcano, including mercury, would have been emitted into high altitudes and some of that perhaps could have been removed, since a large of amount went up in the stratosphere. I'm sure a great deal of it is probably still up there.

Q. Thank you.

MR. HARLEY CONTINUES:

Q. At the beginning of your responses to the questions that were posed by Mr. Forcade, you began to

describe a study -- actually, there are two authors of that study who were looking at the relative contribution of atmospheric deposition to recent contribution and cycling. Do you recall your reference to that study?

A. I'm sorry. I must have post-lunch brain deadness. Help me a little bit.

Q. You were talking about the total loading and methylation issue, and you began to talk about a study, which I took to mean that recent contributions of atmospheric deposition were most important, in terms of methylation and also most important, in terms of cycling, and I felt that you had more to say about that, and I would like to hear what you had to say about that study.

A. You're referring to I believe I referenced Cindy Gilmore and Dave Griminhoff's (phonetic) work, as well I think Jim Hurley from the University of Wisconsin in the water chemistry program. Actually, there's a fairly large group doing some work in METALLICAS, so there's a couple different studies there, but what the issue is there have been for years -- in fact, the thought was that the methylmercury that was entering into ecosystems and bioaccumulating was coming from the bottom sediments over time and some of this born out in

Florida through some studies, but over time, people started to say, well, they couldn't explain the amount of mercury and methylmercury, specifically, and as they got better and better at making methylmercury measurements and the BIODA and in the fish and through the ecosystem, they started to hypothesize that the mercury that was actually cycling, so going from the reactive mercury form methylated by the bacteria, and then going into the organisms was actually the mercury that was falling out of the sky today, so the stuff that falls out today gets chemically transformed and actually winds up -- that's the mercury that winds up contaminating the fish so Cindy Gilmore and colleagues have done some studies where they have actually taken and used as a tracer an isotope of mercury. It's one of the masses of mercury, and they can get this mercury from Oak Ridge National Laboratories, and other places, and they can put that in the system in different compartments and look to see where it goes, and in fact, the mercury that they put in just as precipitation would have been gone into the lake is what they actually are now seeing coming up from the ecosystem in a fairly rapid fashion, so their experiments are duplicating what their hypothesis -- or confirming their hypothesis that

what's important is what's falling out of the sky into the ecosystem, and that's much more mobile and moving through the ecosystem at a much faster rate than the stuff that's buried down in sediment. In fact, some of the stuff that's buried in sediments likely will not become a problem at all over a very, very long geological time frame, so that's the conclusion that they drew. Now, again, that's the study that they have performed thus far, and I know at the Wisconsin Mercury Meeting that's coming up in August that more results from that METALLICAS study will be presented.

MR. FORCADE CONTINUES:

Q. Dr. Keeler, you made reference to the fact that the mercury that is more recently deposited into the stream from the air, did they do comparative evaluations of the isotopes by depositing mercury in the water environment.

A. Yes, they did. They actually put it in the sediments. They put it directly into the water. They deposited it in the air. Then they actually sprayed it on the forest ecosystem, and watched that as it made its way to the forest and to the forest floor and into the body of water that they were studying.

Q. Could you give me a date or name?

A. METALLICAS, and I'm trying to think of who the lead investigator was, but if you look up Gilmore or Griminhoff or Hurley, I think John Rude up in Canada is a principal in that. It's a fairly large team. I know Steve Linberg and Jim Hurley were also involved. It's a team of about 15 different people from, both, U.S. and Canada that are doing that work.

DR. KEELER: The key is trying to get at what's most important in terms of contaminating the environment, and that's what the focus of that whole study is and the indication is that it's recent deposition really is the most important.

MR. FORCADE: When the questions are over, I have a procedural question for Mr. Kim.

MR. BONEBRAKE CONTINUES:

Q. I'm just curious. You just talked about the relative significant of more recent deposition. Does the answer change, Dr. Keeler, in waterbodies in which the sediment is stirred up for reasons maybe associated with a hurricane in an area or perhaps seasonal flooding or drudging.

A. It really depends upon how the mercury is bound in the sediment or in the soil or whatever you are referring to there. If it's tightly bound, it may not

be biologically available. Mercury that's in sand, copper sludge that they get from a copper mine, like up in the UP of Michigan, for example, is not thought to be very biologically available, so if it's in that form, it's stirred up it may not actually lead to a higher methylation rate. If it's in a bioavailable form, then yes, it could.

Q. So would it be your sense that the question of the relative significance of recent deposition is going to be a question whose answer is somewhat variable depending upon the particular characteristics of a water body?

A. It would be characteristic of a frequency of disturbance and the type of disturbance and the characteristics of the water body and the inputs, yes. All those things would be important to take in mind, take into account.

DR. GIRARD CONTINUES:

Q. I hate to bring up Steubenville again, but Dr. Keeler, I seem to recall that you talked about doing air sampling every hour during that study looking at mercury levels in the air. Was I correct in that?

A. Yes, you were correct.

Q. When you had rain events, and you had this

sampling going on every hour, did the amount of mercury in the air change after the rain event?

A. Again, we haven't done an exhaustive study of every single rain event, but for the ones that we could match up or that we did match up the ambient that you do see a very rapid dropout in the reactive mercury and you see a smaller, but significant, drop in the particulate mercury levels, as well, with a very -- or a less of a decrease in the elemental mercury concentrations, so we see that, not just at Steubenville, but we see that in our mercury sites in Michigan, as well, both, in Detroit and at the site in Dexter, which is about 30 miles to the west of Ann Arbor, so you do see what's in ambient air increasing precipitating systems.

Q. You hate to quantify it because the data hasn't been fully processed, but just ballpark. I mean, are we talking just a 50 percent reduction or 100 percent reduction? What kind of a reductions are you looking at after a rain event?

A. If it's a prolonged rain, if it's a rain that lasts more than an hour because that's hour time frame of our measurement, so we have to have something that goes longer than an hour in order for me to answer

your question. If it's a longer rain that goes more than an hour, you will see complete depletion of the reactive mercury from the air. Particulate mercury is already very low, so that goes to nothing, as well, and elemental will stay, approximately, with a background is 1.5 nanograms per cubic meter and doesn't really change much in terms of through a rain event, so after an event, say, that's over an hour where it reduces the mercury in the air down to zero, how quickly do you see the mercury levels go back up? It really depends upon the reason that the rain fell. If it was a frontal system where the wind is changed, sometime it doesn't come back up for quite a wile. If the wind stays coming from the same direction, as soon as the rain is over, there will be a period of time where it could be like the next hour or the hour after that you will see it start to raise back up again, so there is a one-to-one correspondence. I just haven't quantified it, but at our site in Dexter, we actually -- did quantify it for a period or time and it was exactly a 50 percent reduction an hour after the rain came, but then we were making measurements every other hour, so that we couldn't -- it wasn't as clean. For a long rain, you see it go right to nothing. For a rain that lasted 30 minutes, the

following hour reactive mercury would be half as much, and then whether it came back up or not depended upon which way the wind was blowing. The reactive and particulate mercury concentrations that we see at Steubenville and in Michigan are very wind directional and very transport specific. We get transport from the north in Michigan, for example, we see very little often with strong winds, especially during the wintertime and in the summertime, when the wins switch around, you see very high concentrations, but with very specific wind directions, and it always responds the same when it comes to precipitation. We do not have any examples of high RGM with precipitating events going through for multiple hours where it stays up and that goes along with the understanding of how soluble and reactive mercury is in the atmosphere.

MR. FORCADE: If I could have a procedural question. Earlier this week in the panel discussion I asked a series of questions about MPDS discharges mercury content and the contribution of total loading as described on page 69 of the Technical Support Document. There are two references supporting that in the Technical Support Document, and both of those references are incorrect. They have absolutely nothing

to do with calculating mercury, affluent limitations. As far as I'm concerned right now, there is no support for those tables. I have asked -- and I don't need the information today -- but there's a significant open question which I need information from the Agency to explore, and I would like to just, not for purposes of asking questions today, just remind them that that is a significant open question that I need to explore for the conclusion of these hearings next Friday.

MR. KIM: Indeed, Mr. Forcade did raise that. We tried to initially provide the documents that were referenced, and I think I am in agreement with him that it doesn't really seem to mesh up with what was in there, so we are in the process of getting that information, and I'm pretty certain we are going to have it for you Monday or Tuesday, at the latest, next week. So if it could wait until then.

MR. FORCADE: That's fine with me.

MR. KIM: It's not forgotten.

MADAM HEARING OFFICER: There were a couple of things today that we had talked about from Dr. Keeler. One was I believe you have in front of you.

MR. KIM: Actually , I was going to say there were a couple things I was going to bring up

just to sort of close some loops. METALLICUS, the acronym, I can give you what that stands for, if you want that. And then the last thing -- this was just something that was referenced after trying to get a copy of the Powerpoint presentation that Dr. Keeler made reference to a while back and I think it's -- I think the Board and the Agency were the only people that didn't actually have this. I think I have two copies.

MADAM HEARING OFFICER: If there's no objection, we will mark this as Exhibit No. 32. Seeing none, "Mercury Deposition in the Great Lakes Region, James Keeler, University of Michigan Air Quality Laboratories" is marked as Exhibit 32.

(Exhibit No. 32 was admitted.)

MR. KIM: I believe this is maybe in more specific with some nice pictures, but it's, essentially, everything that -- there is a Far Side cartoon I think it's pretty much a Powerpoint presentation of everything that's been testified to thus far, but we did want to make sure we got that in. It took a little while because it was all in color and we had technical difficulties. We have no more color ink left in the building.

MADAM HEARING OFFICER: The other item

that we discussed this morning was the emissions data that was a part and a map. Mr. Matoesian was talking about that this morning and you said you would get that for us.

MR. KIM: Yes.

MADAM HEARING OFFICER: Are we still in the process of looking for that?

MR. KIM: That's information that we are going to have to print out I think from U.S. EPA's website, so that might -- we'll get that, but it may not be until Monday or Tuesday.

MADAM HEARING OFFICER: That's fine. I just wanted to double check on that.

MR. KIM: We have four copiers on the Division of Legal Counsel floor. At any given time, one of them is working, so I'm assuming that ratio holds true throughout the Agency.

MADAM HEARING OFFICER: Is there anything else for Dr. Keeler?

MR. RIESER: Maybe one thing to do. Obviously, we visually observed the LADCO report at the time it was given, but we haven't had a chance to look at it. Perhaps if Dr. Keeler can sit for another hour or, so maybe we can proceed with Dr. Hornshaw give us a

chance to look at this, and then if we can come back. It shouldn't take that long, but I just need to check to see if there's any other questions.

MADAM HEARING OFFICER: Is that possible, Dr. Keeler?

DR. KEELER: That's about right. I have another hour and 10 minutes.

MR. RIESER: If it would help, the minute I'm ready to ask some questions, if I have any one way or the other, I can put my hand up. I hate to interrupt the flow of somebody else's questioning.

MR. KIM: Two airlines in Springfield, so I think our people are just struggling to hold on to the reservations they have got, but that's fine. If, during his testimony you want to just interrupt, that's fine with us.

MADAM HEARING OFFICER: Then shall we begin with Dr. Hornshaw? Before that, Dr. Keeler I want to, personally, thank you very much. It's been very enlightening.

STATE OF ILLINOIS)
COUNTY OF ST. CLAIR)SS

I, Holly A. Schmid, a Notary Public in and for the County of Williamson, DO HEREBY CERTIFY that pursuant to agreement between counsel there appeared before me on June 16, 2006, at the office of the Illinois Pollution Control Board, Springfield, Illinois, Dr. Gerald Keeler, who was first duly sworn by me to testify the whole truth of his knowledge touching upon the matter in controversy aforesaid so far as he should be examined and his examination was taken by me in shorthand and afterwards transcribed upon the typewriter (but not signed by the deponent, his signature having been waived by agreement of counsel) and said deposition is herewith returned.

IN WITNESS WHEREOF I have hereunto set my hand and affixed my Notarial Seal this 30th day of June, 2006.

_____

HOLLY A. SCHMID
Notary Public -- CSR
084-98-254587