ILLINOIS POLLUTION CONTROL BOARD
June 15, 2006

IN THE MATTER OF	)	
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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 I

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 15, 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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Mr. Jim Ingram, Dynegy, Inc.
For Dynegy Midwest Generation, Inc.

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Mr. James Harrington;
Mr. David Rieser;
Mr. Neal Cabral;
For Ameren;

Mr. Keith Harley,
Chicago Legal Clinic

E X H I B I T S

IDENTIFICATION PG.

MADAM HEARING OFFICER: Good morning, everyone. My name is Maria Tipsord, and I'm the hearing officer in this proceeding entitled in the Matter of Control of emissions from Large Combustion Sources, Mercury, Docket No. RO6-25.

Again, this morning to my left is Dr. Tanner Girard. To my right, Andrea Moore, the presiding board members in this proceeding. At the far right is Nicholas Melas, one of our board members. At the far left, is Tom Johnson, also one of our board members. Today from our technical unit we have Alisa Liu and Tim Fox, Andrea Moore's assistant. Connie Newman is in the audience and she is the point person for press concerns. Erin Conley is with as today, as is Kathy Griffen, and any procedural questions you may address to Erin, Tim or I and, I we will try to answer them.

We are I believe starting with Dr. Keeler's testimony. He was sworn in when we entered his prefiled testimony two days ago. In addition, we have already sworn in Jim Ross, Jeffrey Sprague, Marcia Willhite and Dr. Hornshaw, and I believe that's all that have been sworn, and I would remind them that -- any testimony or statements made today will be considered

sworn statements. With that, Mr. Kim.

MR. KIM: Thank you. As you just stated, we will be starting with Dr. Keeler today. I believe he is going to start with the questions posed to him by Ameren Energy, and I think -- I can't remember -- one or two, or however many questions that were also submitted by Prairie State that he will address after that.

CROSS EXAMINATION BY MR. RIESER:

Q. Before the prefiled questions, I was wondering if I could ask some questions just to clear up some things from yesterday, just to confirm a couple of things. Dr. Keeler, your expertise is as an atmospheric scientist. Is that correct?

A. Yes, it is.

Q. And so you're an expert in the mechanics of mercury deposition from the stack, to the ground, if you will?

A. That, plus a whole lot more, yes.

Q. But the expertise doesn't include the methylation of mercury in the aquatic environment. Is that correct?

A. My formal training does not include the biological processing of the chemicals, but I have been

working in this area for 16 years now, and have been part of projects looking at the whole ecosystem cycling of mercury, which includes, both, the deposition of mercury from the atmosphere, as well as the air surface exchange, the photoreduction (phonetic), the chemical processing in the aquatic ecosystem, as well as the methylation and demethylation processes. Over this time period, I have kept up with peered-review literature. I have worked with some of the best scientists in the field on these things on projects including work in Florida work, in the Great Lakes on Lake Superior and elsewhere, so I have more than a passing understanding of most of the processes involved with mercury and the environment.

Q. But the papers you have prepared yourself or that you participated in have dealt, almost entirely, with atmospheric deposition. Isn't that correct?

A. No. That's not correct.

Q. What's an example of one that's not? I have a couple papers where we actually made measurements of methylmercury, a paper that we did with the University of Wisconsin looking at methylmercury deposition and sources of methylmercury. We have a couple of other papers that look at vegetation uptake,

as far as exchange of mercury with enforced ecosystems. We have papers looking at volatilization of mercury from large bodies of water, such as the Great Lakes, Lake Michigan, in particular. I have done work also in Lake Champlane in Vermont, and in my vitae, is I believe -- John, is my vitae part of the record or no?

MR. KIM: Yes, I believe it is.

DR. KEELER: So if you look through there, you will see that there are papers -- I can't tell you how many, but there are papers where we have actually published study results that deal with more than just atmospheric deposition.

MR. RIESER CONTINUES:

Q. With respect to your testimony yesterday, with regard to the study in Florida, is it correct that your direct involvement in the Florida activities was with respect to modeling the deposition of mercury?

A. Could you be more specific, like my --

Q. Let me be more specific. The paper that you prepared, which was included as Appendix 1 of the -- what I understand to be the Florida study, which was the document that was introduced into evidence yesterday, dealt entirely with mercury deposition modeling issues?

A. That's correct. In terms of the report

writing responsibility, that was my sole role.

Q. The modeling of the methylation life cycle within the water body, the EMCM model I think it was called?

A. Yes.

Q. Florida study? That was done Tetricheck (phonetic) check. Is that correct?

A. That sounds correct. Reid Harrison, Curt Pullman were the people -- and they have switched companies and alliances and other things, so I don't know exactly if -- but I think Tetricheck was the company they were working for at the time.

Q. So would it be correct that the analysis in the methylation and the biologic uptake in the Florida work was done by Tetricheck?

A. Yes, and Florida DDE (phonetic) has some involvement, as well, but yes, that's correct.

Q. Do you know whether the EMCM model was designed for the Everglades?

A. You know, the EMCM model was not designed for the Everglades. One of the things -- and I'm glad you brought this up -- is that models can be designed for a specific water body or air shed or specific application. The mercury cycling model was developed,

initially, as I understand it, for sea fish lakes in Wisconsin, specific type of lake, and the model, though, has the physics and chemistry of mercury and interactions with BIODA (phonetic) that allow it to simulate what happens in the real environment, and it takes into account the processes that govern the behavior of mercury. As such, in the model, it can be adapted to another body of water so an extensive amount of work was done by Tetricheck taking the extensive data that was put together by the U.S. EPA, Region 4, State of Florida, the South Florida Water Management District to change the model, so that it would be applicable to south Florida and the Florida Everglades, specifically.

Q. So the model at that particular model that was used in the Florida study was, if not originally designed, then, certainly, modified to apply solely to the Everglades environment. Is that correct, to your knowledge?

A. I think the questions would probably be asked to Tetricheck, if you wanted to get to what the purpose of their model was. The word "solely" is probably not correct.

Q. Is it also true that there was a conclusion of the Florida report that there were no coal

sources, coal-fired utility sources, that were identified in the south Florida area?

A. Again, are you referring to a specific statement that it says in the report?

Q. Yes, I am.

A. If you could point that out --

Q. On the bottom of page 76.

MADAM HEARING OFFICER: For the record, that's Exhibit 20.

MR. RIESER CONTINUES:

Q. Thank you. I will point you to the last sentence, "Although coal is the largest source (45 percent) 65 milligrams per year of mercury emissions of the U.S. (144 milligrams per year) no coal combustion occurs in South Florida and only oil and aquatic related emissions occur."

A. Yes, I see that.

Q. Do you disagree with that?

A. In the sense of utility coal combustion, that's correct?

Q. In any other sense is that incorrect?

A. I believe that they do use coal as a fuel source in some of the cement dealings (phonetic).

Q. Why don't we turn to the questions that I

submitted, already.

MR. BONEBRAKE CONTINUES: I also had a follow-up from yesterday, and I believe an open issue I think that was left open from yesterday. Dr. Keeler, we were talking a little bit about yesterday about Table 12 on the Florida Report, and whether -- which of the data points on Table 12 were within the area that were affected by the reduction of emissions in South Florida. Do you recall that conversation?

A. Yes, I do, and I made an attempt to contact Dr. Atchison at the State of Florida to get a copy of a map or something that would help me show where the sites were, and I did not receive anything from him overnight, so I'm unable to provide any more information to you on that.

Q. There was one statement that I thought was relevant, very relevant to this question in the report, and I wonder if we could direct your attention to that, and I will ask you a follow-up question. It's on page 81 of the Florida report.

A. Okay.

Q. It's the bottom paragraph, and it's the sentence that starts, "The three sites" -- it's about two-thirds of the way down.

MR. KIM: Last paragraph.

DR. KEELER: "Three sites," okay.

MR. BONEBRAKE CONTINUES:

Q. It reads, "The three sites in water conservation 3-A near Site 3-A dash 15 (located near the so-called hot spot of high fish tissue concentrations in WCA hyphen 3-A) also showed some cohorts with significant declines although nearly as many site-cohort combinations also showed no change." Do you see that, Dr. Keeler?

A. I do, yes.

Q. Site 3A-15 was that the particular modeling point that you were referencing yesterday?

A. It is, yes.

Q. And does this suggest to you that there are, at least, three of the sites reflected on Table 12 that were in the immediate vicinity of that model site?

A. Based on what it says here, yes, that's correct.

Q. So those three additional sites would have been subject to the same kind of emission reductions that affected Site 3A dash 15?

A. It says they are near Site 3A-15, so that would be correct.

Q. Thank you.

MADAM HEARING OFFICER: Then I think we are ready to begin with Ameren Question No. 1.

MR. KIM: Actually, I think if we could do Dynegy Question No. 1, and before you begin, I have some additional copies of what was provided in the documents to the TSD, but these are color, and I believe the originals were not. Actually, the Board's copies were in color, so nobody else has those. I can give you those now as an exhibit and then we'll hand these out.

MADAM HEARING OFFICER: Mr. Kim, just for clarification, these are attachments to the TSD?

MR. KIM: Correct.

MADAM HEARING OFFICER: This is Exhibit B to the TSD.

MR. KIM: Yes. It's just that the copies provided to the Board were in color, but other people may not have been able to access them in color.

MADAM HEARING OFFICER: Just for purposes of the report, even though it's already part of the record, I think I will go ahead and mark this as Exhibit 25, if there's no objection. All right. We'll mark this as Exhibit 25.

(Exhibit No. 25 was admitted.)

MS. BASSI: I'm sorry. Is this Exhibit B to the TSD?

MADAM HEARING OFFICER: That's my understanding.

MR. KIM: I believe it is, yes.

MADAM HEARING OFFICER: Just to clear up, we are going with Dynegy first, not Ameren?

MR. KIM: Correct. I misspoke.

DR. KEELER: Question 1: "Mr. Keeler states in his testimony that `Illinois coal-fired power plants are the largest source of man-made mercury emissions in the State.'" A: How large are these emissions compared to natural mercury emission? B: How large are these emissions compared to the total amount of mercury emitted in Illinois? C: How large are these emissions compared to global missions from mercury emissions from all sources?" Taking the data that was in the TSD, Illinois coal-fired utilities emit about 3 tons of mercury. To my knowledge, I assume that you are asking about natural mercury emissions in the state of Illinois. To my knowledge, there is no good emissions inventory number for the state of Illinois. However, in my best judgment, the natural emissions mercury in the state of Illinois would not be very large. We've done

extensive measurements of mercury emissions from natural sources, and Illinois soils, according to the U.S. GS, do not have enriched mercury soils. Therefore, the probability of natural mercury emissions from natural soils in the state would not be very large. Natural mercury emissions are thought to be about a third of the emissions on a global basis with anthropogenic emissions being a third in re-emission from previously deposited mercury coming back off the surface being the other third, so the 3 tons compared to the global amount of mercury that's emitted is a relatively small amount of the total. It's less than a percent. What's important, though -- and we'll get to this a little bit later on -- is really not the total amount of emissions, but the form of the mercury emissions, and by that, I mean the chemical form that's emitted from these sources, and in proximity to the sources to the ecosystem, and we'll get into this a little bit later on, so the magnitude is not really the most important thing to consider here when we think about the impacts of mercury sources on the environment.

Question no 2: "What country has the largest mercury emissions from coal burning?" Over the past few years, there's been a lot of work looking at

mercury emissions from all the countries in the world. At this time, due to the booming economy in China, China is thought to have the largest mercury emissions. I happened to have been in Beijing last fall at a Mercury Emissions from Coal-fired Utilities Workshop, and it was amazing how much mercury is emitted into China in the nation of China from coal combustion, and their projections appear to be that it's going to increase over time, so it is a significant amount.

"Is mercury a global problem."

MADAM HEARING OFFICER: Question No. 3.

DR. KEELER: Question No. 3. Mercury is certainly a global problem. I think, over the last 20 to 30 years, we recognize that mercury contamination is an issue everywhere. Of the 50 states, Wyoming I believe is the only one that doesn't have fish -- warning fish consumption advisories and I think that's still correct. I believe it's because they haven't tested any fish, so this is a problem worldwide, and it really is an issue that everyone has to take into account and is concerned about. The ubiquitous nature of mercury in the environment is what makes it that problem.

MS. BASSI CONTINUES:

Q. When you say you think Wyoming doesn't have any fish advisories because they haven't tested any fish, is that based on some examination of some data?

A. I'm sorry. You linked two of my statements together that I didn't actually say. I said that Wyoming doesn't have any fish warnings, and then I said I don't believe that they have tested any fish. If you were to look at the EPA website for fish contamination, Wyoming is the only white state. I was told that maybe it was because Vice-President Cheney ate all the fish too quickly, but I'm not sure if that's correct or not. That's hearsay, but in fact, when I inquired into that, I was told that they don't have a fish testing program.

Q. Who told you that?

A. An EPA person at a meeting because I presented the table at a meeting that I was at. I presented it at a long-range transport conference a few years back, and it's pretty glaring when you show a map with all the states, except for Wyoming.

MADAM HEARING OFFICER: For clarification, when you say "EPA" do you mean U.S. EPA?

DR. KEELER: U.S. EPA, yes. To my

knowledge, based on the EPA, and that's something that's available on the U.S. EPA website on the mercury site that Wyoming was the only one.

DR. KEELER: Let's see. Question No. 4: "Does all the mercury emitted by Illinois coal-fired power plants end up in Illinois?" One of the things that we were taught very early on in science class is that, to use the words "all" or "always" or "everyone" or "solely," is usually not good practice. In science, there's always an exception to every rule and so my answer to that would be no. All the mercury from Illinois power plants clearly does not end up in Illinois, as does the emissions from any power plant does not end up solely in the state that they are emitted. I would say that's probably a fair statement.

MADAM HEARING OFFICER: Mr. Rieser.

MR. RIESER CONTINUES:

Q. Do you have a sense -- do you have any gauges suggesting what percentage ends up in Illinois?

A. I do not.

Q. Do you have any knowledge, based on your experience, as to how much ends up in Illinois?

A. I have not done any state of Illinois specific quantification of how much mercury emissions

from Illinois power plants is deposited in the state. The research that I performed has looked at the Great Lakes region, and includes all of the Great Lakes states, so I can't give you a quantitative number from how much comes from the state of Illinois, itself.

Q. Thank you.

DR. KEELER: Question No. 5: "Does some of the mercury in Illinois water bodies come from outside of Illinois?" And A: "How much?" Yes. Some of the mercury in Illinois water bodies clearly comes from outside the state. Again, I have not done, or I have not performed any state-of-Illinois specific research. I have looked at the Great Lakes states, which, obviously, includes Illinois. In our analysis of mercury deposition in the Great Lakes, we assess that 40-some percent -- I think it was 43 percent -- of the mercury deposition that fell within the Great Lakes came from within the Great Lakes basin states, and the remaining came from outside, so there's a significant fraction of mercury that comes from outside of the Great Lakes basin, itself. Now, that's the water basin, so that's a fairly tight area, so in fact, most of Illinois would be included in the out-of-the-basin estimates, so our focus was really looking at mercury deposition into

the Great Lakes, themselves, those actually large bodies of water, but that would include, say, the state of Michigan, and any other parts of the states that are actually in the basin, so mercury definitely is a local and a regional and a global transport issue.

MR. RIESER CONTINUES: This is just a clarification. I think you said that most of Illinois is not in the Great Lakes basin?

A. The water basin. That's correct.

MS. BASSI CONTINUES:

Q. My question was do you have, or can you give us an idea of how much of Illinois is not within the Great Lakes water basin? Is there a line? Route 80?

A. I think it's probably --

MADAM HEARING OFFICER: Yes, Ms. Willhite, you are sworn in, and are still sworn in, so go ahead.

MS. WILLHITE: Sure. When you consider what's in the basin and what's not in the basin, it's really what actually drains to Lake Michigan, and there's a very small sliver just right around the edge of Lake Michigan that actually drains to Lake Michigan. That's what's considered in the basin,

so I would probably say, like, 99 percent of Illinois is not considered within the Great Lakes basin.

DR. KEELER: Question No. 6: "In Dr. Keeler's testimony, he mentioned that "source contributions from . . . motor vehicle emissions sources were important in Detroit." Would it be reasonable to suppose they would similarly be important in Illinois?" We've done an extensive amount of work looking at runoff of atmospherically deposited mercury in the city of Detroit to try to understand the source of mercury that makes its way to the waste water treatment plant, and as part of that study, we actually made runoff measurements on highways and streets in the city of Detroit, and from areas which do not have traffic, and from that work, we were able to hypothesize that motor vehicles actually were a source of mercury. After about a decades's worth of investigation and hard work, we've actually been able to start to quantify that motor vehicles actually do contribute to mercury problems, and it's primarily through the fuels and the oil that are consumed in the motor vehicles and that highway surfaces actually have more mercury in the runoff than non-traffic used streets, so through this, we did publish a couple of papers, and I have made several presentations showing

that, in fact, motor vehicles do contribute to surface runoff of mercury, and it's something that we're just finishing a quantitative project looking at that to be able to define emissions factors, and to be able to better define the total contribution of mercury. At this point, the emissions estimates suggest that it's going to be some amount less than 10 percent compared to the total agriculture inputs, but that number will be better defined as we get the final emissions estimates.

MADAM HEARING OFFICER: Mr. Melas.

MR. MELAS: Just a quick clarification. The emissions from the automobiles, the mercury is the same qualitative type -- you mentioned that certain emissions vary in chemical nature. Would the emissions from the automobile type of mercury have the same chemical nature as the kind from coal-fired generators?

DR. KEELER: Thank you for asking that question. That's actually the most important question, and I should have said that in my statement. Actually, the forms of mercury -- we tried to look at the speciation of mercury, so we made measurements of the elemental form, reactive gaseous form, which is the form that we think is important, in terms of going into the ecosystem, and then being the potential form of mercury

that methylates in the ecosystem, and so elemental, reactive, and particulate forms. We see a small amount of particulate coming out of the motor vehicles. We see most of the mercury coming out as elemental, and then we do see a small percentage as reactive, as well. So that's an excellent question, and really quite important in terms of its impact on the environment.

MS. BASSI CONTINUES:

Q. Dr. Keeler, are you -- do you know where the most traffic in Illinois would be located?

A. Do you know where the most traffic in Illinois would be locate? I have not looked at the traffic statistics for the state of Illinois. We have done mercury work in the city of Chicago, and I would hypothesize that that would probably be the highest, having been stuck in traffic in Chicago myself.

Q. Have you driven in Springfield's rush minute?

A. No. I have missed that, but perhaps tomorrow morning.

MR. RIESER CONTINUES: Statistically significant rush hours, aren't we?

MS. BASSI: Yeah. Thank you.

MR. RIESER CONTINUES:

Q. In the answer to the question, you mentioned the studies you have done on runoff, but you also did a study that you discuss in your report regarding Detroit in which you identify, and that was, as I recall, an air sampling study?

A. I wasn't clear on exactly which study you were referring to in that, just so I'm 100 percent clear. Is that the most recent paper we did?

Q. Correct. Lynam-Keeler, 2005, "Source Receptor Relationships for Atmospheric Mercury in Urban Detroit Michigan."

A. Yes.

Q. And in that, as I understand that paper, you identify -- you were looking at atmospheric mercury and doing the statistics regarding source receptor relationships and I think you identify emissions, automobile emissions as one of the sources of the atmospheric mercury that you identified. Is that correct?

A. Yes, that is correct.

Q. I think, also, in this study in Chicago, "Atmospheric Mercury in the Lake Michigan Basin Influence of the Chicago/Gary Urban Area," and that's a study by Keeler and Vette?

A. Yes, Vette.

Q. One of your sampling locations was at IIT?

A. Yes, downtown.

Q. Illinois Institute of Technology, and that would be considered a high traffic area?

A. Yes.

Q. Adjacent to the Dan Ryan Expressway, especially now, and that also identified automobile emissions as a source of atmospheric -- is that correct?

A. Yes.

MADAM HEARING OFFICER: I just have one question. You referred to two different articles and asking questions, specifically, about them. Could I ask you to submit those for the record.

MR. RIESER: I can submit one of them right now and I will submit the other one this afternoon. And these were studies, specifically, referenced in Dr. Keeler's report, which is Appendix B to the TSD.

MADAM HEARING OFFICER: The one that's been handed to me is "Atmospheric Mercury in the Lake Michigan Basin Influence of the Chicago/Gary Urban area." We'll mark that as Exhibit 26, if there's no objection. Seeing none, it is marked as Exhibit 26.

MR. RIESER CONTINUES: I don't know if you want to save Exhibit 27 for the Detroit study for the next session?

MADAM HEARING OFFICER: We'll reserve that Exhibit 27 for the Detroit study.

MR. RIESER CONTINUES:

Q. Let me ask one more question on the same subject. I believe you mentioned that the estimated -- that the amount of mercury associated with automobile emissions was less than 10 percent of the anthropogenic inputs. Is that correct?

A. That's less than 10 percent. That's our preliminary estimate based on today's estimated anthropogenic mercury emissions, which I guess I should make a clarifying point. One of the most difficult things for us to try to convey to people that aren't working in the mercury business is that emissions inventories change constantly. Major source category goes down and the emissions categories can change, so when we're talking about emissions, I will try to be careful about what year I'm basing my statements on because, if you look at the `95-`96 database when municipal waste and medical waste incinerators were still emitting, the percentages of each source category

to the total changes. Now municipal waste and medical waste have been controlled, and so now coal-fired utilities look like a larger percentage of the total just because major source category has gone down, so the fractions change, so I'm referring to the -- making a relative statement to the `99 or 2000 emissions inventory, so 10 percent of the emissions from anthropogenic sources we would suggest is coming from motor vehicles.

Q. That 10 percent, just to finish that particular question, that 10 percent is of the 33 percent of anthropogenic sources that you talked about earlier, the one-third?

A. That's correct.

Q. And with respect to the change in mercury emissions over time, and I will direct your attention to figure 19, on page 76 of Exhibit 20, which is a graph regarding annual mercury emissions in South Florida in 1980 to 2000.

A. Could you tell me what page that is?

Q. 76 is what I have.

A. Figure 19?

Q. So figure 19, page 76 of Exhibit 20 shows significant reductions in emissions, annual mercury

emissions, in South Florida merely between 1991 and 2000, correct?

A. Yes. 1991 on this graph in figure 19 shows an emissions estimate of about 3,000 kilograms per year.

Q. It reduces to less than 200 kilograms per year by the year 2000?

A. About 200, yes.

Q. This reflects your testimony that the control of municipal waste incinerators and medical waste incinerators -- and municipal waste combusters in South Florida over that same time period, correct?

A. Yes. That's what the graph says, yes.

Q. Would you -- is it your understanding that there are similar reductions nationwide of your mercury emissions as a result of those same controls being imposed state by state?

A. That's correct.

Q. And is it of similar magnitude as that reflected here?

A. The percentage reduction was required by the EPA rule on incinerators, and I would say that's probably similar to this.

Q. Thank you.

DR. KEELER: Question No. 7: I did not finish the last part of the question. "Would it be reasonable to suppose that they would be similarly important in Illinois?" That's the end of Question 6. That's referring, again, to motor vehicle contributions. Because, as one of the questions alluded to, because of the location of major urban areas in the Chicago region on Lake Michigan, I suspect that the Chicago area, motor vehicle traffic and mercury emissions would have an impact on Lake Michigan and in the downwind areas because of the fact that it's located kind of in the northern quarter of the state. I would say that motor vehicle emissions in the southern part of the state probably would be less of an importance just because of meteorological conditions. The wind just doesn't blow as often from the north as it does from the southwest.

MR. RIESER CONTINUES:

Q. When you say "impact on Lake Michigan," is that impact in terms of the volume of deposition on the lake surface?

A. Do you mean the mass of deposition?

Q. Yes. Thank you.

A. Yes.

Q. And do you have any understanding as to

whether the deposition in Lake Michigan results in high levels of methylmercury in fish within lake Michigan?

A. I'm not sure if this was covered or not. The Great Lakes, themselves, most of the Great Lakes, themselves, have only limited mercury fish consumption advisories. There are only a few places, Lake Superior and I believe elsewhere. Lake Michigan, the water body, itself because, it is not anoxic. Methylation does not occur in the water body, so that methylation and methylmercury levels in the lake, itself, are not significant.

MR. BONEBRAKE CONTINUES:

Q. I believe you mentioned that -- if I understood your answer correctly, that winds from the southwest were predominant. Was that across Illinois, Dr. Keeler?

A. I think it's across the entire Great Lakes. That's a statement. If you would like more specific -- are you asking me for a specific location what the predominant winds would be?

Q. I'm asking, generally, across the state. If I understood correctly, you were saying, generally, in Illinois the predominant wind direction is from the southwest.

A. South, southwest. Of course, that varies as a function of season of year. You know, we certainly get more northwest and north, northerly winds during the colder months.

MS. BASSI CONTINUES:

Q. In modeling that we have seen performed in the context of nitrogen oxide, NOx, we saw that motor vehicle emissions were not transported long distances. Would that same principle apply to emissions of mercury from motor vehicles or in whatever form the mercury would come out of motor vehicles.

A. I think that because the emissions are surface based, tail pipe emissions, as we were saying the NOx comes out of the tailpipe, which is not very high off the ground, I think a significant percentage of the mercury would be more locally disbursed and deposited, although we do see evidence of the gas phase mercury being transported on larger scales.

Q. Thank you.

CROSS EXAMINATION BY MR. HARLEY:

Q. I'm an attorney here on behalf of the Illinois Public Interest Research Group and Environment in Illinois. Good morning. You had just stated that methylmercury levels in Lake Michigan are not

significant. Were you speaking about the waters of Lake Michigan, the sediments of Lake Michigan or both?

A. I was referring to just the water.

Q. Would you care to comment on mercury levels in the sediments in Lake Michigan?

A. I, personally, have had very limited experience looking at methylmercury concentration in the sediments. I know that Ron Rossman, and the people from the University of Wisconsin have done some sediment sampling, and I know that -- I think you can get that from Lake Michigan Mass Balance Study website, but there is a significant amount of mercury in the sediments. I don't recall how much methylmercury is, quantitatively, how much methylmercury is there, but there is mercury in the sediments, and it does vary, according to nearness to shore, and based on the input of the tributaries, various tributaries into the body of water, so there is significant amounts of mercury in the sediments. My comment was only talking about the water, itself.

Q. Thank you for clarifying that. One other question that I have. You indicated that motor vehicles were a source of elemental mercury emissions. Is that correct?

A. The motor vehicle is a source of all the

forms of mercury, but predominantly, it was elemental.

Q. Would you care to comment at this point about the relative water solubility of elemental mercury by comparison to mercury in its gaseous form and its particulate form?

A. Sure. We will get into this later, but I think it's probably a good point. As you asked earlier, the key with mercury really is understanding the chemical form of the mercury in the atmosphere or in the environment. Elemental mercury is sparingly soluble, which means if you take mercury from the air as its floating around in this room -- there's mercury here -- and put a glass of water out, there's not going to be much mercury that will go into the water, itself, so you could leave your glass of water out for days, and you're not going to get much mercury in that glass of water. If we sprayed reactive mercury into this room and left your glass of water out, you would see a significantly larger fraction of that mercury actually go into the glass of water, so if you take that analogy, and go to large bodies of water or surfaces, reactive mercury likes to go into droplets, so it likes to go into cloud water. It's a very sticky substance. It likes to deposit to the surface, so if it comes out of a stack

and interacts with any type of surface, it's going to want to stick to it much more quickly.

Elemental mercury, depending upon the surface type, most of it is just going to keep getting blown away. It's not going to stick. It's not going to go into the water, so if the mercury comes out of a stack or comes out of a tailpipe, or whatever source, in the elemental form, it's going to have less of an impact on the surrounding area, unless it's coming out in extremely high concentrations. There's evidence near fluoroalkali (phonetic) chemical manufacturing facilities that very high concentrations of elemental mercury come out of those plants, and you can see high concentrations of elemental mercury in the surrounding areas, but in most places, the impact of the elemental mercury emissions on the local environment isn't as great, so in the case of incinerators and sources that put out almost all of the mercury in the elemental form, that has a very large local impact. I'm sorry, in the reactive form. I misspoke. So, if the emissions come out in the reactive form, they are going to have a very local impact. When it comes to particulate mercury, which was the other question, if mercury comes out in a particulate form out of motor vehicle because it's so

close to the ground, it, too, will stay fairly close stay in that highway zone and will get run off with precipitation as it gets washed off. The reactive mercury, of course, if it comes out is going to stick really close by, and it, too, will get washed off or volatilized, depending on the conditions, so the motor vehicle emissions, maybe a smaller fraction, will stay in the local vicinity because it's in elemental form than if it was in reactive form. Did I answer your question sufficiently?

Q. Yes. One other follow-up question to what you have commented on so far, testified to so far. That is, you said that the relative percentage of mercury entering the environment from anthropogenic sources has changed as emissions from medical waste incinerators and municipal waste combusters have reduced. Do you know why mercury emissions from medical waste incinerators and municipal waste combusters have decreased so substantially over the past few years?

A. Well, there was legislation that was passed by the EPA and went into effect I believe in `98. The legislation might have been passed earlier than that, but I think it had -- I think it went in the `98 to 2000 time frame where there had to be a 90 percent

reduction I believe the number was from that industrial sector, and so they had to reduce their emissions by 90 percent, which from our analysis in Florida, and from work that was done in Massachusetts, and I think, as time goes on, it would come out in other places had a profound impact on the local deposition in those areas, and it appears to be an impact on the ecosystem, as well, and I think the Florida Report bears that out, and I think now the biological monitoring that was done in Massachusetts beared out the fact that things seem to be improving in those areas where the reduction took place.

MR. ZABEL CONTINUES:

Q. One question in follow-up on the incinerators, Dr. Keeler. Do you know what most of them did to comply?

A. It depends upon the type. Most of the medical waste incinerators, in the past, medical waste incinerators -- there were a small number of large incinerators, hospitals in urban areas, like in South Florida would send their waste to one large medical waste incinerator and these facilities are very unsophisticated, surprisingly. I actually went to one of the large ones in South Florida and I was surprised that it was pretty unsophisticated, and the economics of

controlling mercury emissions from that. It seemed like they were burning almost pure mercury, when it came down to it, so the economics suggested that they could not continue to operate, so they actually shut that plant down, and what happened is a lot of smaller plants that emit less mercury, but are able to cap their emissions in a better way. The municipal waste incinerators had to add various control technologies and I'm not -- I don't have at my disposal at this moment exactly what all the different incinerators did, but there were a variety of control technologies that they used to control the mercury emissions from those plants.

Q. Did the majority, in terms of volume of the medical waste incinerators, simply shut down?

A. I think, initially, that was the response. Many of the medical waste incinerators shut down because people began sending their waste to other solid waste practices, other ways of dealing with medical waste, but the trend now -- for example, I know in South Florida that now there are, like, a dozen medical waste incinerators that have reemerged, but they're smaller units, but better controlled, but they are still putting out mercury, but it's they are meeting the regulations in smaller units.

Q. Are they new units?

A. I'm not sure. They are new, in the sense that they are new in terms of new sources that have been permitted to emit, but I couldn't answer that question whether they were existing facilities that retrofitted or not.

MADAM HEARING OFFICER: Mr. Rieser.

MR. RIESER CONTINUES:

Q. Just to follow-up on something that happened some time ago. In terms of the automobile emissions, I believe your answer was primarily about emissions in the Chicago area, but wouldn't it also be true that the automobile emissions would also be a potential source in the East St. Louis, Metro East area around St. Louis.

A. Yes. I'm really I'm glad you asked that question. When we look for evidence of motor vehicle emissions, we really see them in the large urban areas. When we look in a town such as Springfield, we would have a very difficult time seeing any mercury levels that were increased by traffic in this local vicinity. We have a hard time seeing any in the Ann Arbor, area which is a little bigger than Springfield, but we do see it in the larger metropolitan areas, so of course, the

St. Louis, East St. Louis area would be another example of where you would expected to see some influence from traffic, just as you do in the ozone issue downwind of that corridor.

MR. BONEBRAKE CONTINUES:

Q. In response to a question from Mr. Harley, you mentioned that there was a relationship between mercury levels in sediment in Lake Michigan and in proximity to the shoreline?

A. Yes.

Q. Can you explain that relationship to us or perhaps describe that relationship to us?

A. Describe that relationship?

Q. What is the relationship between the proximity to shoreline and mercury concentrations in sediment?

A. From my recollection of the presentations that were made at some of the Lake Michigan Mass Balance meetings, there were places where there was higher sediment retention in the southeast corner of Lake Michigan where sediments tend to accumulate there were fairly high concentrations of mercury. In some of the areas where like the Chicago Ship Channel is, and in that area along the shore of Chicago and Gary where all

the heavy industry is located, there were higher concentrations of mercury in the sediments.

We, actually, over the past 15 years, we've done an extensive amount of work with vessels going out on the Great Lakes taking measurements of the air out over the water when the plumes came off shore, and that's the work that's written in that paper that you were given, and one of the things we see is very high concentrations of particulate mercury and other forms of mercury when the flow is off from those industrial areas. You can actually see shiny materials in the surface waters. We actually took samples of microlayer, which is the surface layer of the water on Lake Michigan, and you can see the metallic particles floating on the water, and those samples which we then analyzed actually had fairly high concentrations and other metals. Those particles are very large because you can see them, and those are, basically, the ones that got emitted and deposited very rapidly, and those will then go to sediment, so in areas where there's large tributary inputs, as well as areas with high mercury deposition from the atmosphere, which tend to be located near the shoreline of Lake Michigan, you would see higher particulate loads and higher sediment

concentrations. Of course, the sediment patterns are complicated in any large lake because of the patterns of the reed suspension (phonetic), but they still see patterns of high deposition in a southern part of the lake.

Q. Are the higher levels of mercury in proximity tributaries of Lake Michigan related in any way to waste water discharges of mercury to those tributaries?

A. My role in the Lake Michigan Mass Balance Study was to look at the atmospheric inputs, and the University of Wisconsin was in charge of tributary inputs working with United States Geological Survey, so that was not my role, so I can't testify to what they found. I know that atmospheric inputs were 85 percent of the total inputs to Lake Michigan with tributary inputs being 15, but there was a large fraction of the tributary inputs that they couldn't account for in terms of where the mercury was coming from, so some portion of the tributary inputs, clearly, would come from runoff and other sources like you mentioned.

MS. BASSI CONTINUES:

Q. I didn't get my notes completed on this. You were talking about measuring the plumes or measuring

plumes over Lake Michigan, and I got distracted by looking down and seeing the metals on the surface. Did you say there were higher particulate loads in those particular measurement forays that you were doing?

A. Yeah. They tended to have a higher particulate fraction.

Q. And this is the HGP that you're talking about?

A. Yes, I am.

MR. ZABEL CONTINUES:

Q. This is not on Lake Michigan, but something you said made me think of this. You mentioned reed suspension. Is reed suspension of mercury in a water body -- strike that. Is reed suspension of mercury in a water body, mercury in the sediment, a source of accelerated methylation.

A. Again, I guess I'm a reductive type of person. You asked a lot of things in that sentence. I guess there's not a simple answer to asking whether there's anything that accelerates. That suggests that the rate increases with time. I think that any time you reed suspend a mercury in a form that's not available for chemical reaction up into the water column, you would provide it to be chemically reactive. I don't

think it's technically correct that it would accelerate, but yes, reed suspension does provide a way to get mercury into the water column.

Q. It would make it available for methylation where it might not otherwise be?

A. If the form of mercury was such that it was potentially methylated, yes.

Q. I guess let me be a little blunt, and say what my thought was while you were mentioning reed suspension made me think of that. You talked about the modeling in Florida before. I'm wondering if the modeling -- my understanding is the Everglades are a relatively shallow body of water. Is that correct?

A. I can usually stand in the Everglades up to my neck in water, yes, so it's a fairly shallow place, except for when you fall into the gator pits.

Q. Which they must enjoy greatly, but that's a different thing. My concern is does the modeling address the possibility of severe weather, hurricanes in Florida causing reed suspension, and if so, how?

A. I don't believe anyone's addressed that, but that's an excellent question, and I think that severe storms play a huge role in causing havoc to the ecosystem in South Florida. Interestingly enough, I

think they tend to clean things out. The problem with the Florida Everglades has been that we have kind of dammed it up, and whenever you put in canals and dam things up, it, basically, filled in the Everglades, so we could put condos down there, so snow birds like us can go down and live in South Florida. The Everglades has been confined to a smaller area so less water is flushing through that system, so anytime you do that type of a thing, you are actually building up and storing up more contaminants in that ecosystem, and the big storms, basically, flush that out, and those have been occurring continuously for a long time. We hear a lot more about the hurricanes, but those have been going on for a long time, so they -- actually, they are a positive, I would say, in terms of the mercury and other contaminant issues in South Florida.

Q. Could cause reed suspension?

A. I'm sure they do in the flushing.

Q. Flushing the mercury into the Florida bays?

A. Yeah, and we actually published a paper looking at contaminant levels over time in Florida Bay, and you can nicely see the inputs of the atmospheric over the last 100 years in Florida Bay sediments, so

even though there are these storms that go on that change the pattern of deposition, you can still see those inputs, so the atmospheric signal is still very strong. We can see lead and lead gasoline in the Florida Bay sediments going back for 100 years.

DR. KEELER: Question No. 7: "Would Dr. Keeler consider the Steubenville, Ohio Study site to be representative conditions across the country? A: Representative of conditions anywhere in Illinois, and B: If so, where?" Just to back up, Steubenville, Ohio, is a community that's in Eastern Ohio on the Ohio River Valley. Around 1998, `99, the EPA director of the National Exposure Research Laboratory, Gary Foley, asked the question why there was no mercury monitoring being done in the state of Ohio and there was interest by people in the state of Ohio to have a mercury monitoring site. The EPA issued a request for proposals for a competitive bid process where proposals were submitted to the Office of Research and Development in Washington and we submitted a proposal to that call for proposals, and in that call for proposal, they asked that we choose a site that was within 15 kilometers of a large coal-fired utility. Again, that wording is from my recollection, not from the exact language, but they,

basically, wanted us to identify a location in the country that we thought would have a high probability to have an impact from coal-fired utilities. I've been working in the air quality area now for over 20 years. I started doing atmospheric chemistry and measurements in 1982, and as part of my thesis work, I did work in Southwestern Pennsylvania looking at the sources of acid rain, so I have been looking at sources of air quality or aerial problems in this part of the country for more than 20 years.

As part of my thesis work, we actually went and made measurements in that area and actually went and looked at local sources, went and visited, and went to many of the power stations and zinc smelters and glass welding and manufacturing plants an everything that was in that vicinity.

After I got out of graduate school, I went to the Harvard School of Public Health and continued my work where we were doing a health study looking at the health impacts of particulate air pollution on people, mainly, on children and as part of that study, there was a site in the Steubenville area, and previous analysis had shown that this was a location that had clear coal-fired utility impacts, so as part of

our new study to look at mercury, because of the wealth of data that had been going on at this location for the past -- actually, started in the 70's, we felt this was a good location to go back to, so we went to Steubenville, Ohio, and performed a mercury study, and we're going to hear more about this as time goes on. The question is to its representativeness of conditions of across the country. Again, I'm an atmospheric scientist. I've had formal training in meteorology. When we talk about representativeness, we are saying, "Could you take the information garnered at one spot and transfer it to another spot?" And Steubenville, Ohio, is not representative of, really, of any place, other than Steubenville, Ohio, because of the unique nature of its sources and the meteorological conditions that govern the transport of pollutants to and from that area.

However, if one wants to look at the representativeness of an area, such as the Great Lakes, then the Steubenville, Ohio, area is I think a fairly good representative site of many locations along the Ohio River Valley. It's more representative of a Midwest industrial area than it is not representative, so is it a perfect one-to-one correlation with everyone

in the country? Of course not. Steubenville, Ohio, conditions are not like Florida conditions, in terms of the weather. Otherwise, we would all go to Steubenville in the wintertime. Having been there in the wintertime, I can tell you you would not want to go to Steubenville in the wintertime. You don't want to be in Steubenville in the summer, either, but it's not representative of most places in the United States, but it is a good representative site of the Midwest area that is dominated by coal burning.

"Is it representative of conditions anywhere in Illinois?" Again, the meteorology is probably not all that much different in terms of the predominant winds the amounts of precipitation. I know that, as people here in Illinois say, Illinois is elevation challenged. Most of Michigan is the same way. We don't have much topography. Southern Ohio has a little bit of topography. In the upwind region of Steubenville, Ohio, it's fairly flat, as well, so it's not a mountainess area. There are no topographic differences. Illinois has, of course, the Lake Michigan shoreline. That is a little bit different, but Ohio also has Lake Erie, so there are many more similarities I would say than not, but to say that it's

representative of any point, that's probably not a fair statement. I don't think anyone would try to say that it's a one-to-one correspondence, but it does have a good general I would say representativeness of the midwestern region.

Question 8: "In the Steubenville Study, was there any attempt made to relate deposition of inorganic mercury from anthropogenic sources to methylmercury concentrations in fish?" To continue, the Steubenville Study, as we were asked to propose, was a study to look at the atmospheric -- basically, it was asked to quantify the levels of mercury in the environment, as well as the levels of mercury in the deposition, and to quantify the contributions from coal-fired utilities to the levels that we were seeing in the air and in the wet and dry deposition at that spot. It was not part of the scope of the work for us to link the deposition to aquatic impacts or to cycling or to air-water exchange or any of those issues. It was purely an atmospheric deposition study, so that was beyond the scope of our project.

MR. RIESER CONTINUES:

Q. Yeah, I'm sorry for this. I want to go back to the representativeness. How many -- and I had

these questions in mind, and I might as well get them out now. How many coal-fired power plants are located within 50 kilometers of Steubenville?

A. Of Steubenville?

Q. Yeah.

A. I know that's one of our later questions. I don't have a quantitative number, but there's a large number probably within 50 kilometers. There might be 15.

Q. Do you know what the combined aquatic -- if you're organized to answer this later, we can answer it later.

A. I have a table that lists -- I actually have a utility provided table that has all the megawatt -- I mean, it's actually the utilities that put that data together as part of the information requested by the EPA, and so I can add those up if you would like me to, but it's a fairly large number.

Q. So would it be correct to say that -- I believe you actually said that Steubenville was selected because it was extended in a place where you would see impacts from adjacent coal-fired power plants.

A. Yes. EPA, specifically, asked us to identify a location where we could utilize tools, and

again, I will talk about this a little later in some of the other questions, but we have developed tools over the last 20 years that allow us to make measurements in the environment and to work backwards to identify the sources of the pollution that we measure, and these tools -- some people call it environmental forensics. It's kind of like you find clues to what the source of the pollution is, and then you go and work backwards to identify the source. EPA asked us, specifically, to identify places where we could test those tools and investigate the feasibility and accuracy of using these tools in this type of application, specifically, to look at coal-fired utilities, and this was really an obvious outcome of the 1998 Mercury Report to Congress, which identified municipal waste and medical waste incinerators as the largest source of mercury to the environment, with coal-fired utilities being the second largest.

Having successfully reduced the emissions from the first category, which is the incinerator category, and seeing -- again, to see some of benefit, they started asking the questions "Well, what is the impact of coal-fired utilities?" because there really was no data out there, and they asked the

question why, and so they, specifically, told us to go to an area where we had a fairly good idea that we would be impacted by coal-burning utilities, so yes, that was the purpose for us going there.

Q. So for the purpose of developing that analogy, it would be good to go to a place where you knew you were going to be able to see the impacts that you were going to test?

A. Yes, that's correct. We would not go to South Florida to look for coal-fired utility impacts because there aren't any, so --

CROSS EXAMINATION BY MR. AYERS:

Q. Following up on that question, isn't it useful to go to a place where you have the phenomenon, if you are going to do the science, to try to understand the phenomenon?

A. Yes. That's exactly right. If you're asked to study something, in particular. In that case, we were. It was a very specific request and so we used our, again, 15 years worth of experience at a location to tell us that this was the right place to go, and we actually identified a couple of other locations, as well, not too far from here.

We could have gone from Steubenville

over into Pennsylvania. We could have gone down to Athens, Ohio. There's a lot of places in the Ohio River Valley corridor that would have met EPA's requirements, in terms of being within 15 kilometers.

MADAM HEARING OFFICER: Could you identify yourself for the record.

MR. AYERS: I'm Richard Ayres, Ayres Law Group in Washington D.C.

MR. AYERS CONTINUES:

Q. The second question I guess isn't it true, then, that what you learned in the study, like the one at Steubenville may be transferable in terms of understanding the phenomenon, even if Steubenville is not exactly like another place?

A. Yeah. That's a great question. The methods that have been developed -- I should say right up front that what we call these methods are receptor methods. In other words, a receptor is the place that receives the pollution, and so we'll get into this a little later in other questions, but instead of using a model, which takes the emission from a stack, and then models where those pollution emissions go and then fall down to the earth, the receptor methods make measurements at the place, so they are real

measurements, and then we work backwards to figure out where they came from. And these methods have been under development for the past 25 years at the U.S. EPA, and independent of the work that we've been doing, EPA has been working with some of the best scientists in the field to develop a series of models, and to go through and extensive testing and evaluation of these models to look at their use and regulatory applications and there's a whole literature that is out there with tens of papers, 10, 20, maybe up to 100 papers where other people have used these methods to do exactly what we were doing, which is proportion the amount of pollution that came from a particular source type, to how much was received at a specific location, so that work has been going on for a long time and parallel.

Our work was not to work on that, to show that these methods work. EPA has an exhaustive report of that. These methods have been tested. EPA has developed these methods. They are publicly available. They have had workshops where they have looked at uncertainties, and both, in the methods and calculations and all that is very well documented. It's not something we did as part of our study. We just took and used those developed tools that EPA had, and used

those to understand what we found in Steubenville, so choosing a place like Steubenville was just a way so that we could look, specifically, at coal-fired utilities to see what are the complexities and difficulties in looking at this type of impact because it is not simple. With everything in science, we start at the beginning, and we work up, and as we learn, we improve what we're doing, and so when this study was proposed, they said, "Okay, go where you think you have the highest probability of findings an answer," so we went there, got a good signal, and we've been successful in working backwards to define the contributions from the sources in that area.

Q. One final question, you did this work near the location of a lot of power plants. If, as some have said, that most of the emissions of mercury went up, and far away, rather than being deposited in relatively local areas, would you have seen the signature of the power plants that were located in the relatively local area of Steubenville?

A. Again, I guess this answer is a question that is posed to me later on, but again, getting back to the form of the mercury, there are a number of issues or controversies out there, in terms of mercury transport

and deposition. The form of mercury really determines the distance that mercury is going to get transported, and so understanding the form of mercury that comes out of coal-fired utilities is of great importance. The Electric Power Research Institute working with U.S. EPA and others, have done an excellent job of quantifying the amount of mercury that is consumed by this industry and submitted by this industry, and we do have some information on the form of mercury that comes out of the coal-fired utilities. The data -- again, this is data that is in -- we gave reports suggesting that it's somewhere around 67 percent, plus or minus 15 or 20 percent of the mercury that is submitted from coal-fired utilities comes out in that reactive gaseous form, although on any given day, at any given plant, that number can vary depending on the blend of coal and the type of control technologies and so forth.

In Steubenville, Ohio, there are enlarge number of coal-fired utilities around the plant, and the mercury that comes out of these stacks, based on, again, on the EPA's database, would suggest there's a significant fraction of the mercury that comes out in the reactive form, and this mercury goes into water that's in the atmosphere and gets precipitated out. We

also believe that this mercury is deposited through dry deposition to the earth's surface in a fairly local way. We do see a clear indication that coal combustions dominates the deposition of mercury to the Steubenville, Ohio, area. This is commensurate with our understanding of the form of mercury that comes out of the power plants.

MR. RIESER CONTINUES: Well, that was the whole nut, wasn't it? Obviously, there's a lot of questions on that. I don't know where you want to take them just to keep the record sane in the --

MADAM HEARING OFFICER: Keeping the record sane -- I've given up hope of that.

MR. RIESER CONTINUES:

Q. Fair enough. On the context we have organized our questions, or we can start on it now.

A. I think, if we keep going down, I think you will be able to have a chance to probe at what you would like to probe at.

MADAM HEARING OFFICER: I would like to point out that it is already 20 after 10, and we are going to be taking a break at 10:30. Why don't we try to get through Ameren's questions before 10:30 and we will take -- I'm sorry -- Dynegy.

MR. RIESER: That's fine. I just want the record to reflect that not asking question here doesn't mean we don't get questions on this later.

MADAM HEARING OFFICER: Absolutely.

MR. RIESER CONTINUES:

Q. I do want to ask a question on Mr. Ayres' second question, which had to do with how this operates. When you look at testing and experimenting with respect to phenomenon and the place you expect the phenomenon to be, isn't the next step of that to develop some method for extrapolating that determination to other circumstances?

A. Yeah. I think we always, again, in kind of a reductionist way of thinking about things, you try to identify an approach and methodology that allows you to answer a specific question, and then the next step is to try to broaden that specific answer to a larger context, and we've been doing similar type of work in the state of Michigan, as well. It hasn't just been in the state of Ohio, so we have similar monitoring sites at multiple locations in Michigan, which I believe, in my testimony, I alluded to, and so we were trying to do that. We have been working very hard, and since one of the things that -- you feel, after awhile, that maybe

your head has gotten softened up because I've been banging it up against the wall so long, but we've tried very hard to get both the states and the agencies to expand the type of work we have done to a larger geographical area, so we could answer these questions, and to do that, to take the science from a spot and take it and broaden it, so we can answer these questions in a more scientific, definitive way.

Like everything, the mercury field is fairly new. It's young relative to the acid rain field. We've only been at it for 15 or 20 years, and so it's something that's evolving, but we've made major progress because we learned so much from the acid rain research that was done, and we've learned so much from the acid rain research that the growth period has gone so much quicker, but we would still like to expand, so yes.

Q. Listening to that answer, can I say that you are working on methodologies to extrapolate from your findings of Steubenville, but have not yet completed that work?

A. Well, as my major advisor told me when started in on mercury, and after a decade, I told him I felt like I had just been on to learn the topic. He said to me, "You're going to retire working on mercury."

I have a long time to retire, a good another 20 some years to, work and I believe this is something that -- mercury is an interesting component. It's very difficult to get a handle on in many ways, and so I think, in terms of the changing local, versus regional, versus global concerns, that's changing all the time, and so I think it's something that's going to take a long time. However, as a scientist, I feel like I have a fairly good handle on things that are important for today, and yes, extrapolating -- I wish I had 25 sites. There's no doubt about it, but the sciences, basic chemistry and physics and basic meteorology, and those things are always transferable. The reason that we do work in Florida and Michigan is not because I'm a smart guy, and I want to go to Florida for vacation in the wintertime. In fact, all of our mercury work has been in middle of summer, which I tell my relatives the opposite just, so they don't think I'm a nut, but we work in these different environments, but the laws of chemistry and physics have to be the same in both places . You can't explain mercury behavior in Florida different than you explain it in Michigan. It has to be transferable. There has to be changes in meteorology or temperature or other things that make the behavior of

mercury explainable, and that's what we're finding. We are finding repeatable behavior in all the environments.

I have done an extensive amount of work in New England. We're doing work out west, work in the Mediterranean Sea, in the Arctic. All these environments keep telling us that we are better understanding the chemistry and physics of mercury, and that body of knowledge that we have acquired over the past 20 years really lends to credence to what we are finding. It doesn't make it more blurry. It makes a more better defined picture.

Q. So in order to draw conclusions from the Steubenville work to, say, Illinois, you would actually have to do the work you described of testing the deposition and doing the methodology you described. Is that correct?

A. Again, I think that's a question that gets back to my comment earlier. When we talk about identifying the contributions of the specific sources or source type to the state of Illinois, in particular, you can't go back in time and collect the rain. You can't go back in time and collect the air that was coming through the state, so the only way that you could do that would be to go and collect samples in the state at

the time that you wanted to do that contribution.

However, we actually have collected samples in Illinois. We collected them as part of my Lake Michigan Mass Balance Study, which is samples in Chicago, at IIT, and we have done an extensive amount of work around the Great Lakes Basin, so we have data that allows us to extrapolate and extend our understanding of what's going on to areas in Illinois that I think are very relevant and accurate.

Q. Were there any conclusions in your testimony based on that data specific to conditions in Illinois?

A. I believe there were.

Q. Were those conclusions the same as the conclusions -- the same type of conclusions, i.e, the contribution of local sources, local coal-fired sources to local impacts?

A. Again, this is one of the things that we -- I hate to keep saying it again, but -- the data we collected in those studies was collected in the `94, `95, `96 time frame. At that time frame, municipal waste and medical waste incinerators were the dominant source of mercury, and in the air shed and the Great Lakes, we had a number of very large incinerators.

Plus, the Chicago area has -- the Chicago-Gary area has a number of very large iron and steel production facilities, chemical manufacturing refineries, a number of other sources, so we did make conclusions regarding the sources of the mercury, but the blend of the sources was different at that time.

At that time, incinerators and power plants were about the same, and those were -- I don't know what -- 30 something percent each, in terms of the total mercury emissions, and now the one's gone, so now coal utilities are the largest source with incinerators being a much smaller, so the answer we got then were applicable to the time that we were making the measurements. The tools that we used are, generally, applicable to any time, but even at that time, though, the contributions we were seeing from coal combustion were I would say, relatively speaking, so if you take the one-third of the mercury emissions coming from coal combustion at that time, we were seeing signals in the 20- to 40-percent range, in terms of the contribution of coal combustion to the levels that we were seeing in the atmosphere and in the deposition, so it was consistent with the emissions that were occurring at that time. If we went today and took at look, we would see a different

picture.

Q. So is the answer to that question no.

A. The long-winded answer was given because I think it helped to relate to the conclusions we drew there. We saw the influence of coal combustion on the regional scale, local-regional scale, in those studies. The relative importance of coal combustion was different at that time largely due to the differences in emissions.

Q. So you don't have any recent data with respect to Illinois or the Chicago area that would allow you to draw specific conclusions. Is that correct?

A. I have not made any measurements in Illinois since the 90's. However, the conclusions I believe that we made there are still consistent. We've still been making measurements in Michigan, which is downwind of Illinois, and so we do still have data that helped us understand the sources that are in Illinois, but no, we do not have Illinois-specific measurements.

Q. Thanks.

MADAM HEARING OFFICER: Having arrived at 10:30.

CROSS EXAMINATION BY MR. MATOESIAN:

Q. Did you say that, even in the early 90's,

you were --

MADAM HEARING OFFICER: They cannot possibly hear you in the back of the room.

MR. MATOESIAN CONTINUES:

Q. Did you say that, in the early 90's, 20 to 40 percent of deposition you were finding was coming from coal-fired power plants in Chicago based on your sampling?

A. I said that, from our earlier studies, we were seeing 20 to 40 percent contributions from coal combustion to the ambient concentrations in deposition that we were measuring.

Q. Has there been a significant change in the weather patterns or meteorology for Illinois in the last 10 years?

A. Wow. This is where the legal, versus scientific, definition comes in. What's the definition of -- no. I would say that the simple answer is that the last decade has been interesting; one, meteorologically, but is not that consistent with the 30 year climatology, so no, there's not a significant change, although the weather over the last decade has certainly been unusual in many cases.

Q. Aside from Algora, so you would expect to

see, at least, a similar contribution from coal-fired power plants if you were to take samples?

MADAM HEARING OFFICER: You are going to have to speak up.

MR. MATOESIAN CONTINUES:

Q. You would expect to see, at least, similar contributions from coal-fired power plants today as you did then?

A. My expectation actually would be that we would see a larger fraction of the contribution from coal-fired utilities because the incinerator sector has been controlled, so that would mean that it could be a similar amount of total mercury, but it would be a larger fraction of the contribution from coal combustion.

Q. Thank you.

A. I don't have any evidence to suggest that it would have declined.

MADAM HEARING OFFICER: At this point, we are going to have to take a break. The board meeting is at 11 o'clock. As I stated earlier, there is a pending motion in this rulemaking. If the Board rules on that motion in the meeting, I will have copies of the record available when we come back at one o'clock.

(At which point, the hearing was adjourned.)

MADAM HEARING OFFICER: Before we go back on the record, I want to let you know, in addition to granting the motion to amend today, the Board declined to offer any of the direction asked for by Ameren, Kinkade and Dynegy to the Hearing Officer.

That being said, what I would anticipate is that next week, as we approach the end of the week, we'll see where we're at. As I indicated in my Hearing Officer Order setting this hearing, we will look at the schedules. We'll see where we're at, and see what we need to do, as far as continuing, perhaps, cross-examination, extend prefiling deadlines, and that sort of thing, and we'll do that as we proceed here, and we know where we're at.

That being said, I think we will proceed with Dr. Keeler. I believe we are on Dynegy Question No. 9.

MR. RIESER: Eight, I believe.

MADAM HEARING OFFICER: I thought we finished with eight.

MR. RIESER: Eight related to methyl relationship --

DR. KEELER: I did answer that. That was beyond the scope of the project we conducted.

MADAM HEARING OFFICER: Question No. 9.

DR. KEELER: Question No. 9: "Do different types of emission sources for mercury have different mercury deposition patterns? Yes. We would have different deposition patterns, and again, I'm sorry to keep repeating myself, but the deposition pattern is going to be a function of the type of mercury emitting from the stack, so from the type of stored source it is, and clearly, the characteristics of the stack, the height of the stack, the velocity at which the emission comes out and so forth, so yes, emission patterns will be different depending on the type of mercury and from the different type of sources.

Question 10: "Do different types of sources emit during species of mercury?" Yes. There's quite a bit of information in the literature now showing that different source types do emit different types of mercury. As we have already mentioned, municipal waste and medical waste incinerators emit a predominant amount of mercury in the reactive or ready depositable form, greater than 80 percent. Power plants, based on the

work that's been done by the utility industry, suggests that it's closer to 67 or so percent, but that the amount that's emitted from a specific source depends largely on the exact amount of coal that's used, the type of coal and the blending and so forth.

Motor vehicles will emit a different blend, less reactive, more elemental. Chemical manufacturing tends to emit more elemental mercury than reactive, so yes, the form that's emitted varies dramatically from one source to another. "What elements or facts influence or" --

MR. RIESER CONTINUES:

Q. The 67 percent number, with respect to RGM emissions from coal-fired power plants, you said that's -- do you recall the source of that number.

A. Presbo, et al., if I recall.

Q. Presbo?

A. Presbo. He works at Frontier Geoscientists, and I believe that's the citation that I have from that.

Q. And then that's -- do you know if that represents an average of all coal-fired power plants in the country?

A. It was the ones that were tested using --

I, honestly, don't recall which technique was used, but there were a number of plants that were tested, and that was the average. It was 67, plus or minus 15 or 17 percent, something like that.

Q. That was my next question. Wasn't there a range?

A. Yeah. There was, and again, my recollection is that it's 15 or 17 percent.

Q. I think we talked -- we talked earlier about different coals. Would that -- I think we talked earlier that that would be affected, also, by the different coals that were used as fuel, correct, certain types of coals?

A. Yeah. My understanding of the state of knowledge right now is the parameters that are most important, which is the next question, if that's okay if I continue answering that. The things that affect the or influence the type of mercury that's emitted for coal combustion, the chlorine content of the coal is very important, not only the amount, but the nature of the fly ash that's inherent in that type of coal, and people have indicated things like the iron content also plays a role, and the ash content can vary dramatically from one type of coal to another, and then it can actually absorb

some of the elemental mercury that's emitted, or in other cases, it might tend to have more particulate mercury, so those things are very important, in terms of how much mercury comes out, and again, that's not my area of expertise. I'm just going based on what I have been told.

Q. Do power plant configurations affect this, as well?

A. Yes. Again, that's not my area of expertise, and perhaps somebody else would be better off handling that question, but I know control technology will affect the speciation that comes out of the stack.

Q. Do you know in what way?

A. Well, again, it's a fairly complex relationship because it depends on what the emissions were, to start with, so if it's a high chlorine coal, which has lots of reactive mercury. If a wet scrubber is used, you will tend to use more mercury. It it's elemental mercury, a wet scrubber is not going to be as effective, but again, that's not area of expertise. I recommend that one of the engineers answer those questions.

DR. KEELER: So that was 11 --

MADAM HEARING OFFICER: I don't think

we've addressed nine or 10, yet.

DR. KEELER: 9, I answered, "Do different types of emissions source --

MR. RIESER CONTINUES:

Q. Let me can ask more question, if I may. I don't believe you addressed steel manufacturing, in whether those are sources, in your view.

A. Yes. They are sources of mercury. Any sources that uses fossil fuel for its combustion fuel is going to have a mercury emission, and so iron and steel industry definitely does and the manufacturing of steel produces mercury. We find -- we found quite a bit of particulate mercury, in fact, in the Chicago area, for example, due to the iron and steel industry.

Q. Would the amount of mercury and the type of mercury produced or emitted -- put it that way -- vary on the type of steelmaking process? For example, wet furnaces, as opposed to other types of operations?

A. Again, I'm not an expert on the steel manufacturing process, so I would rather not comment on that.

Q. Thank you.

MR. BONEBRAKE CONTINUES:

Q. Do refineries also emit mercury?

A. Yes, they do.

Q. What forms of mercury are emitted by refineries?

A. We see predominantly elemental mercury when we see influence from refineries.

Q. And in connection with the work that you had mentioned concerning Lake Michigan, were you finding any elemental mercury from refineries associated with the mercury in Lake Michigan?

A. I know that we saw refinery influences on the particular matter, and I don't recall that we saw a strong signal from refining in the gaseous mercury.

DR. KEELER: Now, Question 11: "Is the mercury deposition pattern for incinerators different than it is for coal-fired electric generating utilities?" I would say yes, and for the two reasons that the questions were asked before me. The form of the mercury coming out of the two are -- can be different and the height of the stacks of an incinerator, versus a coal-fired utility would also be quite different, although some of the electric generating units in the state have relatively low stack heights compared to some of the larger ones elsewhere. Some down in the couple-hundred-feet range. That's more

typical of an incinerator stack height. In general, those two things will cause a difference in the deposition pattern.

MS. BASSI CONTINUES:

Q. Is the state you're referring to Illinois?

A. Yes, it was.

MR. RIESER CONTINUES:

Q. Is it correct that the differences are associated with stack heights, and in what way is it associated with stack heights?

A. Well, lower stack height putting out large amounts of reactive mercury is going to really tends to push things towards more localized deposition than a high stack height with the same amount of reactive mercury, and then if you have less reactive mercury with less stack height, you have very localized, within a few kilometers of the plant type deposition.

Q. When you refer to some power plants in Illinois having stack heights of a certain height, which plants were you referring to?

A. I have -- I guess this is a list of all the power plants in the state sorted by stack height.

Q. We have extra copies, don't we?

MADAM HEARING OFFICER: We need to

admit that as an exhibit.

DR. KEELER: He's going to get some copies.

MR. RIESER CONTINUES: Why don't we hold on the issues on this issue, until I can get a copy of this. Thank you.

DR. KEELER: Question 12: "Not all inorganic mercury deposited to all water bodies from the atmosphere become methylated. Is that correct?" Yes, it is correct. Some of the mercury that's deposited to a water body, depending upon the form that it's deposited in, can actually be transformed into elemental mercury and again be re-admitted from service, so some fraction of the mercury gets immediately sent back up. Some of the mercury that's deposited to a body of water will attach to particles and sink to sediments, so that it won't instantaneously be methylated. It has potential to be methylated at a later time.

MR. BONEBRAKE CONTINUES:

Q. What percentage of mercury, as you just described it that's deposited into water bodies is transformed and re-admitted?

A. It's water-body specific.

Q. Is there any general range that results of

that process, recognizing that there's going to be variability among water bodies?

A. I would say there's no general range that I can say.

DR. KEELER: Question 13: "Some of the mercury deposited into water bodies is reemitted. Is that correct?" As I just mentioned, yes, it is. In the Lake Michigan Mass Balance Study, for example, of the mercury that was deposited to Lake Michigan, about one-third was reemitted, so two-thirds of the mercury went into the water body and one-third was reemitted.

Question 14: "The amount of methylation" --

MR. BONEBRAKE CONTINUES:

Q. Just a follow-up to that answer, do you have a reason to believe that that percentage would be significantly different for other water bodies in the Midwest?

A. I believe that it would be different than inland lakes. It may be very typical for the large lakes, but I think you would get a real range in concentrations, depending on the aquatic chemistry.

Q. In the lakes, would you have thought it to be higher or lower?

A. Again, it would vary quite a bit just as the chemistry in the lakes varies quite a bit. The DOC and the calcium carbonate and other basic chemicals that are in the lakes, those concentrations vary over, like, the whole state of Michigan, so I would think the evasion rates would vary, as well.

MADAM HEARING OFFICER: Mr. Zabel.

MR. ZABEL CONTINUES:

Q. Just as a follow-up to that question, was a similar analysis done on the deposition of the Everglades?

A. We published a paper looking at the earth surface exchange of mercury. It was not a mass balance, so I can't put a quantitative number on how much mercury was deposited versus how much was reemitted. The other difference is that we were able to calculate the flux from Lake Michigan based on measurements of the water body. The situations clouded in the case of the Everglades because of the vegetation that's there. There's a strong tendency for the aquatic plants to actually mediate some of that evasion, so some of the mercury that's in the sediment actually gets sent into the atmosphere via the plants, and so we didn't do like an evasion from the marsh land as part of that study.

Q. So there would be two reemission mechanisms in the case of the Everglades?

A. That's correct. Instead of just being from water, there would be another one.

Q. Is the reemission process that we've been discussing limited to elemental mercury deposited into a water body?

A. Yes.

Q. So the higher the level of deposited elemental mercury to a water body, generally speaking, the higher the reemission rate for a water body?

A. I would not say that's correct.

Q. What about that statement is inaccurate?

A. I would say that there's probably not been enough work to suggest that the more elemental that goes in, the more elemental that comes out. That's not necessarily consistent with some of the work that we've done.

Q. Although the percentage remains constant, and there's a greater volume of elemental going in, that's going to suggest a greater volume of elemental being reemitted, right?

A. That's if there were no other processes affecting the elemental mercury once it was deposited to

the surface, which there are tremendous processes. Mercury attaches to particles as soon as it transforms, so it's not a correct statement.

MR. ZABEL CONTINUES:

Q. I guess a follow-up question of mine, did the model used in the Everglades take reemission into account?

A. The cycling model does, yes.

Q. How does it do this?

A. Again, I think it has biotic than antibiotic, which means through chemically transforming the mercury into elementally formed evasion (phonetic) and also biologically changing the form of mercury into -- the exact mechanism, you would have to refer to the report in order to be able to get that.

Q. I guess what I was curious about was how you indicated that it was more difficult in the Everglades than in Lake Michigan, how that was quantified in the model then.

A. It was modeled.

Q. It was just modeled?

A. Yes.

Q. There was no collection of data comparable to Lake Michigan?

A. No, there was not. There was no concurrent, long-term monitoring of that. The work that we did in the Everglades was part of a specific dried up deposition project that we did where we made measurements through the winter and summer seasons to get, for the first time, some answers on evasion and dry deposition of mercury to that ecosystem, but there was no long-term record that would be comparable that could be used in the Florida TMDL work as we did with the Lake Michigan Mass Balance Study.

Q. So when you did the modeling on the Everglades, you had assumptions about reemission?

A. I didn't make any assumptions. The Tetricheck people had to take the knowledge that was gained from other people's work and use that in their models, yes.

MR. RIESER: My question has been asked an answered.

MADAM HEARING OFFICER: Mr. Harley.

MR. HARLEY CONTINUES:

Q. Would you elaborate on how the chlorine content of coal effects the emission of reactive mercury?

A. The question was on the chlorine content

of coal and its relationship to RGM emissions.

MADAM HEARING OFFICER: The RGM, is that --

DR. KEELER: Reactive gaseous mercury. The relationship suggests that the more chlorine that's in the coal, the more reactive gaseous mercury you are going to form, and that gaseous mercury would be in the form of chloride coming out of the stack, so or some other compound that would have chlorine in it, so more chlorine, more reactive mercury has been the tendency.

Q. Is a higher concentration of chlorine in coal associated with bituminous or sub-bituminous coal?

A. That's a good question. It's actually a fairly complex question to answer. Just saying that sub-bituminous coal would have less chlorine or more chlorine is too simple an answer, I believe. It think it's quite variable. In general, it may be that the average for bituminous coal is slightly higher than for sub-bituminous, but again, I think you can find pretty wide variability within those two types of coal, and then with other coals, so I think that's not that straightforward.

MR. RIESER CONTINUES:

Q. So you don't agree that, on average,

sub-bituminous coal has significantly less chlorine than on an average of bituminous?

A. No. I said I think it's possible that the average might be less for sub-bituminous than for bituminous, but I said there's a large variability in that, and that I think you would have to look at the specific type of coal to make sure that, in fact, that was true. The important parts in that is that sub-bituminous coal also will have less BTU's, so you have to burn more of it, and so the relationship between the chorine in the mercury and the energy content really are important, in terms of whether you put out more reactive mercury from that same type of -- or from that same amount of energy generated, so again, coal and chemistry of coal is, again, not my area of expertise. I'm not a geologist, but I'm going based on, again, much of the fine work that was done by the utility companies.

Q. Based on that fine work, focusing in on one type of sub-bituminous coal, I believe is how it's frequently used around here, with respect to Power River Basin coal, do you have an understanding of what chlorine levels we see in Power River Basin coal is significantly less than chlorine levels seen in Illinois bituminous coal?

A. I would say that statement is correct, on average.

MADAM HEARING OFFICER: Just so you know, you have to speak directly into that microphone, especially when you turned your head. We started to lose you. Mr. Harley, did you have a follow-up?

MR. HARLEY CONTINUES:

Q. So does it follow, therefore, that a coal plant operator who switched from low chlorine sub-bituminous coal that's from less, to higher chlorine bituminous coal from Illinois, there would be a co-benefit in doing that in reducing, potentially, mercury emissions from that facility?

A. I understand your question. Let me answer this. Probably the reason we're having these hearings in first place is this is a complex issue. The control technologies that will be used play a big role on being able to answer that question. From going to many meetings, such as the one I went to in china where they talk about control technologies and so forth, the vendors that I heard speak said that, if there was more reactive mercury coming out of the coal-fired utility because of higher chlorine content, that they would be able to remove the mercury more easily, than if it was

all in the elemental form, which requires a little bit more difficult control measures, so if, in fact, what you said was true, and they had the proper controls, then, perhaps, they could reduce the total amount of mercury more easily than if it was more in the elemental form, but again, there's a million assumptions in that that there's controlled technology. The exact type of coal, the ash content, all of those kinds of things, so there are a lot of engineering variables that go into that that make it a difficult question to answer.

MR. RIESER CONTINUES:

Q. Would it be accurate that a lot of these questions that were answered or were, at least, discussed, and if not, will be part of the technology discussion that will probably take place next week?

MR. KIM: Yes.

MR. RIESER: That's the beauty of a simple answer. Let me go back, if I may.

MADAM HEARING OFFICER: We're getting some interference. I think we are going to switch it out.

MR. RIESER CONTINUES:

Q. Just to go back to the issue of the reemission of mercury, is it accurate that the way the

cycle works through the water body that some of both of the RGM and the elemental mercury that are deposited to a water body are reemitted as elemental mercury?

A. Yes. The mercury that deposits in either form will be reemitted in the form of elemental mercury.

Q. And so to the extent it's reemitted, that bad mercury is not available for methylation, correct?

A. That's correct.

MADAM HEARING OFFICER: Before we go on to the next question, Mr. Kim, did you have those exhibits?

DR. KEELER: The table that's being submitted is a listing of the Illinois coal-fired EGU stack heights by the facilities.

MADAM HEARING OFFICER: And we reserved Exhibit No. 27 for the Detroit Study, so we will mark this as Exhibit 28, if there's no objection. Seeing none, it's Exhibit 28.

(Exhibit No. 28 was admitted.)

MR. RIESER: I have the Detroit Study, if it would be a good time to throw it in.

MADAM HEARING OFFICER: Sure. We'll go ahead and mark it. I have also been handed "The Detroit, Michigan, Source-Receptor Relationships for

Atmospheric Mercury in Detroit, Michigan," which we reserved Exhibit No. 27 for. If there's no objection, we will mark that as Exhibit 27. Seeing none, that's Exhibit No. 27. Thank you.

(Exhibit No. 27 was admitted.)

MADAM HEARING OFFICER: Mr. Rieser, you had some questions based on the stack height I believe that you wanted to ask.

MR. RIESER: You know what, why don't I look at it at a break, and we will come back to it.

MADAM HEARING OFFICER: That's fine. Then I believe we are on Question 14 from Dynegy.

MR. ZABEL CONTINUES:

Q. Just a quick question on Exhibit 28, it says, "Ranked by gross load megawatts." I don't think the Baldwin station has 13 megawatts. Is it megawatt hours?

A. I believe that's correct.

Q. Then it must have some particular year. I guess I don't know what the number represents, if you could find out Mr. Kim and let us know?

MR. KIM: We can find out.

MR. BONEBRAKE CONTINUES:

Q. A follow-up, do you recall, Dr. Keeler,

the average height of the municipal waste combustion units in question in the Florida Study?

A. The average weight?

Q. Average stack height.

A. I don't recall what the average stack height of all those waste combusters are, but they tend to be 150, or so, 150 or 200 feet or less, but I don't know what the average is.

Q. Do you know what the average was with respect to the stack height of the medical waste incinerator unis at issue in the Florida Study?

A. It was definitely less than 150 and maybe in the Florida report I -- I don't recall if that information was in there or not.

DR. KEELER: Question 14: "The amount of methylation that can occur in a water body depends on site-specific conditions. Is that correct?" Yes. Question 15: "Demethylation can also occur. Is that correct?" Yes. Question 16: "Is it possible to accurately predict the amount of methylmercury that will be found in a fish based on atmospheric deposition of the inorganic mercury to the water body that the fish lives in?" As we have discussed, models have been developed that will predict the amount of methylmercury

found in a fish based on the atmospheric deposition of inorganic mercury to the water body that the fish lives in, and these results appear to give very reasonable answers. The models that apply to the Florida Everglades as part of that TMDL gave results that compare I think very favorably with the actual measure data of mercury in the fish in those ecosystems, so I would say that it is possible to predict.

MR. HARRINGTON CONTINUES:

Q. Was that model adopted for the Massachusetts Study.

A. I'm not aware of the Massachusetts Study.

Q. Were there any -- was that model utilized in any other studies?

A. I believe it has been used in other studies and off the top of my head, I'm not sure where else, but I think there were other TMDL's that Tetricheck has worked on.

Q. Was there any further verification of a model with actual field data to determine its accuracy?

A. The data has been continually collected in Florid, and it seems to track the predictions very well, so they continue to collect biological samples from the Everglades area where the modeling was performed, and

yes, they are doing continued verification, and the model predictions are tracking pretty nicely.

Q. That's with respect to Florida?

A. Yes.

Q. That's very peculiar and unique environment, is it not, the Florida environment?

A. It is a unique environment.

Q. And would that model necessarily be applicable anywhere else as adopted in Florida?

A. As I mentioned earlier, you would not use the same parameters that you would use in the Florida case. You would adapt them using the ecosystem parameters that you would measure in that specific ecosystem, and so the things that were adopted, as you suggested, for Florida would not be appropriate to another location. You would have to use correct aquatic chemistry data, environmental conditions, climatology, all those kinds of things, in other words, for that model to work. I believe they did apply it where it was developed, up in Wisconsin.

MR. BONEBRAKE CONTINUES:

Q. The model that was used in the Florida study, Dr. Keeler, that model was used to predict methylmercury levels in fish tissue at only one

location. Is that correct?

A. Again, I think it predicts at more than one location, and again that was not my work. That was work done by Tetricheck for the State of Florida. It is detailed in that report.

Q. You recall this morning we looked at some language in the Florida report, which indicated that three sites in the vicinity of what was referred to as the "hot spot" in half of the -- what was called the cohorts, there was no change in methylmercury fish tissues. Do you recall that?

A. Yes, I do.

Q. Does that, therefore, mean that the model that was used in the Florida Study was, in half of those cases, predicting no change in methylmercury levels?

A. The observation was that there was no change, correct, in that table.

Q. That's what we talked about this morning.

A. Right, so the model predicted that you would see a change, and in some of the fish, it was born out that there was change, and some of them there was not, that's correct.

Q. So the model did not accurately predict methylmercury fish tissue levels, at least, at all

locations. Is that correct?

A. That would be a correct statement.

MADAM HEARING OFFICER: I think that finishes Dynegy's questions. Mr. Kim, where are we going next?

MR. KIM: I believe we are next going to move to Ameren's questions to Dr. Keeler. I'm kind of hopeful when we get to Prairie State's questions that they have already answered them in the course of others, but we will look and see.

DR. KEELER: Question 1: "According to your report and written testimony, the scope of your presentation to the IPCB is to describe the source of the mercury deposition to the Great Lakes, and to specifically discuss the importance of coal-fired utilities to the region. A: Is it correct that you were not asked to address the impact of Illinois coal plants on mercury deposition within Illinois, and B: Is it correct that you have not performed any source-receptor studies which determine impact of Illinois coal plants on mercury deposition in Illinois, and C: Are you aware of any -- are you aware of whether any such studies have been performed?" I was asked by the State of Illinois to address the work that we have

done looking at the impacts of various sources on mercury deposition to the region. They did not ask me to not look at it, the State of Illinois, as the question suggests. I was asked to look at all sources and all of the sources of deposition to the Great Lakes, including the state of Illinois. It is correct that I have not performed an Illinois-specific source-receptor study, but having concluded Illinois within the greater context in the Great Lakes in the study that we have done, we have made measurements, as I mentioned earlier, in three times one in Kankakee, Illinois, as part of the Lake Michigan Urban Air Toxic Study, and Chicago as part of the Lake Michigan Mass Balance Study and in Bonnville, Michigan, as part of that same study, but we -- again, those were in the context of looking at Lake Michigan Study, not specifically, looking at Illinois. I'm unaware of any other studies that have been performed, specifically on the state of Illinois for this purpose.

MR. BONEBRAKE CONTINUES: Did you use the phrase "Illinois-specific study" in that answer?

A. I believe I did, yes.

Q. What do you mean by "Illinois-specific study"?

A. The question asked me if I -- "Is it a correct that you were not asked to address the impact of Illinois coal plants on mercury deposition with Illinois?" That is incorrect. That's what I meant by "specific," that specific study about coal plants in Illinois on Illinois. That was a double negative.

MR. KIM: It's a funny-worded question. I think he's -- I think he's tried to answer it within the frame work of the question. If you would like to rephrase it.

MR. BONEBRAKE: It's not my question.

DR. KEELER: 1-A that is no, that is incorrect.

MR. RIESER CONTINUES:

Q. It's incorrect in that you -- start over. What you were asked to do with your testimony was look at all the studies that have been performed in the Great Lakes region and summarize them, correct? That was one of your tasks.

A. No. They asked me to look at the studies that my laboratory has performed looking at the sources of mercury to the Great Lakes region.

Q. Page two of the question -- excuse me -- page two of the testimony under "Purpose of Testimony"

says, "I was asked by the Agency to prepare a state-of-the-art assessment of the sources of mercury deposition to the Great Lakes, and specifically, discuss the importance of coal-fired utilities on the deposition of mercury to the region." Correct?

A. That's what I tried to paraphrase just now.

Q. By "Great Lakes," did we discuss this morning that the Great Lakes reference is to the Great Lakes Basin which only includes a small portion of the state of Illinois?

A. The Great Lakes Basin reference was only in reference to the one modeling study that I referred to where we were looking at within the Great Lakes Basin, sources to those, which are outside the Great Lakes Basin, but our body of work is larger than just the Great Lakes Basin.

MADAM HEARING OFFICER: That would have been Exhibit 26, the report.

MR. RIESER CONTINUES:

Q. Thank you. When you use the term "Great Lakes" in this sentence, what did you mean by it?

A. I mean all the Great Lakes states, basically.

Q. All the Great Lakes states?

A. And the province of Ontario.

Q. When you use the term "region" in this context, does this mean the same thing?

A. Same thing, yes.

Q. But other than the studies you described that had sampling stations in some points in Illinois, you haven't done any studies within the state of Illinois?

A. Only the studies that we collected in the samples in Illinois are the ones I'm referring to.

MR. ZABEL CONTINUES:

Q. Just so I'm clear, Doctor, the Great Lakes study was all five Great Lakes?

A. Yes.

Q. I don't count Lake Champlane, as some New York congressman would.

A. Actually, it was a Vermont congressman, but yes, that's a correct statement.

Q. So that was the region that ranged from --

A. From Minnesota, to New York in this case.

Q. Thank you.

DR. KEELER: D: "What is the basis for your statement at the end of your testimony that,

`Areas with elevated mercury deposition due to emissions related to coal combustion have been identified'"? This statement is based upon the work that we've done in the state of Ohio as part of the Steubenville Study where we performed a receptor modeling study to determine that, approximately, 70 percent of the mercury deposited via wet deposition at that site was related to coal-fired utility emissions. E: Are these areas in Illinois?" How have they been identified?" The answer to that is no. F: "Did you participate in drafting the technical support document, TSD, prepared by Illinois EPA for these proceedings?" Yes. I contributed to the Technical Support Document that is found in the appendices.

MR. RIESER CONTINUES:

Q. You added the report that's Appendix B to the TSD. Is that correct?

A. I don't recall what the --

MADAM HEARING OFFICER: Yes, that's correct.

MR. RIESER CONTINUES:

Q. Did -- were you involved in the drafting of the section which I believe is Section 5 that deals with atmospheric deposition?

A. No.

Q. Did you review it?

A. After it was submitted I looked at it, yes.

Q. But not before it was submitted?

A. No, sir.

DR. KEELER: Question No. 2: "On page 81 of the TSD it states that `Thus it can be expected that significant mercury emissions reductions in Illinois will yield significant reductions of mercury deposition in Illinois.' Did you author this statement?" No. Do you -- B: "Do you make the statement in your report in Appendix B to the TSD or in your testimony?" I did not make that direct statement in either of those. C: "Do you believe that there is a factual basis for this statement?" And my answer is yes. I do believe it's a factual basis in that statement.

MR. RIESER CONTINUES:

Q. Could you please describe the factual basis which may have been well where you were going.

A. Again, the factual basis for the agreeing with that statement is that we have done a body of work now over the past 15 years looking at the sources of

mercury deposition to areas all over the Great Lakes Basin, including some sites here in the state of Illinois, which suggest to me that coal-fired utility emissions are having an impact on mercury deposition in the state, and do have an impact on the mercury concentrations in the air in the state of Illinois. That's why I agree with those statements.

Q. Is there quantification that you have performed that can measure that amount?

A. Again, the Lake of Michigan Mass Balance Study we collected samples for 18 months at Bonnville, Illinois, in wet deposition, as well as the gas and particle phase. Again, that's gas and particle phase mercury at that site and source proportion was done on that data, as well as the data that was collected in Chicago, Illinois, looking at the various sources, and that work was actually in the doctoral thesis of Matt Landis, and that can be looked at there. Some of that work is in the peer-reviewed literature, and in the paper that you suggested, and in that work, they found a significant -- again, my memory is that it was about 20 to 30 percent of the ambient mercury in deposition was related to coal combustion.

MADAM HEARING OFFICER: Mr. Harley.

MR. HARLEY CONTINUES:

Q. The work that you just described, is that the basis of the statement in your conclusion that 21 coal-fired power plants in Illinois emit close to four tons per year of mercury into the atmosphere?

A. No. That's based on the emissions inventory.

Q. Thank you.

MR. RIESER CONTINUES:

Q. The reference you had to the Chicago Study, is that the paper we talked about this morning that I think is Exhibit 26, "Atmospheric Mercury in the Lake Michigan Basin" --

A. Yes.

Q. Is it accurate that the sampling for that study was primarily applicable to the lake?

A. No, that's incorrect. Correct. We did have sampling over the lake, in addition to running five sites, Bonnville, Chicago, a site on the border between Illinois and Wisconsin, a site in South Haven, Michigan, and a site in Sleeping Bear Dunes, Michigan. At the same time, we were taking measurements at a site in Lake Superior up at Eagle Harbor, as well as in Dexter, so all of those sites were simultaneous, so the great

majority of the samples that are collected were not collected over the water.

Q. And did you also say you've done a source apportionment as part of that study?

A. Yes. Dr. Landis did a source apportionment as part of his thesis work.

Q. That source apportionment consisted of associating certain chemicals with certain types of -- certain types of groups of chemicals together? Would that be correct?

A. It was a variance of the type of analysis that we did in Ohio, yes. It was a receptor modeling calculation that used both the elemental and chemical composition of the precipitation or ambient samples together with the meteorological data.

Q. When you do that type of study, does that allow you to identify specific sources or groups of sources?

A. Receptor modeling, in general, unless it's done on a plant that's in isolation out in the middle of nowhere really gives you an answer for the source category. It does not give you an answer for a specific source.

Q. So by doing that type of study, you

couldn't identify a particular power plant as the sole source of coal combustion in the chemicals that you're seeing. Is that correct?

A. The only way that that could happen is if they were -- if it was distance wise separated from other plants. If there were two plants next door to each other, it would be difficult to do that, yes.

Q. You also make the statement that -- this is on page 4515 of the report, that?

MADAM HEARING OFFICER: Specify --

MR. RIESER CONTINUES:

Q. Over the paper -- excuse me -- and this is Exhibit 26. You done remember every page of every report?

A. No, getting hard to do that.

Q. Right down at the bottom, the paragraph begins --

A. 4511?

Q. 4515. At the bottom, it says, "In fact, the urban air shed" -- and you're referring to the Chicago-Gary open area -- "the urban air shed was a complex system of numerous point sources in distinctive meteorology." Do you see that?

A. On 45 --

MADAM HEARING OFFICER: It's on the left side.

MR. RIESER CONTINUES:

Q. It begins "The spacial -- you see that?

A. I see that.

Q. We're in the same place. You still believe that, I assume, that the urban air shed was a complex system with numerous point systems in distinctive meteorology?

A. Yes. I think urban areas are, generally, that way.

Q. Does that mean that it matters a great deal where you put your sampling point, in terms of what findings you are going to get?

A. This paragraph, specifically, was addressing where you put the reserve vessel over the water in order to be able to see specific source influences, yes.

Q. So you would agree with me that it matters where you put your sampling point?

A. It matters really in a big way when talking about over-water measurements, yes. It matters, generally, yes, where you put your sampling sites, but it really made a big difference in terms of over-water

measurements because of the strong stability over the water during the summer months.

DR. KEELER: Question 3: "Is it correct that the conclusions in your testimony regarding the sources of mercury deposition were based on the work you did in Steubenville Ohio?" Yes. "Has that work been published in any peer-reviewed journal?" The work, at this point, is now in the process of being published in a peer-reviewed scientific journal. We were hoping to submit the paper about a year ago, but it was held up in that process as a request from the then EPA administrators, since that is a cooperative agreement, which means that we're working collaboratively with scientists from the U.S. EPA of Research and Development that our paper be subjected to, both, a strict and rigorous internal EPA review by their scientists, as well as an independent outside review by independent scientists outside of the EPA before we submitted it to the journal, largely, because of the sensitivity surrounding the upcoming CAMR rule, so that delayed the publication submission by almost a year, so the publication is right now in the process of being finalized, and we expect publication of peer-reviewed literature within the next three months.

MR. RIESER: I'd just like to say that, because we don't have the actual report with its supporting data and sources and specific conclusions, that, should this proceeding be continuing after that study is published, that I reserve the right to ask additional questions of Dr. Keeler after the time that it's published.

MADAM HEARING OFFICER: So noted.

DR. KEELER: Question B: "Is it possible that you will change any of your statements or conclusions as a result of the peer review process?" No. The reviews came back quite favorably, and only made suggestive and clarifying comments regarding any of the science that was performed, and so no, none of the conclusions will have changed, and even the quantitative statements will not change. C: "Is the underlying data available for review?" EPA policy, as well as that of most scientists is that, once the peer-reviewed publication becomes in press -- I mean, not in press. I mean has come out in peer review that the underlying data can be made available, so that's the answer. That's a fairly consistent way that everyone approaches intelligible property rights when it comes to scientific investigation.

Q. So the answer to C is no. Is that correct?

A. The underlying data is not available today for review. I should offer, though, that as part of the peer review process that EPA undertook, it was unprecedented, in terms of the rigor of the evaluation. We provided them, not only the raw data that we collected as part of the study, but we also provided them with the exact model and model formalisms, together with all the input parameters that we used in our calculations to allow them to independently run the models and come to their own conclusions, and in addition, apply their own receptor models and statistical approaches to look at the data, and came up with the exact same answers that we did in that review process, so in terms of the external review, that was done.

Q. Is it accurate that, both, yourself and -- is it Mr. or Dr. Landis?

A. Doctor.

Q. Both, yourself and Dr. Landis, have presented Powerpoint presentations that include some portions of the data?

A. Do you mean that you don't have?

Q. Is it true that you presented Powerpoint presentations that contain some portions of the data?

A. Yes.

Q. And that was selected by you, and I assume Dr. Landis for the purposes of those presentations?

A. What was selected by me?

Q. The data that you chose to present at those presentations.

A. Yes.

Q. And the answer to the question and then the question in terms of what I have and don't have, of course, is whether there's a copy available of the presentation made to LADCO in February that I didn't get.

A. Yes. There is a presentation copy available that you can have, yes. All the public presentations are available. Most of them -- I think four or five --or publicly available on the website and some of the utility groups already have the LADCO presentation.

Q. But you understand that the LADCO presentation has not been on LADCO's website, so to my knowledge, it hasn't been available, so you can make it available is part of the process?

A. Yes.

Q. Thank you. When can we expect to get a copy of that? Can we get one today, so we can talk about that tomorrow?

A. I would have to check to make sure that I have that on my laptop and if I do, I can get a copy of that to you.

MR. BONEBRAKE CONTINUES:

Q. You mentioned some feedback from U.S. EPA to the data that you provided to the Agency. Has that feedback been in writing?

A. The feedback from EPA regarding the data?

Q. Regarding the data that you submitted for their review in the Steubenville Study?

A. We got a written review, yes, that was provided from the peer reviewers, yes.

Q. Peer reviews at U.S. EPA?

A. Those were -- no, there was not. These were external peer reviewers.

Q. Who were retained by U.S. EPA?

A. By an outside contractor working for U.S. EPA.

Q. Is a copy of those comments publicly available?

A. You would have to direct that question to the U.S. EPA.

Q. Do you have a copy of those?

A. I do, yes, not with me. I have a paper copy back in my office. I don't carry them with me. It was probably about 200 pages worth of comments because of the extensive review that they did.

DR. KEELER: Question D: "Have you ever released, for public review, any description of the methodology you used for source attribution?" We have made presentations at a few forums that describe the methodology for source attribution, and as I mentioned earlier, all the methods that we used have been published extensively in the peer-reviewed literature, so we did not use any new techniques like, PMF and Unmix, which are two statistical approaches developed by Paatero and Hopke, as well as Ron Henry at USC, and it has been extensively peer reviewed.

MR. RIESER CONTINUES:

Q. And how often have those methodologies been applied to mercury?

A. Well, that's one of the novel parts of what we have done. They have not been applied very often for mercury.

Q. Have they been applied ever for mercury?

A. I'm not sure of the answer to that question. There is a possibility that there's one application, but I don't know.

Q. And we've talked about this methodology for source attribution briefly in different parts. Is this the same methodology you used in Florida?

A. Actually, the methodology we used in Florida was similar. The paper deadvantage et al. 1999 that was in "Environmental Science and Technology" used a similar approach. It was a factor analysis multivaried technique. The techniques that we're using now have are a decade later, and they have gone through a whole tremendous amount of improvement, including the statistical handling and uncertainty analysis, and so forth, so it's a much better and much more robust statistical approach to doing source apportionment than what we used in Florida.

Q. This probably as good a time as any for you to describe that method.

A. The Florida methodology?

Q. No, the source attribution methodology that you used in Steubenville.

A. Sure . As I mentioned earlier, what the

receptor modeling does -- the receptor model methodology utilizes measurements taken at a location, and those measurements include -- in this case, we make measurements of precipitation every time it rains, so every day that rain falls, we collect that, and then we take and analyze those samples very carefully in a Class I clean laboratory at the University of Michigan for the concentrations of trace elements by some fairly sophisticated analytical techniques, ICPMS, ion-coupled plasma, mass spirometry and for mercury and major ions, so we have a list of about 40 trace elements. Ions and chemical constituents in every single rain sample. The statistical approach then takes all of those samples and works backwards, statistically, to determine what were the major factors that contributed to the variation that was found in the precipitation mercury levels, so it takes this very complex large database and kind of mathematically determines what sources contributed to mercury in each of those samples. That methodology can be done -- or that approach is done in multiple ways. In this case, in our paper, we have used both positive matrix factorization, which is a program written by Dr. Paatero and Hopke, which ensures that the factors that are calculated -- or the source factors that are

calculated are mathematically stable, and also, allow you to input the uncertainty in the measurements that you make. And then another model that's independent, but a similar mathematical concept is Unmix. Again these are both factor analysis models is independent and doesn't allow you to include the uncertainty calculations into that. We ran both of these models independently. In fact, one of the questions, the next question is "What were your respective roles on the Steubenville project?" One of the ways that we worked on this project collaboratively is EPA has several receptor models that are expert in using these models and developing these models and at the University of Michigan we independently ran the PMF and unmixed models from the researchers that were doing the work at EPA, so that we could then compare the results that we got. In the process of doing the initial work, both models wound up giving us comparable answers. One of the questions later on was why did I say about 70 percent contribution from coal-fired utilities? The reason for the approximate was so that I could more precisely give the answer for a combination of the two models. PMF gave a contribution to coal-fired utilities of 70 percent, and Unmix actually gave a contribution of 74 percent, but

there was an uncertainty of about 15 percent, about both of those numbers, and therefore, the mean for the two I could have put 72 percent, 72.1, or whatever it was, but I put it short hand as 70 with an uncertainty about those numbers, so those methods, as I said before, have being rigorously compared and developed over the last 15 years down at EPA, and in the scientific community.

Q. Let's take this a step at a time to break it down. In order to identify -- when you use the term "source" in the phrase "source-receptor modeling" --

A. Yes.

Q. Again, as you said earlier, that refers not to a specific source, but to a class of sources, correct?

A. Yes. That's correct.

Q. So you got coal-fired power plants automobiles, steel plants, whatever, and in order to identify a given source, is it correct that you identify certain chemical fingerprints, if you will, associated with those types of emissions?

A. Yeah, and that's the key to the whole thing is that we do identify what we call chemical signatures. It 's like a fingerprint for a person. Each major source category will have a specific

fingerprint, or signature, and sources that are in the same source category have fairly similar signatures. If they were dramatically different, then they would look like two different sources, so two different coal plants that very different signatures, so one that burned one type of coal, versus burning another type of coal exclusively, would look like two different sources. In this case, we have signatures that have been developed through the literature over the past, since the mid 70's, that give us ideas about what these signatures should look like from coal burning, from motor vehicles, from iron and steel production, from all kinds of different sources. One of the things that sets my group apart from the work of other receptor models is that we do all of our own chemical analysis in-house, so we are involved in collecting actually source-signature data from plants, from motor vehicles out in the field at the sources, and then also analyzing the samples that we collect in the field, so that there's no possible differences between analytical laboratories, so we've been very instrumental in providing the actual source signatures and using the advanced analytical techniques that we have, we actually are pushing the forefront in finding new elements and new chemical markers and new

signatures for the various sources that we're looking at.

Q. I think you said in that answer that the chemical signature for coal plants is the same across all types of coal plants. Is that correct?

A. No. That's not what I said. I said that if two plants were burning different types of coal that they would have a different signature.

Q. So have you identified different signatures for plants that burn bituminous, as opposed to plants that burn sub-bituminous coal?

A. We have analyzed coal from that sub-bituminous coal versus bituminous coal, and it has a different characteristic signature. You -- it's getting back to the question that was asked about the chlorine content. The chemistry of the coal is different. That's why there's different mercury, different reactive mercury formation. We are working towards trying to identify an ambient signal that would allow us to separate out the two types of coal in the ambient air.

Q. But at this point, you don't have that capability?

A. No, and it wasn't important, in terms of the receptor modeling that we were doing. It's just a

goal that we have.

Q. And is it accurate that the source-receptor studies you have performed to date have been primarily in areas that burn in bituminous coal such as Steubenville?

A. The type of coal that's mined in that area is certainly sub-bituminous coal. I don't have a record of what actually was burned in the plants in the surrounding area on a day-by-day basis. I don't know if that's available or not, but as I understand it, there's blends of sub-bituminous and bituminous coals burned in the power plants in the general region.

Q. And in basing the identification of sources on a chemical signature, does that allow you to make a determination as to the proximity of those sources to your sampling point?

A. No. Just the observed data by itself does not have implicit within a distance, so what we do is employ hybrid models or meteorological information together with the help from these receptor models to tell us the distance scale and the specific source locations that were contributing to the mercury deposition, and basically, it's taking all the available meteorological data we can get from surface data to

upper air data to numerical models to do a very detailed analysis of every storm event, and then match that together with the help from the receptor models.

Q. Is that similar to the type of analysis that was done in -- was that the type of meteorological analysis done at Steubenville?

A. Yes.

Q. Was that using hy-split and there was one other model that I think was referenced in the Florida Study.

A. In the Florida Study?

Q. I'm sorry. I've read too many studies.

A. I have done too many studies.

Q. The Ram Study (phonetic)?

A. No. We did not employ rams in the Steubenville Study.

Q. What where are the meteorological models that you used in Steubenville?

A. We employed hy-split and we -- because of the fact that we've been developing our own version of the chemical model on the C-MAQ, which is the EPA mercury model, we've been using MM-5 as the meteorological preprocessor.

Q. And so it's the use of the meteorological

models that allows you to make a statement with respect to the proximity of the source?

A. Yes, sir, and actually, the observed data is much more powerful than, actually, even the models.

Q. In what way? When you say "observed data" what are you referring to?

A. I'm talking about using NEX-RAD, surface maps, observable detailed meteorological records from the Great Lakes region. Most of the work that we've been doing, which is something that I've been, personally, doing for 25 years now, is taking observed meteorology and using that to understand aerial issues in various parts of the country.

Q. So the observed data you were referring to is the observed meteorological data?

A. Data provided by the National Weather Service, but I should mention that we also use -- we have on-site in Steubenville our own meteorological tower and our own set of meteorological data that we also utilize.

Q. Why don't we go on to four, then.

MS. BASSI CONTINUES:

Q. In these signatures, in the signatures that you were talking about that you have developed or

that have been developed over a number of years, as I understand it, there is a different signature for different types of industrial source categories or non-industrial sources of categories. How can you tell the relative contribution from each type of contributor that has a signature?

A. That comes down to the mathematical process that's involved in the, both, PMF and Unmix. Are you familiar with multivarious statistical techniques?

Q. Oh, no. You have to make this simple.

A. It comes down to -- there are a number of elements and ratios of one element to another that define the fingerprint for a specific source, and what it, basically, does -- last night after I ate all these jellybeans I think I woke up with a stomach ache from the jellybeans, and I was trying to figure how I could use the jellybeans to draw out this analogy for you. And I decided I shouldn't go there.

Q. But you knew the question was coming.

A. Yeah, because it really is a good question, and it's one that I think, as you get into the mathematics, that you can see the beauty of it. It's basically an ID value problem for someone who's done

physics or engineering. It, basically, is an optimization. If you have a series of unknowns, and you have a series of things that you know, such as the elemental composition, you can solve those equations to get the best solution to make all the equations true, and in doing that, the answer, basically, is the Ion-deductor (phonetic) or the source factor that it calculates, and in doing that, it tells you how much variance is explained, or how much of the data can be explained by that one particular source, and then you take and relate the amount of mercury that you collected to the amount of these other trace elements in that source, and you can get a statistical relationship, and around that, then it gives you goodness of fitness statistic and a whole bunch of statistics that tell you how well your model performed. If there isn't a relationship there, your model will give terrible results and your goodness of fitness statistics come out lousy, and in this case our goodness of fitness statistics came out very good and the relationships were very clean. And so we were very, very confident, and very happy with the outcome of the results from the two years worth of analysis.

DR. KEELER: I was on question 4-A I

didn't answer. "What portion of the work was performed by Mr. Landis?" As I mentioned earlier, this was a collaborative project with U.S. EPA Office of Research and Development, and Dr. Landis is our project manager on the project, and he's involved in all facets of the research, from site set-up, to sampling, to analytical results, to modeling. And so he's been involved in all facets of the project. "What were your respective roles in the Steubenville work?" The RFP was written by EPA, so they asked far specific targeted pieces of work, but in a cooperative agreement, the EPA cannot ask us to do anything. It's cooperative study, so all the work that we are doing is the work that I initiated through my direction through the approaches that I chose to use in this project. I'm the project director and principal investigator on the project and involved in the same, from site set-up, to site sampling, to analysis, to interpretation of the data.

C: "Has he published any of his findings regarding Steubenville in any peer-reviewed journal?" No. The intellectual property rights belong to the University of Michigan, and the code belongs to the U.S. EPA. Within a cooperative agreement, again, the principal investigator is given the first right to

publish the scientific results. However, we are joint partners in this endeavor.

"Are these data available for public review?" Our data -- I assume that's what you're asking. Again, it's a normal procedure to make available scientific results, once the peer-reviewed journal and article comes out.

E: "To what extent did you rely on work performed by Mr. Landis?" Again, I'm not sure to what extent or what context you are asking the question, but Dr. Landis is an excellent scientist and we relied upon his work flout the project, and value his judgment in all aspects of the project.

MR. RIESER CONTINUES:

Q. Did the two of you come to the same conclusions regarding the Steubenville Study."

A. We worked on this project. As I mentioned earlier, EPA began doing some of the modelings, and we were doing some of the modeling independently, and it was hard not to come to the same conclusion. In this case, the importance of coal-fired utilities on the mercury deposition in Ohio was so significant that we did come to the same conclusions. I think as our peer-reviewers showed us, it's difficult to come to any

other conclusions.

Q. You make the statement in your testimony in the second paragraph of your conclusion that, on page five, "Source-receptor studies have recently been completed that indicate the coal-fired utilities contributed, approximately, 70 percent of wet deposition measured at a site in Eastern Ohio over a two-year period, from 2003, to 2004," which I assume is this Steubenville Study we are talking about?

A. Yes, it is.

Q. In one of the presentations that Dr. Landis gave, didn't he say, specifically, that it was not coal-fired utilities, but coal and fuel combustion, and not solely electric utility generation?

A. I would have to look at the presentation to -- I know that one of the early briefings that we are forced to give, one of the things that occurred is that EPA, Tim Opelt, who was the acting -- or not the acting, assistant administrator at EPA at the time, really pushed EPA to try to get us to get our results out because of the impending rules, and because they thought it was pertinent to writing the rules, and in that process, he urged Matt to go to Washington at a very early date when we had preliminary results and present

those results, and so one of the interesting things in the briefings is that you will see that there are changes from one briefing to the next, in terms of some of the quantity of numbers, and the number of decimal places, and other ways that things are listed in there, and if it's one -- if it's a briefing to Tim Opelt, I don't know if it says on the front or not.

Q. It does. It's the briefing for Tim Opelt, April 27, 2005. This is a Powerpoint presentation for which I do not have copy, but will by tomorrow, so it can be introduced as an exhibit before the Board.

A. That is the first mention of our preliminary results, so in that presentation, Dr. Landis would have been the one who would have made those slides.

Q. Did you work with him in putting these slides together?

A. I would have worked with him on the results that are included in those slides, but I did not work next to him putting those slides together.

Q. I'm reading from one of the slides entitled "Results" and I have just the one copy, so I can show this to you to verify, but if I can read from it, and again, I will have copies for the exhibit

tomorrow. "Approximately, 70 percent of the mercury wet deposition in the Steubenville site is attributable to local slash regional fossil fuel coal and oil combustion sources," and then there's a bullet under this that says, "Not entirely attributable to electrical utilities."

A. Okay.

Q. Do you agree with that statement?

A. I think, at that time, when we had gotten those preliminary results we had not gotten to the point where we had done a more definitive interpretation.

Q. What had you done in the intervening time that allowed you to change the conclusion to the one that you have in your testimony here?

A. We have done a considerable amount of more work, one of which was to try to understand, as Matt said here in this presentation, where he put coal and oil combustion sources, we actually took a much closer look at the sources that were in the area, and the transport and meteorological conditions to go with the just the elemental data that we got to make sure that, in fact, we didn't feel the oil combustion was a major contributor. This was -- I think Matt was trying to be extremely careful in his presentation to Tim Opelt at

that time because, literally, the results popped out of the computer within the same couple of days as when he had to make his presentation, and interestingly enough, this was -- I don't know if it still says -- so briefing for Tim Opelt. I know the version that I had seen actually said, "Not for outside consumption" because -- due to the preliminary nature of the work, so that somehow is not on there anymore.

Q. No, it's not, and it's available on the U.S. EPA website.

A. Actually, is it available on U.S. EPA or on the E-Wire website?

Q. U.S. EPA. But I'm not answering the questions here, but that's quite fine. Is the 70 -- the number of, approximately, 70 percent, what were the ranges that you had for that?

(A small break was taken.)

MADAM HEARING OFFICER: Let's go back on the record. Dr. Keeler, you were looking up some information to answer a question from Mr. Rieser.

MR. KIM: While he's looking that up, Exhibit No. 28, which I believe was the table that shows stack heights Mr. Zabel had asked a question about one column of numbers, and I believe that that should be the

correct identification for those numbers is gross load by megawatt hours, and those figures represented the average of the highest three yearly gross loads as reported by U.S. EPA, CAMD, for the period of 2001, 2005. So over that five-year period, the average of the three highest.

MR. ZABEL: That makes a great deal more sense. Thank you.

MR. RIESER CONTINUES: Looking this up -- could you read back the last question to Dr. Keeler?

(The previous question was read by the court reporter.

DR. KEELER: The PMF model has predicted a value of 70 percent a d the Unmix model predicted 74 percent. Again, this is -- I just picked up an earlier version, so I'm not positive that these are the final numbers, so I'll give you the range. We did two years' worth of measurement. The entire year of 2003 and the entire year 2004, and we did the apportionment on the two years combined, and estimated using the two different models, how much mercury came from coal-fired utility boilers to the deposition of mercury for 2003 and 2004, separately. The main reason for doing this is that the deposition from one year to

another can vary dramatically. In 2003, the measured mercury deposition in Steubenville was about 13 micrograms per square meter. In 2004, it was 19.8 micrograms per square meter, so there's a fairly large difference between the two years. In 2003, the mean contribution from coal-fired utility boilers was 9.5 with the range of 7.2 to 15.8. That's a five to 95 percent confidence interval around that mean. What has been developed over time in these models is the ability to propagate uncertainty through the models, and continue to re-run the models varying the concentrations that we got in the samples to simulate uncertainty, and you can run this over hundreds and hundreds of times, and then you can get a mean, plus an uncertainty range around those numbers to give you a better sense of how robust your solution is, so that's what that refers to, and for the Unmix model, it calculated a mean contribution of 9.9 with a confidence interval of five to 15. For 2003 and for 2004, the mean contribution from PMF was 12 with a confidence interval of nine to 20, and the Unmix model predicted a mean of 15 with a mean of 8 to 23. So both models give, if you were to take the means, or whatever, they gave very similar results, in terms of percentages. And the uncertainty

in the numbers is what I gave you, so that's the confidence interval on those.

MR. RIESER CONTINUES:

Q. Are there estimated coal-fired utility boiler percentages associated with those numbers, as well?

A. I don't have them in front of me, but that's what the 70 percent was, and the mean for the two years is 70 and 74 percent, 70 for PMF and 74 for Unmix. You were asking me previously about the Landis briefing where it had fossil fuel, oil, plus coal, and again, I just wanted to make sure it was clear that that briefing was done, literally, a couple days after the initial analysis was done only on the 2003 data, and at that time, the statistical robustness of the solution was such that we weren't very confident in the solution that we were getting because we didn't have a large enough sample size, and hence, why we went and incorporated in the 2004 data into this analysis, and you asked about the question about coal-fired utility boiler contributions, versus coal combustion I believe is what you were referring to, correct, all coal combustion sources, and initially, when we --

Q. I think it was just combustion sources.

A. Okay. So we were able to separate out the oil combustion from the coal combustion very cleanly, so there wasn't any need to have that designation in the follow-up briefings and in our final conclusions.

Q. I think you said, with respect to the publication, that you were looking to begin or submit for publication around October or so of `05, but then you had to run it threw a peer-review process?

A. That's correct.

Q. So by October of `05, you had everything pretty well nailed down?

A. Yes, sir?

Q. And I think you --

A. You say, "About October of `05." I can't tell you whether it was November 1, or I mean, to be honest, it was the end of October. I know it was before Thanksgiving and I know -- but I don't know the exact time.

Q. Plus or minus one holiday, in other words. I think you said, also, that you participated in an international workshop on mercury control for coal combustion in Beijing. Is that correct?

A. Yes.

Q. And you were there with Dr. Landis?

A. I was, yes.

Q. And Dr. Landis gave a presentation at that regarding your findings?

A. He did, yes. Had had some other information.

Q. Did you work with him on putting that presentation together?

A. Again, the results that went into that presentation were ones that we co-put together, but I did not help him actually put the numbers on the slides or build the tables or anything like that.

Q. But --

A. I did not review his presentation, no.

Q. You didn't review his presentation?

A. No.

Q. Did you watch his presentation?

A. I did watch his presentation, yes.

Q. Did you agree with it at the time you watched with it?

A. Did I agree with it? Since it was a collaborative study, I didn't -- I concurred with his conclusions.

Q. I would like to show you what's going to be marked as exhibit --

MADAM HEARING OFFICER: We'll mark them in the morning. That's probably the best to wait, until tomorrow when you actually have them.

MR. RIESER CONTINUES:

Q. What I have, for ease and quickness, is a copy of the title page and two pages within the slides that Dr. Landis prepared for the Beijing presentation. In the interest of time and getting this thing out quickly within the period of the break, again, I will get colored copies of the whole thing, and I will bring those tomorrow, so the whole thing can be submitted to the Board as an exhibit, but for purposes of the question, we only need these couple of pages, so Doctor, if you need to look at the whole thing in order to look at these and verify that you remember what else was in there, I have got a copy, but if I can work with these, that would be great to start.

A. I don't believe the presentation varied all that much, and I certainly believe that the conclusions and results, or whatever, did not vary from one presentation to the other. The exact numerical numbers might be slightly different. I know we did refine the way we did the uncertainty analysis from one time to another, so that they were consistent between

the PMF and Unmix, so there might be some slight variances in the numerics, but the conclusions and the results don't change all that much. If you look on the first page of this three-page exhibit, and again, this is just a portion of the whole thing, the page entitled "Preliminary Steubenville Source Apportionment Results."

A. Yes.

Q. 2003-2004 and heading across the top is "Measured Mercury Wet Deposition; PMF Estimated CFUB Contributions," CFUB is identified as Coal-Fired Utility Boiler, and "Unmix Estimated CFUB Contribution." Do you see that?

A. Yes, I do.

Q. So there are percentages provided in the columns for PMF estimated CFUB contribution, in addition to absolute numbers, and those percentages, as you can see for PMF for 2003, 73 percent; 2004 is 62 percent. The Unmix percentage contribution are 60 percent, and for 2003 for 2004, it's 59 percent. Do you see that?

A. Yes, I do.

Q. Are these the same numbers that are in your report that's being presented for publication?

A. No, they are not.

Q. What way have they changed?

A. The numbers I read to you are the numbers that --

Q. I don't recall you reading a percentage number.

A. Because I didn't have that calculation in front of me, but I did not -- these numbers were preliminary data, so this presentation that Matt gave in China was based on the preliminary results from the April-May time frame.

Q. So as of the date of this, October 31, when this was given, I thought you said that around that time you had submitted this for public for peer review and publication.

A. Just to correct what you just said, no, that's not what I said, and I was specific in saying that we would hope to submit the paper for publication at the end of October, and at that time, EPA asked us to put into a peer-review process.

Q. So you submitted it for peer review around this time, October?

A. Yes.

Q. And was the paper complete at the time you submitted it for peer review?

A. Yes, it was. Perhaps, you don't give

presentations, but very often you put together a presentation on the plane as you're going over, and sometimes you lose the materials that you have from the previous presentation to put together the new presentation, and I suspect that that's what Dr. Landis did on this account. As I said before, I didn't work with him on putting this presentation together, and so I can't verify that's what he did. He was in the back of the plane. I was in the front, as it should be. Neither of us in the First Class, however, but in fact, this was a preliminary -- as it says on there "Preliminary Steubenville Source Apportionment."

Q. Did you make any efforts to correct it, to correct these numbers when they were presented?

A. You don't have an opportunity to correct.

MADAM HEARING OFFICER: Excuse me, Mr. Rieser. I apologize for interrupting, but I just have a couple questions I would like to ask for clarification. Dr. Keeler, you're saying the numbers -- the numbers that are in your final Steubenville Study results are different from these, that these reflect the preliminary numbers from the preliminary data?

DR. KEELER: Yes that's correct. Let me just back up for a second. We were asked to rush to

do this analysis by EPA, so that they could include this in the mercury rulemaking. Hence, we did a 2003 quick analysis. We told them that we felt this was not a robust solution to the question they were asking, so we included -- we went and we got the 2004 data and included a two-year data set, so we could provide them with a more robust analysis. They, basically, were after us on a daily basis to try and come and provide these answers. In April, I went and made a presentation of very raw and preliminary analysis. Now, at the university, we do this all the time where someone will get a result, present that, and everyone will critique them and give them comments and suggestions for ways to improve things. Because of the importance of this issue, it was done on a federal level because it was cooperative agreement, and so EPA was doing this behind the scenes in their own internal labs. These presentations that were given, many of them were from one EPA group to another EPA group or Dr. Landis to the assistant administrator were meant for information purposes, and give them some update as to what was going on. These were never intended -- and that's why the word "preliminary" is given on these, is that these were never intended to be final. This was preliminary work.

At this time, we hadn't even finalized the database. We were still working very diligently to get the final data base put together, so that the data that went into this analysis was not even finalized at this time. The presentations that I have been asked to talk to you about are just that. They are preliminary results that came along with the presentations that were given in different venues by Dr. Landis, but these do not represent the final numbers.

MADAM HEARING OFFICER: Thank you. Sorry. I was a little confused on all that.

MR. RIESER CONTINUES: Mr. Kim, I'm trying to remember if you were here for the part about asking for the LADCO slides. Do you have Dr. Keeler's LADCO slides?

MR. KIM: We don't have those, at least, to the best of my knowledge. I think the person in control of those would be Dr. Keeler, so --

DR. KEELER: As I mentioned, I will check to see. I didn't see it on this, but if I don't have it, I can ask somebody to E-mail that for me.

MR. RIESER CONTINUES:

Q. If we could have those for tomorrow, I would appreciate it. Let me -- while we have this lull

here, let me go back to an item about chemical signatures. You have certain elements that you associate with certain types of source emissions, correct?

A. Again, I'm sorry. I couldn't hear what you were saying.

Q. When you do the chemical signature analysis, you have certain elements that you associate with certain types of emissions, correct?

A. Yes.

Q. You also identify percentages associated with those types of sources, correct, X percent coal, Y percent steel?

A. Yes.

Q. Now, when you are looking at the analysis -- the initial chemical analysis just has X amount of mercury, X amount of selenium and X amount of sulfur, etc., correct, among other elements that you analyze?

A. For all intents and purposes, yes.

Q. How do you derive the percentage of -- I assume there's, like, one element of mercury, X micrograms of mercury, correct, in the sample data that you're looking at?

A. We make measurements of every time it

rains, how much mercury deposition is found in every single sample.

Q. How do you derive the percentages of mercury that are associated with a given source category?

A. The statistical method, PMF model or Unmix model, calculates for each sample the absolute amount of contribution from each of the samples, and calculates how much mercury is predicted to come from that source factor.

Q. What is the derivation of that calculation? I mean, not the mechanics of it, obviously, but what is the model looking for when it makes that decision?

A. Well, it's actually a fairly complex answer to that, but it's basically looking for covariation or elements that are changing with time similarly and uses that to determine what sources are contributing to those elements.

Q. And the time element, where does that come into the analysis?

A. Because we collect a sample every single time it rains, so on each day, it would be a different sample on every single day that it rains.

Q. So it's not just within each individual sample, but all samples taken together. Is that correct?

A. Yes, that's correct.

Q. Thank you.

DR. KEELER: Question No. 5: "In your testimony, you reference a study you performed regarding apportionment of mercury sources in Detroit. A: How do you define the terms of "regional" and "local" for purposes of this study, and B: Did you identify the coal-fired power plants that you considered to be local for purposes of your study?" You're asking me how I defined "regional" and "local" in the paper that I submitted as the Lynam and Keeler paper. Is that correct?

Q. Correct.

MADAM HEARING OFFICER: Exhibit 27 for the record.

DR. KEELER: The terms "local" and "regional" often get confused. In fact, recently, a representative from the Electric Power Research Institute incorrectly cited my presentation at LADCO saying that I suggested that regional transport was continental scale transport, which I did not say. Local

transport is actually the transport that's going to occur within one semidiennial (phonetic) cycle, or less than one half of a day. So basically what that means is how far pollutants can travel within about a 12-hour period. A typical transport speed is about five meters per second, which means that -- again, this is on average, that if you're talking about local scale transport being kind of within an urban area. Somewhere up to, depending on the size of the area, but anywhere from very close to up to 150 to 200 kilometers. In terms of EPA modeling, they refer to local scale as less than 10 kilometers. I mean 10 miles in distance scale, very, very close. So that's a very different reference than what I'm referring to. We think of the term "local" in terms of meteorological sense that an air mass can stay fairly consistent through the course of one semidiennial pattern, which is, like I said, somewhere less than 200 kilometers in scale, but will vary tremendously, depending upon the wind speeds, so on a given day, local transport could be as far away as only a few kilometers on a day where there's very heavy winds. During a wintertime period, it might be even longer than that. Regional would then take off from that scale from that local scale to the transport that

is, typically, controlled by synoptic meteorological forcing, which is several days, three to five days, so that can be up to -- maybe a couple thousand kilometers, at most, but no more than that, so transport from Ohio to somewhere east of the Mississippi or west of the Mississippi, possibly, but not to the coasts. That's not regional scale transport. That would be more continental scale transport, so when we're referring to Detroit local, we're really referring to Southeast Michigan in that paper. When we're referring to local in the Steubenville, Ohio, area we're really referring to -- in terms of miles, if people are more comfortable with that, 50 kilometers to 100 miles or so distance scale.

Q. So when you use the terms "local" and "regional" in the Detroit paper, they have the same meaning as they will in the Steubenville paper. Is that correct?

A. For the most extent, yes.

Q. When you use the terms "local" and "regional" you are typically referring not to air mass movements, but to specific things, like sources, talk about local and regional sources?

A. We try to talk about sources being local

if they are in the vicinity of the plant, so sometimes the distance scale will be a little bit shorter than on a meteorological sense, so a local source might be in Detroit, for example, the Ambassador Bridge and diesel traffic at the Ambassador Bridge if it's only one kilometer away or kilometer and a half away from our site, so that would be a local source.

Q. When you describe local sources -- well, for example, in your testimony in the conclusion on page five -- this is the third sentence of the second paragraph of your conclusion -- "The deposition of mercury is heavily influenced by a few large precipitation events that contribute significantly to the annual deposition and these events are associated with emissions from local slash regional sources." So when you refer to "local slash regional sources" in this context, what types of distances do you have in mind?

A. When I refer to "local slash regional scale," it's often more accurate to express that scale when referring to precipitation events because of the nature of the disbursion of pollutants that feed into precipitating systems, so I mean, from sources that are very close, within a few kilometers, to those that are out hundreds of kilometers to even as many as a thousand

kilometers away.

Q. So the term "local and regional sources" is used in your testimony means anything, from adjacent, to something that's a thousand kilometers away, maybe even further. Is that correct?

A. No, closer.

Q. Closer than adjacent?

A. No, adjacent to a thousand kilometers or closer.

Q. Or closer, so a thousand kilometers is the outer bound.

A. Yes. That would be a good --

Q. When you use the term "synoptic" what does that mean?

A. I was asked this yesterday, and I immediately started to want to give a meteorological answer, and I realized that nobody will understand that. "Synoptic" refers to the scale in which you can see a high and low pressure system on the map, hence the word synoptic, as in visual. It really refers to the scale that you see weather systems on the weather station when you all look at the weather man, and you see a low pressure system or the front coming through, and then you can see a high, it, generally, takes up a region

from Minnesota to New York, so that's a synoptic scale, several days worth of transport.

Q. Thank you. Go ahead to B, please.

MADAM HEARING OFFICER: Mr. Harley has a follow-up.

DR. KEELER: You asked me a number of questions, and I gave you a number of answers, and I want to make sure that it's clear I have to be fuzzy on the definition of distances because, when it comes to the meteorology, it varies from day-to-day, from hour to hour, so the transport is not like putting it on a train, and carrying the pollutants consistently away from one place. It's going to vary and the winds don't travel in straight lines and the wind doesn't just blow horizontally. It blows up into the atmosphere, so when we talk about distance scales and local scale transport, versus regional scale transport, versus continental scale, we have to understand that these things are time-varying, and there is a fuzziness to it, so I'm trying to give you a general answer to these questions that give you a sense of what we're looking at, but I don't want to give you the impression that these things are written down, and everything more than a thousand kilometers or 1,500 is somehow a different scale because

that's not the impression I'm trying to give you.

Q. So again, looking at your testimony, sentence -- same paragraph on page five, "Source-receptor studies have recently been completed that indicate the coal-fired utilities contributed to, approximately, 70 percent of the mercury wet deposition measured at a site in Eastern Ohio over a two-year period. This finding is not unexpected as the Steubenville site was selected due to its close approximation to a number of coal-fired power plants," and then we go on to the sentence that I read about local and regional sources, so these large -- the number of large coal-fired power plants are included in these local regional sources that could include all sources within a hundred kilometers -- excuse me, thousand kilometer circle of Steubenville?

A. That's correct.

MADAM HEARING OFFICER: Mr. Harley.

MR. HARLEY CONTINUES:

Q. You testified that you were able to acquire information about -- you testified that you were able to assess the volume, the total volume of mercury from every precipitation event that occurred over a two-period, from 2003 to 2004.

A. Yes.

Q. And you were able to describe that, in different precipitation events, you would find different concentrations of mercury and other contaminants that were present?

A. Yes, that's correct.

Q. In your study, were you able to estimate the total volume of mercury that was deposited on Steubenville, Ohio, through precipitation over the two-year period?

A. Yeah. That's the -- those were the two numbers -- again, my computer went blank, but it was 13 point -- I don't remember what the number was.

Q. 13 micrograms per square liter (sic)?

A. Square meter. If I wasn't clear, I apologize for my mispronunciation.

Q. 13 micrograms per square meter would have been the total volume over a two-year period or total mass per square area that was deposited in 2003?

A. In 2004, an additional 19 point -- whatever the number was that I gave -- micrograms per square meter was deposited at that site.

Q. Does your study then go on to consider the fate and transport of mercury which would be deposited

on Steubenville, Ohio, through precipitation at these levels?

A. I'm sorry?

Q. What happens to that mercury?

A. That was not something that we had as part of our scope of work for that project.

Q. Do you have an opinion about what happens to that mercury?

A. The mercury that's deposited in Steubenville?

Q. Yes.

A. Well, again, we are making measurements in a place that's primarily grass fields, and so the mercury that deposits there, some small fraction would likely oxidize, or I mean, get reduced and then come back up from the surface. The majority of the mercury that's deposited would probably attach to organic material in the soils and stay there at our site. Surrounding our site is the Ohio River, so mercury that deposits into that, obviously, will get transported down river, and again, some of that mercury is going to attach to particles and go to sediment in the river. Some of that mercury will become methylated and work its way up the ecosystem, and some fraction of that mercury

deposited in the Ohio River will evade, come back out of the water, but those are the main things that would happen to the mercury that gets deposited there. I should add the one part that we haven't talked about at all, yet, is the mercury that's dry deposited, and that's a very important part. Some of the mercury will actually go into the plant material, the trees the leaves, the plants, and actually stay there, and become part of the organic-bound mercury in these plants, which then depending upon the deciduous trees, when the leaves fall, that mercury is deposited to the earth's surface, and then is there for methylation and decomposition as the plant material decomposes, so that's an additional source of mercury to the surface.

MR. RIESER CONTINUES:

Q. Was deposition measured in Steubenville?

A. We have been collecting ambient data continuously. We have been using instrumentation that gives us the reactive gaseous mercury forms, the elemental mercury forms and the particulate mercury forms together with meteorological measurements that we are doing on site, and we plan on modeling the dry deposition. We also, in doing this area, did a series of intensive studies, which we have not completed to

date that we will be doing surrogate surfaces, and other new techniques that we have developed to be able to validate and compare to the models that we have developed to do the mercury dry deposition, so at this point, I don't have solid estimates for dry deposition, but it's something that we will have at the conclusion of this study.

DR. KEELER: Question 5-B: "Did you identify coal-fired power plants that you considered to be local for the purposes of your study?"

MADAM HEARING OFFICER: Again, for purposes of the record, we are back to talking about the Detroit Study.

DR. KEELER: We are talking about the paper that was submitted to the Board Lynam and Keeler paper. We have done a considerable amount of work in Southeast Michigan over the past 16 years on mercury deposition and sources, and there are actually only a handful of actual coal-fired utilities that are in Southeast Michigan, and these include mineral power plant, which is on Lake Erie, and there are two or three others that are actually even closer to our site, and unfortunately, I'm having a post-afternoon mental lapse here, but there are -- there's only a hand full of

sources that we consider local, and again, those are fairly close, certainly within 50 miles of our site in Detroit.

Question 5-C: "Do you know what type of coal was utilized in these power plants during the duration of your study?" I'm not aware of data that provides the actual type of mercury, type of coal that was burned by these power plants on a day-by-day basis, and so I don't have that information, but I do have, in the Michigan Mercury Utility Work Report, which I think is cited somewhere in these documents there is a table listing which plants burned bituminous, which blended bituminous and sub-bituminous, which I believe is most of the plants that were in that five or six that I mentioned were blenders. They used both, but then a few only used sub-bituminous, so that data is available in that report, so I am aware of it but I don't have the day-by-day blending and how much was used of each type and so forth.

Question D: "Do you know what type of emissions controls these plants use?" Again, Table E to that Michigan Mercury Electric Work Group provides the mercury -- or the emissions control that's used on each one of those plants. I believe that was utility

provided to the work group.

MR. RIESER CONTINUES:

Q. With the type -- and I think we probably talked about this, but I have the same late afternoon thing you have got going on. Would the type of emission control and the type of coal used affect the chemical signature that you rely on?

A. I believe that the signature that we look at can be influenced by the type of control. An example would be if there was no type of particulate control on the source, that would have a profound effect on what came out, in terms of the major trace elements, which most of those are going to be in the particulate form. If there's some type of a scrubber, a wet scrubber, of course, that's going to remove a large degree of the soluble gases, so yes, those things will have an effect on the signatures. The interesting thing is that when you look at the signatures that have been collected over the years, you can see variability in certain elements, and you try to not use those to define your sources, but they do introduce some uncertainty in your profiles and that's one of the reasons why these new models are able to propagate through the uncertainty in the signatures to give you that sense that, okay, what if you're off 10

percent in this element and this sample because of something like a control or because of some other chemical transformation?

Q. Is it your expectation that these power plants, at the time you did this study, had no particulate control?

A. Oh, no. I'm not aware of other plants out there --

Q. I hope not.

A. Okay, so, sorry. I asked you a question again. I apologize. No. That's not my expectation. I was giving you an example.

Q. Well, the follow-up, if there are, send them my number.

DR. KEELER: E: "What other sources of mercury emissions did you identify as being local with respect to the study site?" Detroit is very similar to Southeast Chicago in that it has a very high density of motor vehicle traffic, iron and steel production. There is a municipal waste incinerator about 10 kilometers away from our site. There's oil refining and chemical manufacturing, together with a very large sludge incinerator. Those are the major sources that we identified in that area.

F: "What was your basis for determining that RGM you identified was a result of the local emissions from coal-fired power plants?" The answer I wrote to myself is I'm not sure what you're referring to. If you could maybe point to what you're asking me, I could maybe answer the question.

MR. RIESER CONTINUES:

Q. Sure. On the top of page 3153 in the left-hand column.

MR. KIM: Which document?

MR. RIESER CONTINUES:

Q. I'm sorry. We are looking at the Detroit paper. I have another copy, if you need it. I'm looking at page 3153, on the top. It's in the paragraph, "The presence of sulfur dioxide and RGM." Do you see that?

A. Yes.

Q. The third sentence -- excuse me -- fourth sentence says, "Since, both, RGM and sulfur dioxide are primary emissions, we conclude that this factor describes local emissions of RGM from coal-fired utility proximate to the monitoring site in Detroit."

A. So you are asking me what the basis is for that conclusion?

Q. Yes.

A. We have five-minute average SO2 concentrations, as well as concentrations of NOx, CO, fine particulates, five-minute concentrations of developmental mercury. Hourly concentrations of reactive gas and reactive and particulate mercury together with the onsite meteorological information, plus all the meteorological information that we collected from all the sites from the National Weather Service, and during times when we got transport from the direction of a couple of the larger coal-fired utilities, this is when we saw this SO2-RGM relationship, and it also turned out when we did this analysis that that factor identified the periods when we had that type of specific flow from that source, so it was done through a data analysis of looking at when the spikes of these things occurred together. The Monroe power plant is to the south, southeast of the site. It's one of the larger facilities, and we could see that on occasion at our monitoring site and this was very different than when we saw --

Q. I'm sorry. You could see that --

A. In the data, and this was different when one looked at the data when we got flow from the island

where the industrial source was coming from the coke oven and iron and steel facility and the sewage sludge incinerator and refineries. It had a very different characteristic to it, so this confirmed in our mind that this analysis, which was done independently, was telling us that this was coming from coal-fired emissions.

Q. Not only coal-fired emissions, but coal-fired emissions from a certain facility?

A. Again, if I didn't put a facility here, I guess it was not one facility. It could have been from more than one because I think that was more than one episode that we are talking about in that paragraph.

Q. So local emissions in that sentence I assume also means this 50 kilometer range that we have been talking about?

A. That's right, during one day.

Q. And the approximate also refers to that 50-kilometer distance?

A. Where it's approximate.

Q. It says, "Describes local emissions of RGM from coal-fired facility proximate to monitoring site."

A. That's right, approximate.

Q. Thank you.

DR. KEELER: Question No. 6: "Is it

correct that the Steubenville study is designed to be a four-year study and completed in 2006?" No. The study was initially designed and put out on the street as an RFP to be a two-year study. The study has been -- was extended to become a three-year study because of the additional equipment that was given to us, so we requested an additional year of measurement and had been, since then, extended one more year because of the importance of this site, in terms of the results that we were seeing, so now the study is intended to -- measurement collection is going to run through 2006. We'll get done collecting data at the end of 2006, and there will probably be a subsequent year of analyzing the samples, doing the analysis and doing the modeling that goes along with that. So originally, it was a two-year study.

MR. RIESER CONTINUES:

Q. When do you -- this is sort of Question B, but we might as well get to it. When do you expect the 2005 data to be available for review?

A. That is Question B, "Is the data for 2005 available for review?" The 2005 database is being built at this time. We are working on the last two quarters of the year. It takes quite a while to analyze all

these different samples because it's not just precipitation aerosol samples we are collecting, as well as the other gaseous data and meteorological data. All that data has to be processed and put together, so we are hoping that the 2005 data will be completed shortly. What does that mean? It's June. We are going to be in the field for the next two months. It's likely not to happen, until the fall, so October-November time frame.

Q. Is that going to have to go through a peer review process, as well, or subject to publication, or is that something you expect to be released to the public?

A. Our intentions, at this point, are to put all of the data together into a complete analysis of the entire data and submit that for per review. My guess is it will probably go through another exhaustive peer review internally and through EPA, but I don't know that for a fact, so it will be released after that, that process.

Q. Thank you.

DR. KEELER: "Is it accurate that the information you present in your testimony is based upon the first two years study 2003, 2004?" The answer is yes.

Question 7: "You indicated that you served on a Michigan Electric Utility Work Group, which studied ways to reduce emissions from coal-fired power plants. A: Did you participate in the final draft of the report dated June 20, 2005?" The answer is yes.

B: "Did you participate in the drafting of the chapter on mercury emissions and deposition, which is chapter 3.3 on page 50 of the report?" The answer is yes.

C: "Do you agree with the statement on page 50 that, `The concern over mercury in the environment stems from its eventual deposition at the earth's surface and subsequent conversion to methylated mercury'"? The answer is yes.

D: "Do you agree with the statement on page 56 that `oxidized mercury, or Hg0, that is deposited on the surface of the Great Lakes would not likely enter the reaction pathway that would lead to the production of methylmercury in the lakes; although tributaries and surrounding wetlands would support methylation activities?" I did not write that sentence. For the most part, it's correct, except I believe that there was some type of mistake made in that. I'm not sure that they were correct in their oxidized mercury or

Hg0. I don't know if they meant -- Hg0 is not oxidized mercury, so the statement is factually incorrect as it's written, but the intent of the statement is, for the most part, correct that mercury in, both, the elemental form and in the reactive form that deposits to the Great Lakes water body, itself, is -- some of that mercury is going to evade and come back out, and I think that's the intent of the sentence that was in that report.

MR. RIESER CONTINUES:

Q. Also, the reaction to the methylation reaction pathway is not commonly active in the Great Lakes?

A. Yeah. As we discussed earlier, the most of the Great Lakes are oxygenated fairly well down to the -- so there's no methylation that's occurring in that oxygenating water. The big lakes, themselves, are not where the methylation is occurring. The methylation is occurring when that precipitation and pollution deposition hits the forested areas around the Great Lakes and the wetlands, and then the rain washes that pollution off, or the mercury that's in the rain. Then it runs off and goes into the wetlands where it then can subsequently undergo the methylation, and then that runs off into the tributaries, and feeds into the shoreline

of the lakes, but the question is correct. It doesn't happen in the Big Lakes in open water.

E: "Why does not the report discuss your work at Steubenville?" As I mentioned before, the work in Steubenville, we were forced to rush and do some of this analysis in the spring of 2005. The mercury work group that I was a part of had started quite a bit earlier than that and had been going on for a long time, and although they were very anxious for us to get this into peer review, and get it out in the literature, there was an understanding that we weren't going to include non-peer-reviewed publications in that report just as a way to be fair across the table, and so that's why it was not included. It was not excluded since I was a member of that work group, I did not exclude my own work because I didn't feel as if it was a good enough quality. It was just that we agreed to these rules, and I lived with them.

F: "Do you agree with the statement on page 58 that the results of the Wisconsin Utility Case Study performed by -- I'm sorry I'm not going to butcher your name -- spell it, V-I-J-A-Y-A-R-A-G-H-A-V-E-N, et al., indicated that, on an annual basis, coal-fired utility boilers in Wisconsin

contributed, approximately, one to four percent of the mercury being deposited via precipitation near Wisconsin MDN stations. Do I agree with that statement? I have no basis to agree or disagree with the statement. I'm aware of the work and the report that was done for the Wisconsin utilities. And presented to the mercury work group. I have no reason to doubt the validity of their work, and I would suggest that in the case of Wisconsin utilities seeing that most of their utilities their large utilities are located on the east side of the lake, most of their emissions would tend to belong to the east, and would not be deposited in the precipitation, so it's not inconsistent with my thought, in terms of where precipitation comes from and goes to, in terms of delivering pollutants to the state of Wisconsin, so that's my answer.

MADAM HEARING OFFICER: Point of clarification, "MDN station" is that monitoring stations?

DR. KEELER: MDN refers to the mercury deposition network.

MR. RIESER CONTINUES:

Q. There are power plants other than those along the eastern coast of coal-fired burning power

plants in Wisconsin, other than those along the eastern shore of Lake Michigan, are they not, western shore?

A. Yes. I think there are a couple that are also on the southeast side I guess or southwest side, excuse me.

DR. KEELER: G: "Do you agree with the statement on pages 60 to 61 that, `the local impact, or potential hot spot, is likely overestimated by Regional 3-D Eulerian models"? I would say, no, I don't agree with that. It really is largely a function of the model, in the parameterizations of that model, so I would tend not to agree with that generalization.

Q. So when you say it depends on the model, are there specific models that you think are likely to overestimate local impact?

A. Again, I would have to be intimately familiar with the model in order for me to give you an example of one. It would depend on the picture of emission sources that you were looking at and how the model parameters some of its scale processes, and so forth, in order for me to generalize that question.

Q. For example, the C-MAQ that's utilized by U.S. EPA.

A. If one is asking me the question do I see

instances in modeling output that suggests the C-MAQ overestimates deposition in some places, I would say that, from my experience, that I see C-MAQ underestimating deposition in areas where we have measurements where there's a great deal of mercury, for example, and other places where it overpredicts based on the measurements, so again, I think that's a very difficult generalization to make, and one I would not agree with. I don't think there's a hard and fast rule that you could say that's a correct statement.

Q. And do they also be sort of gets into H, that -- would you agree with the statement it's likely to be overestimated by the Team model -- T-E-A-M?

A. I am familiar with the Team model through the publications that have been written. I am not, intimately, with the parameterizations in the Team model and how they handle some of those things, so I wouldn't be able to answer, but H: I do agree that C-MAQ and Team are both examples of 3-D Eulerian models, so the answer to that is yes.

Q. Do you think that the C-MAQ and Team models are useful for looking at the issue of mercury deposition?

A. I'm, both, a modeler and a measurements

person. When one can model a physical process using mathematics and equations, one can confirm that they understand what controls the process. That's what the basis for engineering is. If one can model something, one learns and gains great insights to the physical and chemical processes that are underlining the true physical realities that occur in the environment. As someone who does, both, measurement and models, I am equally what would you say -- I look at both of them with a sense of knowing that both are very uncertain, and that both can be used to collaborate the other. Models are imperfect, and models, especially for something as complex as mercury deposition, are something that, at this point in time, are not to the point where I feel comfortable with using them to -- because I don't feel that they do behave and describe the phenomenon that we see in the environment based on our measurements, so models are useful tools, but what you put into the model, the input parameters, how the physical parameterizations are done in the models will have a great impact on the quality of the output that the model has and not all models are created equal. I think that the models that have been published in the peer-reviewed literature have come a long way. I think

that the state of the sciences should be applauded where we are at at this point, but we have a long ways to go, and it's not the modelers problem. It's the other half of me that's trying to describe the physical and chemical reactions that are needed in the models. If I give them the wrong model reaction rates, then they can't model the process properly. If I don't give them the proper speciation in the emissions data, they cannot predict the appropriate deposition downwind. I think the models in terms of their description of meteorology have gotten pretty sophisticated, but the fact remains that it's still a struggle with actually predicting where precipitation falls, if you look at the way that these models predict each event that we sample, so if we compare an event estimate from C-MAQ, or from some other model, we do a poor job because we can't get the precipitation rate amount or the rate correct. We don't get the precipitation falling in the correct location. These are problems that all models have that parameterize meteorological processes.

Q. Would the same uncertainty be associated with a source-receptor model?

A. All these are source-receptor models. Source-receptor models are, basically, taking some

attribute at a receptor and providing a relationship, how much comes from this source winds up with that receptor, so whether you start at the source, or you start at the receptor, they are both receptor models, so are you asking me are these the same uncertainties in receptor models?

Q. I'm asking you whether there are the same uncertainties in the source-receptor model that you identified yourself as performing.

A. So the source receptor-modeling that I refer to and that was utilized to come to our conclusions on the portion of coal-fired utilities at Steubenville are receptor models. They are starting from observations at the receptor, and they work backwards, and they do not rely upon understanding the chemical processes that go in the atmosphere. They don't require that you understand the species, exact speciation that occurs at the power plant. They only require that you have a detailed characterization of the measurements at that site, and that's one of the advantages. That's why receptor modeling started because in the early days there were measurements made of particulates in the atmosphere, and we didn't know where that particulates were coming from, and we were

able to identify sources that people didn't even know were there based on using these receptor techniques and working backwards and identifying a source of that particular pollution, so no, they don't have -- they don't suffer from the same uncertainties as the project models would.

Q. My recollection is that you testified that the source-receptor -- excuse me -- the receptor models identify are categories of sources, correct?

A. I don't understand that question.

Q. What the receptor models identify are -- is not a specific source, a specific smokestack, for example, but a category of sources, coal-fired power plants?

A. Correct.

Q. So in order to locate the specific source and identify it's proximity to the receptor, you have to add another step, which involves meteorology, correct?

A. Meteorological modeling, correct.

Q. Is the meteorological modeling subject to the same uncertainties that you have just described?

A. This is the beauty in this analysis that we depend largely on observations in that type of analysis. We do use a model, like the hy-split model

that gives you where the pollution came from. You can start at a receptor and it will tell you where the air came from that arrived at that point in space, and there are uncertainties in that calculation, but we include that in our modeling. We take into account that there's an uncertainty in the upwind pattern. That's something, again, that many of the other researchers that look at this do not include that. They assume that the trajectory is a perfect calculation, but we look at it as a problemistic function, that the trajectory represents the highest probability that pollution would follow that path and propagate a certainty about that analysis.

Q. So the uncertainty associated with the meteorologic models that you use in your receptor studies is less than the uncertainty inherent in the C-MAQ or Team modeling?

A. It is because it's not part of our results or our conclusion. When we get a result, and this is why, when you keep asking me about the distance scales, what's local versus regional and so forth, is that we don't overinterpret what we're doing, and the scale that we ascribe to that the sources could have been in is a little bit larger than what we would like. We would

like to be able to pinpoint it to a spot, but because there's uncertainty in these calculations, it becomes a little bit blurry, but what's nice is, at the end of the result, we can pinpoint an area like Southwestern Ohio so something the size of an area of a state is the kind of the smallest geographical region that we can identify.

Q. When you use the meteorologic models that you described in your receptor modeling, how far back in time or back in distance do they go?

A. That varies from study to study and what we're looking at. As one goes farther and father backwards in time, the calculation has greater and greater uncertainty, and one of the things I did as a Greenhorn graduate student over 20 years ago was to actually look at trajectories that went back five and seven days compared to those that went back three days, and look at our ability to predict where the air came from using five-day trajectories, versus three days, versus 24 hours, and what we found was -- and this is actually work we did under the utility acid precipitation project filed by my advisor, Perry Samson, at the University of Michigan who was the principal investigator on that. We actually used the three-day

back trajectories, and found they gave us very, very good information describing the synoptic meteorological conditions pertaining to air mass transport, so through a set of analysis and meteorological tests and so forth, we found that a three-day was the most reliable, although understanding that, of course, air is transported much farther than that, and again, if you were looking at carbon monoxide, or if you are looking at a stable interpollutant that doesn't have any transformations or deposition, then one might select a different approach, but since we are looking at precipitating systems, the choice of a three-day trajectory or five-day trajectory doesn't strongly influence our analysis.

Q. What are your assumptions with respect to the amount of mercury in the air, furthest back extent of that meteorologic model?

A. We don't make any assumptions about that. There is no inherent assumption about the amount of pollutants going back along the trajectory.

Q. Then going back -- what are you measuring back along the trajectory? The air movement?

A. Yeah. That's only telling us about the meteorological conditions that occurred upwind.

Q. There's no factor for looking at where -- we made these discussions about local and regional sources, which have a radius of about one thousand kilometers, about?

A. Yeah.

Q. How do you know that the mercury that you assume is from a local-regional source within this thousand kilometer radius circle is from within that circle and not going outside that circle?

A. What we will do is we will actually look at the rainfall patterns that occurred -- we will take the meteorological data and look at it. It's kind of a the best way to describe it is you take the 30-minute meteorological data and plot it out on the piece of paper so that the maps that you see and then put it in motion, so you watching it as it's moving through time, and you can actually look and see where the air mass came from, and where it precipitated along the path where the air mass came, and you can look and see where the air was flowing into the storms, and where that storm or that cloud cell actually moved, and then precipitated, and so we do this for each storm that we have data for, and we can work backwards along those to a point where we are confident that we have captured

where that storm started, where the air mass came from and eventually precipitated and aided by NEX-RAD data, together with all the surface meteorological measurements, and this is a very tedious analysis, and it takes a lot of time, as you can well imagine. If you've ever done a meteorological analysis, we still do things the old way where we take out maps and we plot out things by hand and actually put these things together, together with the data that we are collecting, so we can look at the variability, really, as a snapshot. Sometimes we will look at the NEX-RAD data in five-minute intervals and play it like a movie and play it back and look at these snapshots, and in doing that because reactive mercury is a form that's most likely to go into those precipitating systems, together with particulate mercury, we can then know that those emissions had to have come from a point in time in space upwind where they could have been removed at our site, so elemental mercury that was coming from China, for example, takes a very long time to oxidize in the atmosphere, and it can float around and float around and float around, but it takes a long time and converts at a very low rate. If we have a lot of mercury in our sample, it's almost impossible for a mercury that was

emitted, say, use the example of California in the elemental form to have it get to enough where it's going to explain the amount of mercury we found in our deposition sample in Ohio, and so we have an understanding of the chemical conversion, and an understanding of the types of mercury that are emitted, and you can only explain that by looking at sources within a certain vicinity that emit the types of mercury that would go into the solution, and go into clouded water. Of course, I'm oversimplifying this to make sure everyone understands what I'm saying, which I know is fairly difficult, but still, that's the basic taking-apart and dissecting, doing a CSI case on a precipitation event. We are taking all the information that we can and dissecting it, knowing what we have by looking at it over 20 years worth of precipitation data for other species, like sulfate, nitrate, precipitation, and using that to then determine the radius from which these sources could come, and then having over 200 precipitation events, you put this ensemble of events, this weight of evidence together, and then paint a picture on the region or area that that mercury could be coming from.

Q. Would some portion of the mercury that you

observed at the receptor site come from these more distant sources, or is there an assumption that none of it comes from those distant sources?

A. No. We have always stated, although people like to pin you into a box, and say that you don't believe there's any global transport. I've never said that. It's, in fact, we see some 20 percent could be coming from very distant sources beyond the regional scale, so there is going to be global transport. If we are able to knock down emissions to a point where let's just say this rule went into effect, and we were able to take 90 percent of emissions out of coal-fired utilities, that 20 percent signal would become an important one to be worrying about, but that signal is varying over time, but you can see that 20 percent signal if you look at the remote sites to the west where there are no coal-fired utilities. You can look west of the Mississippi, and look to see that the deposition that they incur out there is typically less than 4 micrograms per square meter, where we are getting 20 in Steubenville, so you do see that global signal, and it's real, and it's something we are looking on, in terms of getting other nations -- China, India, and other places -- to be concerned about their mercury emissions, as

well.

Q. When you use the term "value 20 percent," that's 20 percent of --

A. The observed mercury deposition that we see.

Q. The observed mercury deposition. Does your model differentiate between coal-fired utility mercury at different distances within that one thousand kilometer radius circle, say, 1,500?

A. Are you asking me about, again, individual plants?

Q. Yes.

A. No. Because of the uncertainty in the meteorological analysis, we can't differentiate between a plant that's located 15 kilometers from another one in that sphere, so the answer is no.

MR. AYRES CONTINUES:

Q. Could I jump in with one question at this point? Mr. Rieser has used this thousand kilometer radius several times, and I just wanted to ask the witness if that is the outer limit of what you call "region"?

A. Yes. I think that's a good way to think about it. I think that's really, when we are looking at

regional, that thousand kilometers is the outer region.

Q. Would it be likely to be smaller throughout?

A. In most of the large precipitation events that we see at Steubenville, it's actually much smaller. It's less than 50 kilometers. One of the questions that you asked me earlier and I thought you were going to ask me the same question because I did answer it before was that you asked me would we -- if, in fact, the mercury that was the mercury that we see in the wet deposition could we explain it by emissions of all elemental mercury. If so, if the local power plants were only emitting elemental mercury, could we explain our deposition pattern? The answer is no. So, if all the power plants only put out elemental mercury in the entire region, then we could not explain our data, so that's fairly important, so it really confirms the fact that coal combustion sources are putting out a significant amount of mercury in that reactive, particulate form, and that's consistent with our understanding and thought processes in the atmospheric chemistry.

MR. RIESER: Would you read the last part of that answer back, please?

(At which point, the previous answer was read by the court reporter.)

MR. RIESER CONTINUES:

Q. That it's some portion of RGM and some portion is elemental.

A. It's not an according to the model at all. It's a confirming a point, in terms of our interpreting our data.

Q. In what way?

A. Because our understanding of the chemistry of elemental mercury is such that it would not see the large amounts of mercury in the deposition that we see based on just elemental mercury being the form that would be in the precipitating systems that deposit the mercury to Steubenville.

Q. In answer to Mr. Ayres' question I think you changed something that you said before with respect to your testimony, so I just need to confirm it. Right at the end of your testimony, you talked about the deposition of mercury having influence by large precipitation and these events are associated with emissions from local and regional sources, and we had a long discussion about how those are defined, and you define them in the meteorologic sense, and it was my

understanding that the combination of local and regional implied the distance that had been using because it was your phrase a thousand kilometers away, and since it can come from anywhere, I'm thinking of a circle of a thousand kilometer radius.

A. That's correct.

Q. So are you changing that definition of how you're using "local" and "regional" in that sentence of your testimony?

A. No. I gave a sub-answer. The answer to that in the testimony is still correct. What I said was that, for a number of the largest events, we determined that they were coming from less than 50 kilometers away. I said -- I did not make the general statement that all of them were coming from less than 50 kilometers away, so my general statement in my testimony is still correct.

Q. And how are you able to determine that they were less than 50 kilometers away?

A. Again, based on meteorological conditions in those situations, meteorological conditions was such that the transport was very slow, and storms did not move very quickly, and so the spacial extent was very, very isolated.

MR. HARLEY: Madam Hearing Officer, out of deference to my peers who are actually being paid to be here, we've elected to sit at the second table, but I do want to point out that we have appeared at these proceedings, and would be very grateful, even though we are sitting at the second table, if we could get copies of exhibits when they are passed around.

MADAM HEARING OFFICER: And I apologize, Mr. Harley. I have not been looking up when that's happening, and we'll see to it that you get exhibits in the future. Keel.

MADAM HEARING OFFICER: Also, if we do have problems getting copies of things, the EPA I know has a copier here, as do we. We can get copies.

MR. KIM: We will make sure we have copies for, at the very least, Mr. Harley.

MADAM HEARING OFFICER: With that, I think we are ready to begin with the questioning again. Are we ready for 7-H?

DR. KEELER: I answered 7-H.

MR. RIESER CONTINUES:

Q. I just have a couple. Is it your understanding or belief from the data that you got that this Steubenville the utilities that, say, within 50

kilometers of Steubenville are putting out -- are emitting large amounts of RGM?

A. So you combined a number of statements that I made into a new statement, which doesn't really express what I said in the several independent statements. A, the 50 kilometers was pertaining to a different point, referring to a couple of the largest precipitation events, and the second part of your combined sentence was do I feel like there's a large amount of RGM coming out of the power plants. That was another statement in which I said we couldn't -- we couldn't explain the large amount of mercury deposition we see in our precipitation events based on local and regional power facilities putting out all elements of mercury that they had to have been putting out reactive mercury for us to see that. I can't quantify the amount of reactive mercury, but I did say that it was a substantial amount of their emissions had to have been in the reactive mercury form, so just to clarify, so I didn't put those things together.

Q. Following up on that, you talked about a 20 percent global mercury I think was the phrase. Is that correct?

A. 20 percent that came from --

Q. Global sources?

A. From distances greater than the regional scale, let's say.

Q. How did you arrive at that number?

A. Well, A, that was, approximately, the difference in my -- it really is a difference, if you begin looking at the amount of deposition at sites that are west of the Mississippi, and at periods where we get what I would call -- I call them clean air sectors or transports from directions where there aren't a lot of sources. We get fairly low deposition amounts and because we don't see strong tracer signals from those precipitation samples and we get transport from, say, the northwest out of Canada, but we still see some mercury. It appears to me that that's something that could be from oxidation of mercury that was transported over long distances, so the absence of strong tracers in this small amount of mercury almost always is visible in this very small mercury events, and that's where I kind of have a sense for 20.

Again, I didn't mean to be quantitative that the 20 percent is our estimate at Steubenville. That's not what I said. I said there could be something on the order of 20 percent

contributing to a background over the Great Lakes region. But again, the importance of that background is going to vary over a time period. Clearly, that's a small signal in Steubenville compared to what we see from the local coal-fired utilities compared to the local and regional utilities.

MADAM HEARING OFFICER: You need to identify yourself.

MR. RIESER: Let's go on to eight, please.

MADAM HEARING OFFICER: Mr. Zabel and then Mr. Harley.

MR. ZABEL CONTINUES:

Q. Before we go on to eight, Dr. Keeler, I can follow this at all. You have a monitoring station at which you take a sample. You analyze that sample for mercury. I'm talking about Steubenville now.

A. The precipitation source assessment?

Q. Yes.

A. Yes. We collect precipitation samples, and we analyze those samples for mercury, a suite (phonetic) of trace elements and major ions.

Q. Just somewhat of an aside, is that total mercury?

A. It is total mercury.

Q. And you analyze it, as you said, for the trace elements that, I assume, have been fingerprinted to specific source types. Is that correct?

A. I'm sorry. I don't understand your question.

Q. Earlier you talked about fingerprinting specific source types.

MADAM HEARING OFFICER: I think he used the word "signature."

DR. KEELER: That's fine, source signature, same thing.

Q. Specific source types by trace elements. Is that correct?

A. That's correct.

Q. So you now analyze the sample for the mercury content and the trace element content. Is it through that trace element and your model that you allocate the quantity of mercury among those source types?

A. It's all of the chemical composition, the major ions, the elemental composition, and the mercury, and the PMF, or unmixed models that deconvolute this sample's contributions back to the sources that

contributed, yes.

Q. So whatever algorithm you've got built into that model will say X percentage of that came from coal-fired power plants. Is that correct?

A. It identifies the source which then we use our understanding of the chemical signatures to identify that source, yes.

Q. What do you do with that global portion that you mentioned a moment ago?

A. Well, the global portion is usually in the unexplained category.

Q. How big is the unexplained category?

A. In this case, that's where I got the 20 percent factor.

Q. I guess what -- and maybe this is built into the trace element analysis is you've got an analysis of all those other elements to a apportion the mercury. Why don't you apportion 100 percent of it?

A. You can only apportion the amount of mercury that has a relationship with these other elements, so if there are -- so if the case -- if, in fact, it's a mercury form that was chemically transformed in the atmosphere, just been floating around and other trace elements which were there were removed,

so it's just this gaseous elemental mercury that's floating around the earth, and then it chemically gets transformed because it gets removed, it would not have the same tracer to go with it, so therefore, it would not be able to -- the model would not statistically be able to separate it out as a new factor, so basically, it gets in the unexplained category.

Q. I guess I'm having trouble getting around the unexplained category, Doctor.

A. If you think about in terms of a regression analysis, when you do a regression, and you can explain your R squared is .86. it tells you that 14 percent of the variance in your data is unexplained. That's what I'm trying to say.

Q. Now I understand. Thank you.

MR. HARLEY CONTINUES:

Q. Based on your testimony, I feel very bad for Steubenville, Ohio. I'm not sure. That's my question. In your opinion, is there any reason to believe there is a disproportionate or preferential mercury deposition on Steubenville, Ohio, by comparison to other similarly situated towns?

A. No. There is nothing unique about Steubenville, Ohio, that would make it stand out or be

unique, in terms of it receiving some unusual amount of mercury deposition. The quantity of deposition that's received there is really a function of its geographical location in the United States. The fact that the precipitation and the storms that bring the precipitation have an orientation that go from the south, southwest, up to the Steubenville location, and then right now, it's all of those factors taken together. The high density of emissions, together with the way that the storm tracks -- storm tracks follow that makes Steubenville a place that receives high mercury deposition. There's nothing in particular or special about it.

MADAM HEARING OFFICER: Ready to move on to question eight? Mr. Bonebrake.

MR. BONEBRAKE CONTINUES:

Q. One follow-up. The 20 percent unexplained portion that you were just discussing with Mr. Zabel, is that all the positive is RGM?

A. I'm sorry. I must not be making myself clear, then. The 20 percent we were talking about was in reference to precipitation deposition. We were talking about an unexplained amount of mercury that was in the deposition that we can't account, in terms of

saying, "It came from this source or that source." Partly, that's because of the uncertainty in the calculations and everything else, but it doesn't really -- I can't say that it's related to RGM or that it's in an RGM form, or anything like that, so I think I confused you somehow.

Q. So but that 20 percent portion you don't know of what type of mercury is comprised?

A. That's total mercury assessment, so the total amount of mercury that's in the precipitation sample 80 percent of it we can explain and 20 percent of it we can't.

Q. I understand that what I'm --

A. I mean, most of it is going to be in the oxidized form. When we do that type of analysis where we speciate the mercury from just a total mercury to whether it's particulate or dissolved or reactive we wind up getting a predominantly larger amount of oxidized mercury in that sample. It will be 70 to 80 percent oxidized mercury. Some of it is particulate, but we don't put much credence in that because, in order to really get at the specific numbers -- and that's not in the paper, and has no bearing on the calculations. It doesn't come into account at all. It's just that

sample is not taken in the way to be able to look at that number, specifically, and it's not important to us, but it does wind up being in an oxidized mercury form in the rain, so question 8 --

MR. RIESER CONTINUES:

Q. Just as a follow-up on Mr. Harley's question, this is question is asked later, but I think it makes sense to ask it here.

MADAM HEARING OFFICER: Could you identify what question it is later, so we can mark it off the list, please.

MR. RIESER: This would be 13 A and B, "How many coal-fired power generating units are located within 50 miles of Steubenville and what is the combined capacity in megawatts of these units?" These are the questions.

DR. KEELER: Again, the information I have available to me, or whatever, is the information I would have to go to the website and pull it off from EPA from the 1999 ICR. I mean, I have got that information back in my lab, but -- it wasn't pertinent, in terms of defining my conclusions, or whatever. We used that information, and we have -- I can provide you with a map, if you would like, that shows the sources as

provided by EPA, but the megawatt capacity and so forth, I don't have that.

MR. RIESER CONTINUES:

Q. It wasn't important to your study?

A. It wasn't important in this -- obviously, it is important, in terms of those plants are emitting mercury, but it's not important, in terms of the conclusions that I drew because I don't look at individual plant information at all. In the modeling studies that I do, I don't need that information for receptor modeling, you need that for deterministic models.

DR. KEELER: Question 8: "On page 81, the TSD states that you suggest `the lifetime of elemental mercury in the atmosphere is likely much stronger than previously believed.'"

MR. RIESER CONTINUES:

Q. That should be "shorter."

A. Because my answer was no, that's not an accurate statement of my testimony.

Q. Fair enough.

A. So the question should be it's likely much shorter than previously believed?

Q. Correct. Is that an accurate statement?

A. Yes. I believe it is an accurate statement. B: "What is the basis for that statement?" One of the biggest uncertainties in all of the mercury modeling and to understanding mercury chemistry at this point is the rates of reaction for mercury in the atmosphere. We learned through work that our colleagues have done in the Arctic that elemental mercury can very rapidly on a time frame of almost instantaneously react with atmospheric halogens, bromine and chlorine in the atmosphere to transform the elemental mercury to reactive mercury and deposit to the surface of the snow pack in such a way that all the elemental mercury is depleted from the air over the course of hours. It's a very interesting phenomenon that occurs at Arctic sunrise. This really got the mercury world shook up because it was something that we hadn't anticipated. Most of the work that had been done prior to that suggested that mercury chemistry was really slow, that it would take days and days for you to oxidize mercury and convert it from one form to another. Over the past several years, we have learned that we have a poor understanding of the mercury chemistry, that we don't understand what chemicals and what compounds are oxidizing mercury, and through the work of a large

number of scientists, we now know that mercury can transform to the atmosphere from one form to the other. It can be both oxidized and can be reduced and that chemistry suggests that, in certain environments, such as downwind of urban areas, that you can actually get rapid oxidation of the mercury. By "rapid" there I don't mean like in the Arctic, instantaneous. I mean over the course of hours. In the same type of time frame that is introduced in regional transport, you can get transformation of elemental mercury to reactive mercury, and so that would then shorten up the lifetime of mercury in the atmosphere and that's the basis for my statement.

Q. Has that phenomenon been observed anywhere other than in the Arctic or marine-boundary environments?

A. The phenomenon with the halogens is something that has not been documented anywhere, but in the Arctic, and in some cases, in the marine boundary layer. We have not seen it in the marine boundary layer, by the way. We have made our own measurements and don't see that phenomenon, but others claim that they do, but that's -- the reason for that is it's associated with the Arctic sunrise. The whole winter

it's dark. The chemicals build up in the snow and ice. The sun comes out, and all those chemicals get released. It's a rapid explosion of all these chemical reactions together with the ice that's there, so that's a very different phenomenon. We do see in Michigan at our sites and in Steubenville evidence of atmospheric chemistry taking place where elemental mercury is changing into reactive mercury, so we have observational evidence of this happening, and we're in the process of trying to define that better by improving our models, so we can describe that, but it's something that is fairly new, and not everyone has included those processes in their models.

Q. Are reductions happening, as well, from that?

A. Yes, they do. Reduction does occur. It occurs in cloud water, and it's thought to occur in other situations, as well, although we have not seen those -- or those reduction reactions occur in our observational studies, but we do see reduction occurring in cloud water, and it's fairly important reaction in terms of our cloud chemistry.

Q. Thank you.

DR. KEELER: Question 9 I think. "In

your testimony you discuss the U.S. EPA's there's a -- C-MAQ model to determine the impact of domestic mercury sources on atmospheric mercury deposition. A: Are you familiar with the Team model used to perform some of the model Michigan report?" Yes. B: "Do your comments regarding C-MAQ also apply to Team?" Could you be specific about what comments you are referring to?

MR. RIESER CONTINUES:

Q. The comments with respect to its uncertainties.

A. Yes. My comments are the same. I would say that all Eulerian deterministic source oriented models suffer from similar large uncertainties due to the fact that they, A, don't adequately describe the physical and chemical processes that control the behavior of mercury in the atmosphere or the interactions of mercury with the surface of the earth, so I would say that they are all equally uncertain -- I shouldn't say they are equally uncertain. They all share in that large uncertainty an inability to model mercury transport and fate.

Q. Is that a larger uncertainty than other deterministic models, for example, the model used in the Everglades?

A. No. I would say that the uncertainties in all of these models are quite large, and again, models are a tool, and you use the tool that you have at your disposal, and when we did the work in the Everglades, the model that we used was, at that time, the best developed tool that we had. If we were to go back and redo that analysis, we would have used a more sophisticated tool, and redo that in a different, so they are all very uncertain. What we know now that we didn't know then is that we were really off in our understanding of atmospheric chemistry.

Q. You didn't know that at the time of the Everglades?

A. At the Everglades, yes.

Q. What ways were you off, in terms of the --

A. We really didn't understand the complexity in the mercury chemistry at that time. We felt that the reaction ratings were slow enough where chemistry wasn't important. We didn't consider vertical redistribution of mercury in ways where I think we should have. So there's lot of uncertainties we have learned a lot over the last 10 to 12 years that made me feel even more uncertain about where we are at with the modeling.

Q. The C-MAQ model has been through several

versions and several episodes of peer review, has it not?

A. I don't know that that's correct. To my knowledge, unlike the receptor models, which have been through exhaustive peer review, and so forth, C-MAQ, to my knowledge, has been part of several inner comparisons, but I do not believe that it has undergone the same Agency verification and validation that, let's say, that the RATA (phonetic) model did back in the acid rain days.

MR. BONEBRAKE CONTINUES:

Q. You mentioned that you had some concerns about uncertainties in the model used in the Florida Study. Also, that you had acquired some additional knowledge pertaining to some of the factors related to that model, Dr. Keeler?

A. I'm sorry. I apologize. Could you re-ask the question.

(At which point, the prior question was read by the court reporter.)

DR. KEELER: I don't have concerns over the use of the model, or in fact, if I went back, I don't think I would change any of my conclusions based on what I know now. I would just use a different model,

knowing the uncertainties of the chemistry are as large as they are.

Q. Those uncertainties in chemistry, if you were to re-run if same -- use the same model and re-run the model, but would you change some inputs to the model based on the additional information you have available to you today?

A. Actually, I made that statement trying to make the point that we have a -- we have increased our understanding of the chemistry tremendously to the point that, to apply a model such as that one anymore, would not be the best model choice. It turns out, because almost all the mercury that was emitted from the incinerators came out in the reactive form, and the reduction reactions that we understand that are important in cloud, really don't -- wouldn't cause us to change our answers at all, that, in fact, the modeling we did in Florida probably would stand up pretty well. If we were to re-do it, we wouldn't have to re-do much. The things that we know now are much more important, in terms of looking at the super long range, so global redistribution, and really looking downwind of major urban areas, so regional oxygen chemistry, which again, Florida does not have very high oxygen levels. The

levels of ozone are extremely low, for the most part, in South Florida.

Q. If I understand that correctly, you are saying the uncertainties you talked about are related primarily to global transport issues?

A. Global transport and urban chemistry type reaction.

Q. Doesn't global transport have an impact on local deposition?

A. Doesn't global transport have an impact on local deposition? I'm not sure why you would call it -- does global transport have an impact on deposition everywhere? Is that what you're asking me?

Q. At any particular location, some portion of what's being deposited at that location may be derived from a source outside of the region, as you have described it, right?

A. Every place that you have mercury there is a probability that some of that mercury came from an area that you would say is not in the local or regional area surrounding that site, and that mercury could have come from a source that was located on the other side of the globe, or it could have come from a molecule of mercury that was emitted from a plant down the road that

went around the globe once, and got reemitted and came back, and we can't differentiate that mercury, so the global pool is a combination of mercury that was emitted by our sources, our coal-fired utilities, our incinerators, as well as those that were emitted from Chinese power plants and incinerators, and no, I cannot rule out any one location. Some mercury is part of that reemission or long range transport of emissions from some place else.

DR. KEELER: Question C: "Are you aware of whether the Team results have been validated against MDN data." It's not typical for one researcher to look into the validation of someone else's use of their own model. When one uses the model, or one develops their own modeling application, we try to validate our own work, and so I'm not intimately aware of what validation has been done by the Team model. I have read the peer-reviewed literature papers that have been published on the Team model. The word "validate" means different things to different people, and showing a comparison of predicted wet deposition versus MDN wet deposition, to me, is not validation. It's a comparison, so but that doesn't mean that that model hasn't been validated. I'm not aware of any validation

of that model, but it may or may not have been.

Q. Why would that the constitute a validation?

A. "Validation" has a very specific meaning when it comes to models, and in comparison of one part of the model, output is not validation. Validation suggests that you have compared the basic mechanisms and processes in the model in a way that you can point to real observations, and say that the model subparameterizations are replicating reality. I can run a model that will just use precipitation amount, and predict with the same R squared the amount of mercury deposition that you could get at almost any spot and you could say, "Gee, I got the supermodel, and there's my comparison, so I validated it," but to me, I'm not describing anything. I'm just doing a statistical explanation, so if you look in the model in literature, and look at where models are actually validated, which means you take the same input data and same emissions data and same meteorological data, and you run models, and you have various checks that you can make on the model output at various steps to verify and validate that the model is actually doing what you think it is doing. That's a validation process, and again, the

model might have been validated. I have read the peer-reviewed literature papers, and I have no basis of knowing whether a validation was done or not.

DR. KEELER: D: "Are the uncertainties" -- I already identified that -- answered that one. D is no.

MR. RIESER CONTINUES:

Q. Are there difference levels of uncertainty between the two?

A. Between C-MAQ and Team? Is that --

Q. No, between the receptor study and the C-MAQ model?

A. Are there different levels of uncertainty? I would say yes.

Q. In what way?

A. Again, understanding that I'm wearing two hats. I'm the modeler and a measurement person, so I don't want to criticize myself. I'm going to criticize the other side, so I'm not trying to pick on one, versus the other. In order to be able to model from a source perspective, the fate and transport and deposition of a pollutant, one needs to understand all of the processes one has to understand the emissions, in terms of the speciation; one has to understand the chemistry; one has

to understand the processing of the mercury and the clouds; and one has to understand how the gas molecules are interacting with the surface, all of this. That's a lot of science. There's a lot there, and based on my measurements, I would say that the uncertainties and our ability to define the rates of chemical reaction of mercury in the atmosphere and the rates of deposition of mercury in the atmosphere, those uncertainties are much greater than the uncertainties in our measurement capabilities, much greater. I mean I would say that borders a magnitude greater in source modeling than we are in receptor modeling, so the two are completely different.

Q. When you talk about the source modeling, that includes the component that involves the meteorologic model. Is that what you are doing?

A. No. Source modeling is C-MAQ and Team --

Q. I'm sorry, receptor modeling. I misspoke

A. No. When you are talking about meteorologic modeling, again, we are using meteorologic observations to do that. Trajectory modeling has inherent it an uncertainty based on the time resolution and the spacial resolution of the data that's collected from the National Weather Service, and that uncertainty

is fairly well documented. People have been attacking trajectory modeling for 25 years, so there's pretty good literature describing biases and uncertainties in trajectory calculations and how they would affect prediction models.

Q. Does your receptor model account for the non-linear transformations between the different forms of mercury in the atmosphere between the source and receptor?

A. The PMF and unmixed models do not have a chemical transformation term in them. So they don't take into account transformations, so that if there was some phenomenon that one could come up with, which, basically, what we do is we try to understand is there some non-linear relationship that could occur and how would that effect it, and in doing that analysis, if you could come up with something that you could say would be non-linear relationship you would have to figure out how that would impact the relationship of the data at your site, and that's inherent in the uncertainty analysis that we do, but no, the models do not take into account uncertainty -- or I mean, non-linear transformations.

DR. KEELER: Question E: "Can the source receptor approach be used to predict the impact

of different regulatory approaches on mercury deposition?" Not directly. Unlike a source model where you can vary the emissions in the inventory, and say, let's cut mercury emissions from some sector, and then re-run the model, and then see what the difference is. Receptor modeling only takes the observed results and works backwards for telling you how much came from each source sector, but it is -- it's a linear process, so that you could say, if you were to cut mercury emissions from that source, that it would a commensurate impact, in terms of the contributions to the sample in that -- at that site, so it doesn't allow you to prognosticate. You can't look into the future. I can't model 20/20, for example, using a receptor modeling approach.

Question F: "In using the source receptor approach, do you typically attempt to correlate your results with findings from available atmospheric deposition modeling?" Because we're using observations, and working backwards to come up with a source, we do try to go out and look at whether anyone else has predicted source-receptor relationships to see how well we are doing. In the case of all of our studies, we, generally, try to do that. With mercury now, there are more predictions coming out, but in the past, there

haven't been all that many, but yes, we do.

MR. RIESER CONTINUES:

Q. Have you done that with respect to Steubenville?

A. Only in the respect that we did make a comparison with what -- the results that were put together by U.S. EPA using their CMAQ model.

Q. What was the result of that comparison?

A. The CMAQ model, which went into the CAMR rule modeling, found that, for Steubenville, coal-fired utility boilers contributed 43 percent of the mercury deposition in the grid square where Steubenville is, and the grid square was a 36-kilometer grid square, so 36 by 36 kilometers, so that number is an average of that grid square. The only thing, and the biggest caveat here is that those results were for the calendar year 2001. The results that I have quoted here today were for our modeling for the years 2003-2004, so it's really comparing apples and arranges, but to get a sense for how well CMAQ was doing, we made that comparison, so you can't directly compare the 43 percent from the CMAQ model to what we did because it's different years, and the meteorology is very, very different, and since we saw 13.2, or whatever it was in 2003, and 19.8 in 2004,

that there's a significant big uncertainty just from one year to another, so comparing apples to oranges isn't a good idea, but that's the only data that was available.

Q. Is there an uncertainty factor associated with the 70 percent number that you have talked about with respect to Steubenville?

A. What's the uncertainty number?

Q. We'll leave that for later.

DR. KEELER: G: "What steps have you taken to evaluate the accuracy of the Steubenville results?" As I mentioned earlier, one of the strengths of our study really has been the extensive peer review that was completed by EPA in its external reviewers. As I mentioned, we provided the raw data and the models to the external reviewers to re-run the models, and to use whatever other tools they had at their disposal to evaluate the conclusions and the raw quantitative answers that we gave, and when we were given back those results, and when they gave us our report, they, basically, confirmed our numbers and said that these were very solid, robust answers. The conclusions that we got were very strong, and I would say that's a very strong indication of the quality and accuracy of the work that we are doing. Also, I should say, in terms of

evaluating the accuracy of the predictions, one of the things we did is we went and looked at, again, the EPA emissions inventory for, basically, for the whole Midwest going from east of the Mississippi, and if you look at that emissions database, and look at what is burning coal and where in the greater vicinity, almost all of the coal burned in the Midwest -- I don't remember the exact figure, but a large majority of it is burned by utility boilers, which again, kind of goes along with the answers that we found from our receptor modeling.

Q. I'm sorry. When you use the term "vicinity" that --

A. Like I said, east of the Mississippi.

Q. The peer review, that's external to the EPA. Is that a specific body, like the NAS, or somebody like that?

A. EPA hired a contractor to ask for independent review from three independent scientists who felt they had the qualifications. I wasn't involved in that. I have no idea how they went through the selection process. None of the EPA people that were involved in that study were involved in that peer review section. I had no control over that, so these were

independent scientists who had modeling measurement and source-receptor relationship qualifications.

DR. KEELER: Question H: "Are there any studies that evaluate source-receptor studies?" I think I mentioned before the EPA has been involved in a number of, basically, model innercomparisons and evaluations for the receptor models over the last 15 years, and those are documented in the peer review literature, and yes, there are plenty of those, and there's also been a lot of work being done as far as the receptor modeling developed by EPA.

MR. RIESER CONTINUES:

Q. But it's accurate that those prior receptor models didn't address mercury, correct?

A. Some of them did.

Q. Which ones?

A. I'm trying to think now. I think the Hopke Group applied PMF, I think it was, looking at -- I think it was mercury, and he also applied a trajectory-based approach -- PSCF I think it's called -- applied to mercury measurements that they made in New York.

Q. Do you know when those were performed?

A. I, honestly, don't recall.

MADAM HEARING OFFICER: I think we'll -- five o'clock has arrived. We have finished -- we're at Question No. 10.

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 and 17, 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, and said testimony is herewith returned.

IN WITNESS WHEREOF I have hereunto set my hand and affixed my Notarial Seal this 25th day of June, 2006.

_____

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