UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

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ENVIRONMENTAL PROTECTION AGENCY

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A G E N D A

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P R O C E E D I N G S

MR. BRIDGERS: Good morning. We are going to ask everyone to go ahead and take their seats. We are going to get started here in a moment. So with that, I will reopen the hearing.

Again, I'm George Bridgers. I'm here with the US EPA, and just to re-mention, since I said I was opening the hearing, I just want to make sure it's clear for everyone, this is a public hearing, and everything that's being said and presented is being transcribed and will be part of the docket. So I hope -- as I did yesterday, I start with the appreciation of everyone in the room, but I also hope that everyone had a great evening last night and enjoyed the temperate weather here in central North Carolina.

A little bit of housekeeping. I got the nastygram yesterday evening. It was nobody's fault in the room, but security called me at about 6:00 and said, "You've got about 50 guests that have your name as being signed in, and they haven't signed out." So I don't know -- I understand there may have been some confusion on exit yesterday. But as you exit today, just make sure you sign out at the guard desk. Otherwise, they are going to look for me to find you, and I'm -- "They're gone."

But anyway, and another -- just a friendly reminder, at lunchtime, if you exit to the patio at the lunchroom, you will be locked out, and you will have to go through security. I think we made that clear yesterday. If you walk out a door and you are outside, you'll have to go back through security to come back in.

So we have one more panel this morning, and then we are going to transition to some EPA presentations mid-morning, and then the public comment portion of the conference at the end. I know some of you will have flights to catch, so you may not be around the whole day. If you know me, you know that one of the things I talk about is feedback, good, bad, and otherwise. And we do have a public comment docket for this conference, but outside that docket, if you have comments on how we have run this particular conference with the panels and some of the other presentations, if you have other suggestions as to how we might run the 13th, I welcome that feedback, and things that went well, things that didn't go well. They don't have to go to the public docket, but they can come to me. We will take those under consideration.

I have no clue. The 13th may be aligned with public rulemaking. We might be doing additional revisions to the Guidelines at that point, or updates to formulations to one of our preferred models. So that may change the character of the 13th. We will kind of cross that bridge when we get there. But nonetheless, I enjoy the feedback, critical and otherwise, so please send that in to me.

Without further ado, I'm going to turn the mic over to James Thurman here to kick us off with our model evaluation panel, and just with a placeholder that there is a surprise this morning. Later this morning we have a little surprise for everyone. And that's in a good way.

MR. THURMAN: So this is our last panel, and it's being -- it's last because all the things we talked about yesterday kind of lead to this, put in these options, like flow wind, new downwash, prognostic data. How do you know they work? You have to evaluate the model. We did that for the prognostic data. We did model evaluations on AERMOD to see if prognostic data performed just as well or if not better than National Weather Service data. These new ALPHA and BETA options, we'll be going through model evaluations. So it's fitting that this is the last one, because everything leads to this. So if our panelists can head up to the front, I will just have some brief discussion points before I introduce the panelists.

We are going to talk about model evaluation techniques for near-field and long-range transport. In the near-field, we will discuss the EPA protocol for determining best performing model, or as easier to say, Cox-Tikvart protocol. This is for regulatory applications in the near-field. We will talk about advantages and disadvantages, why they are the opinions of the panelists. We will talk about the episodic versus long-term field studies. You know we have the evaluation databases we use for AERMOD. An episodic one would be -- example would be like Tracy. You know, we talk about that a lot. Long-term, those are the continuous ones, like Baldwin, Bowline, Lovett. So then we will talk, you know, how you do evaluations for episodic if you can't really use Cox-Tikvart.

We will talk about nonregulatory applications, such as risk assessments, where you're more concerned about where an impact occurs, not necessarily if an impact occurs. You know, where it's happening, in like a population center or something like that. Then we will talk about long-range transport evaluation needs, and then we'll talk about key features of model evaluation databases.

So just a brief word on Cox-Tikvart. Mark will talk more about this in his presentation. It's the EPA's protocol for model evaluation in near-field based on the robust highest concentration and absolute fractional bias. This is the heart of the methodology. The RHC is the measure of the top end of the concentration distribution, usually the highest 26 values. It looks at 1-, 3-, and 24-hour models to monitor comparisons based on a monitored RHC and a modeled RHC.

When you look at the one-hour, you are pairing the monitor and the -- monitor receptor in space and meteorological conditions, what's called the scientific component. It may not be the same hours, but it's the same conditions. The 3- and 24-hour are unpaired in space and time. It's basically the max monitored RHC and the max modeled RHC are compared to each other. And you are going to calculate absolute fractional bias for each one of those averaging times, then combine those in a composite performance measure, and you can weight each averaging period depending on application. The default is kind of like each one is a third. If you are looking more at 1-hour you may weight that more than a 3- and 24-hour. And then you take those composite -- the CPM values and calculate the model comparison measure. You take the difference between two different scenarios, their CPMs, that's your MCM, and then you pair those, and that tells you which one is performing better relative to the other. And then finally you can do -- evaluations can include bootstrapping to determine statistical significance across the evaluated models, like 1,000 samples and compare.

So we will talk -- I will introduce our panelists, if they want to come up. Our first one is Mr. Bret Anderson. He's no Smokey the Bear, but he does work for the Forest Service. Come up. Put you at the end. If you weren't here yesterday, Bret is a physical scientist for the USDA Forest Service. Previously he worked for Region 7 as the lead regional modeler and started with the Nebraska Department of Environmental Quality. His technical experience is in permit modeling, meteorological and photochemical modeling, long-range transport modeling, and smoke transport modeling. Bret is a graduate of the University of Nebraska-Lincoln with a BS in geography and has an MS in computer information systems from Bellevue University.

Our next panelist is Mark Garrison. Do you want to head up? He is a partner and technical fellow with the Environmental Resources Management, ERM, with over 40 years of experience as a meteorologist and air quality dispersion modeler in the environmental consulting field for the electric utility industry, and the US EPA Region 3. Mr. Garrison has extensive experience with permitting and air quality issues for air emissions sources for a wide variety of industries, both domestically and internationally, and extensive experience in the application and evaluation of air quality models and finding solutions to complex problems.

And our final panelist is Erik Snyder from Region 6. He is the lead regional air quality modeler. Sometimes I call him the "lead" regional air quality modeler. He has 24 years of experience in the air quality field, including 18 years in the Air Branch in Region 6 in Dallas. Prior to joining the EPA, he worked for the state government and consulting in the air quality field. He has a BS in engineering physics from some university in Oklahoma. I don't know which one.

MR. SNYDER: OU.

MR. THURMAN: Did you know Barry Bosworth [sic]?

MR. SNYDER: Actually, I knew Boz. Not well.

MR. THURMAN: So we will go over our charge questions. We have four charge questions.

The first one is: As part of the model evaluation process for establishing preferred models, the Guideline recommends the use of the EPA Protocol for Best Performing Model; i.e., the Cox-Tikvart method. Is the Cox-Tikvart method still appropriate for near-field regulatory applications? And what are -- what do you see as the advantages and disadvantages of the protocol? And how can or should applications that do not fit the Cox-Tikvart paradigm, such as episodic or short-term tracer studies, be evaluated?

And then number two: What evaluation methods, other than Cox-Tikvart, may be appropriate for consideration by EPA in updating the Guideline, or could be used now for nonregulatory applications, such as risk assessments, where spatial and temporal distributions may be more important?

Our third question is: What evaluation methods and tools are available and appropriate for long-range transports? In comparing the model evaluation needs for near-field and long-range transport applications, what are the metrics most important or relevant to each, and why do they differ?

And then finally: What are the key features of a model evaluation data set for near-field models and long-range transport? What would we need for a data set?

So like we have done before, we will go alphabetical. So we will go -- start with Bret, if you want to come up here.

MR. ANDERSON: I really don't.

MR. THURMAN: That's fine.

MR. ANDERSON: No. I will come up there.

MR. THURMAN: All right. Each one of you have 20 minutes.

MR. ANDERSON: Believe me, I will be

done in five. I'm gonna take a lesson from Rick Gillam yesterday, and I am going to defer on questions 1 and 2 and focus on 3 and 4 because, as you know, as it was mentioned, you know, we focus on the -- in the land management community yesterday, we focus most commonly on the long-range transport applicational models. And so that is where, you know, the majority of work that I have done, in terms of performance evaluations, has been. It's been on long-range transport applications.

And so I played an instrumental role in the 2012 EPA report that evaluated all available -- at the time, all of the available transport models that are used in emergency response and for long-range transport applications. And we started that work when I worked for OAQPS here and then continued it when I moved on to the Forest Service.

And one of the things that we had to do when we were evaluating -- you know, coming up with an evaluation paradigm, was to take a step back through history and look at what EPA had done previously, in terms of all the different evaluation efforts. And the first one that we ran across was a study that was published in 1986, and that was what I referred to as the eight-model study. And basically what it keyed off of was there was a meeting of the -- American Meteorological Society meeting in the early 1980s, I think it was in Woods Hole, Massachusetts, and it was where -- and there was a Forest Service researcher by the name of Doug Fox that was the lead there. And the paper got published out of this that described all of these different performance metrics and then also discussed data organization strategies: pairing in time and space, you know, pairing in space and not time, pairing in time and not space. You know, various -- various organization schemes.

And so shortly thereafter, EPA published a Federal Register notice for a -- you know, asking for a model call, essentially. It's like, you know, I have everybody, you know, that has a model that is used -- you know, that can be used in a long-range transport capacity to give us -- give us a copy of it and let us evaluate it, see if it could be used, adopt it into the Guideline as a preferred model. And so that's the evolution of that eight-model study.

So the results from that eight-model

study were, you know, kind of interesting from the perspective that, basically discovered there was -- you know, they basically did the shotgun approach to model performance evaluation. They threw every metric at it, every data organizational strategy, and didn't tailor the evaluation paradigm to what the particular regulatory application was. So the models competed in an absolute sense with no tailoring of the paradigm for how it would be used in a regulatory capacity. But what -- what was learned was that no one model did all that well, you know. And, you know, some did well for, you know, the Savannah River Tracer Experiment, some did well for the Oklahoma City Tracer Experiment, but none did well overall.

And so we had to move -- then we moved forward, and there was another program in the late '80s -- started in the late '80s called the Rocky Mountain Acid Deposition Model Assessment Project, and that was kind of the -- that bled into then the IWAQM process, you know, Phase I and Phase II. And so in the -- in the Rocky Mountain Acid Deposition Model Assessment Project, what we found was that there were -- basically, they were looking at it -- several models. One was called the Acid Rain -- I think it's called ARM3, the Acid Rain Mountain Model -- Mesoscale Model, ARM3; and then the other one was MESOPUFF II, and they used the same organizational strategy and the same metrics largely that came out of the eight-model study that was published in '86, I believe, and MESOPUFF II. They just gave a model, you know, the highest rank if it scored in a particular data organizational category and for a particular metric. And so they just gave -- they just gave a weighting scheme and said, okay, if you were the best-performing model on this metric in this data organization, you get like three points for that. And then ranked it across, you know, each of the different categories and different organizational schemes, and it turned out MESOPUFF II ranked one point higher than ARM3. It was like 23 points and ARM -- you know, ARM3 had 22 points. But what was interesting about it was MESOPUFF II did the best when it came to data unpaired in time and space, whereas ARM3 did much better in the spatial sense.

And so it got -- you know, it got us to thinking a little bit about, you know, nobody seems to be following a consistent paradigm here, in terms of how we are using these models. And I said one fundamental aspect of it is that, in long-range transport modeling, it is fundamentally different than a near-field model, because you are concerned with the location -- you know, the ability of the model in a spatial sense, whereas in, you know, like, you know, what is being described here, you know, we are un- -- you know, we're looking at unpaired in time and space, you know, as, you know, the operational component of the model for the highest -- you know, the highest end of the distribution of the concentrations. We are not dealing with that in long-range transport.

You know, we may be -- you know, we may be doing, you know, increment analysis where we're, you know, concerned about, you know, a value not to be exceeded more than once per year, but at the end, we're still concerned about, A, you know, the ability of the model to be able to predict at a particular location, which, you know, implies a greater skill and spatial sense than what it was.

So that was a fundamental that we, you know, saw going back to those old studies, was the fact that there was -- you know, there was no underlying -- didn't appear to be any underlying logic to, you know, the fundamental paradigm the

EPA has always, you know, operated under in the -- I think it was the 1986 interim procedures document for model performance evaluation, which is the fundamental of evaluating the model in the -- you know, in how it will be used for a regulatory capacity, which we didn't see.

So then we move forward to the IWAQM Phase II process, and we basically had two different models. There was the -- well, I guess it was just one model was being looked at, was CALPUFF, but it was -- you know, they were looking at how they were going to supply the meteorology for it. So there was the new ATMOS diagnostic model, and then there was also CALMET. And, you know, there were two different techniques.

And so they went back and they looked at the old tracer experiments, you know, the Savannah River and the Oklahoma City Tracer Experiment, and they started using plume fittings statistics, you know, which, you know, crosswind integrated concentration, and then fitting a Gaussian -- you know, basically a Gaussian curve on the 100 and 600 km arcs. And so I'm sitting here and I'm going, well, here we go again. You know, it's like, you know, we are not -- we're not evaluating the model, how we use it in a regulatory capacity.

And so we just -- you know, so when we -- when it came time to actually redo a perform- -- you know, to redo the performance evaluations, we decided that we had to just take it from the ground up and revisit the logic of how EPA had been evaluating these long-range transport models. And so we went back and started looking at some of the studies that had been done, you know, in like post -- post Chernobyl. You know, there was, like, the atmospheric -- we call it the ATMES-II experiment, which is where they had the -- they -- the European community competed however -- you know, different models that are used for emergency response purposes, and they evaluated against a, you know, perfluorocarbon tracer experiment called the European Tracer Experiment, or ETEX. And then they had a -- what I felt was a rather coherent set of statistics that were being put out that focused on not only the spatial skill of the model but the ability to look at the model and how well it pairs over the entire distribution of concentration. So you are getting a -- you are getting a much greater sense of how the model does in both spatial scores but also in terms of how it's predicting over the entire range of -- or the entire distribution of concentrations.

So when we began going through the model performance evaluation starting in 20- -- you know, 2008 and ending in 2012, we started with the ATMES-II paradigm. And so the -- to get to the question about, you know, the available -- you know, the available data sets and software was NOAA has on the HYSPLIT website -- publishes a software called the DATEM software, which is their -- and the program is called statmain, and it's the statistical package that they use in order to evaluate HYSPLIT against all the, you know, mesoscale tracer experiments. And we used that and then just, you know, converted -- you know, for each model that was being evaluated, just converted the output into the format that statmain wanted to see so that we could do the, you know, head-to-head model performance evaluation.

And the one thing that -- the one unique thing that NOAA came up with was a model comparison metric that in -- was introduced at the -- I think we introduced it at the 10th Conference, which is called the RANK metric, which looks at -- it's a composite metric. It's not based just solely on absolute fractional bias, but it's based on fractional bias, the Kolmogorov-Smirnov pyranometer [sic], Figure of Merit and Space. So it -- you know, it looks across bias, scatter, error, and, you know, spatial scores, and then comp- -- you know, comes up with a composite metric, then you can -- you can compare one model against another to just, you know, get a better idea of how it's -- you know, how it's -- you know, one ranks against another, instead of just being -- focusing on one particular statistic being fractional bias.

And so, you know, the -- so we felt that that was probably the best paradigm that we had seen, in terms of how models were being evaluated in the long-range transport category. And so we adopted that approach to doing that.

And one of the things we learned coming out of it was even that metric had its problems, because when you started digging under the hood, and you started seeing why is one model performing one way versus another, we started finding some interesting things. And one of them was, some models did extremely well on the spatial scores, but they did very poor on, you know, we will say, like, the scatter. And some models actually were in -- you know, in the mid to upper rankings, but they had extremely low spatial scores.

And so you go and you look at it, and you find out, oh, well, it's -- it's the fraction -- they are doing well on fractional bias, because it's extreme -- they have an extremely low fractional bias. Well, how can you have a poor spatial score and have a really good fractional bias? Because your observations and your model predictions are 180 degrees out of phase with each other, and so when you come up with the metric, it turns out to be a 0, and so they score extremely high. And so that was kind of nonsensical. And so what we ended up doing was we ended up breaking up that RANK metric and redoing it.

And so what we did was we rewrote the software so that it would compute fractional error as kind of the absolute major of error, and then there was a -- this goes, I think, to when Erwin was pushing the ASTM method -- the ASTM method has -- you know, has a lot of statistics associated with it, but one of the things that was introduced, I think as a paper that was written in 2004 by Chang and Hanna, was the breaking up fractional bias into a two-dimensional figure. So you have fractional bias false positive and fractional bias false negative.

And so you start getting a handle on the directionality of the error. Is it more prone to, you know, overpredict versus underpredict? Because that's another fundamental paradigm in the EPA, you know, when you are talking about meeting Section 3.2.2 requirements, is that models cannot be biased towards underprediction. But the statistics that we were using, you couldn't get at that. You know, you couldn't understand whether it was overpredicting or underpredicting because of how the RANK metric was, you know, formulated. And so we recast the RANK metric.

And so you had absolute -- you know, you had fractional error as your -- you know, your gross error statistic, and fractional bias false positive to give you a measure of how well the model performs, you know, in -- you know, in terms of its degree of overprediction. So even if a model had a very low fractional bias false positive, meaning if it, you know, was -- it was either following the one-to-one line fairly well, or it's just completely off and it's, you know, in

the false negative category, what happens is the fractional error penalizes the model for, you know, just absolute error, even though the false positive might be -- you know, your fractional bias false positive
might -- you know, might have a decent score associated with it.

So moving forward -- now, I'm done here -- but moving forward, I think the -- I think the key is that -- you know, is to have EPA -- if EPA does go the route of, you know, putting another, you know, model in the long-range transport category back into the Guideline at some point, or, you know, whatever -- whether it's, you know, just doing a -- you know, an alternative models demonstration for whatever model, you know, for an increment value -- for a cumulative increment evaluation, these are the things that I need -- you know, that I wanted to stress to EPA, was the fact that the evaluation para- -- the 2012 report was probably the best evaluation paradigm you are going to find out there, and that -- you know, that's one that, you know, has been widely published, and I think it's one that makes the most sense, from a regulatory standpoint, because of how the models are used in a regulatory capacity, because spatial skill of the model is extremely important for long-range transport purposes, and working across the entire distribution of concentrations.

Now, you know, for EPA's purposes, you are talking about, you know, peak value, you know, as far as, you know, not to exceed an increment more than once per year for a short-term standard. But on the long-range transport side from the FLM perspective, we're concerned about the -- you know, the long-term concentrations and the ability of the model to -- you know, to predict with some degree of accuracy over the entire distribution of the concentrations, because we are also concerned about chemical transformation and deposition. So we have -- you know, so we have particular concern -- you know, have a vested interest in making sure that whatever model EPA does recommend in the long-range transport category, that it, you know, has -- that it is the best-performing model for -- you know, for that category for the right reasons.

And so I think, you know, like when you ask -- you know, James, when you ask the question about the key features of the model evaluation data sets, there is just so few of them. You know, there is like -- there is only, what, maybe half a dozen mesoscale tracer experiments, and I think everybody knows the names of them. You know, there might be a few newer ones, you know, beyond ETEX. I think, you know, the Park Service had a broader study where they were doing some tracer releases from power plants down in Texas that, you know, could be used, but there just isn't a lot of data sets that are out there for, you know, model evaluation purposes.

And so I -- you know, I think, you know, finding -- you know, if EPA does go the route, I think doing something similar to what you do for the AERMOD data sets or the near-field data sets of actually having a central repository where people could download them, and that there is coherent guidance available to folks on how to evaluate, you know, a long-range transport model for regulatory purposes. I think that would go a long way, because that's what -- I think where we have suffered the most has been just that lack of -- the lack of coherence in, you know, the paradigm that is used in whether or not it is actually suitable -- you know, it's a suitable test of a model in a regulatory capacity.

And so those are my two sales pitches for, you know, that is to just, you know, focus -- if you go that route, focus on getting a central repository for the data, have a recommended software package that you use to do the performance statistics, and make sure that the package covers this -- you know, the statistical metrics that are important for, you know, long-range transport. So with that, I will go ahead and shut up.

MR. THURMAN: Thank you, Bret. You didn't mention CALMET. George mentioned a surprise -- while I get ready here.

(Pause.)

MR. THURMAN: George mentioned a surprise. Surprise, Tyler here. And also, we have the charge questions of panelists I will hand out, as George mentioned. Make sure you get their autograph before you leave.

Next up -- I'm sorry. Let me introduce you. Sorry. Next up is Mark Garrison. He's got a presentation.

MR. GARRISON: I'm Mark Garrison, in case you didn't hear. I first wanted to thank EPA for inviting me to be a participant in this. I think, my perspective, the panel format has been very successful. I really think it's a good way to go with these. And, you know, I think I also want to thank Dean for the selection of panelists, which turned out to be very fortuitous, because I know absolutely nothing about Charge Question Number 3, and of course Bret has covered that very well. So I'm gonna focus on Charge Numbers 1, 2, and part of 4, and I'm gonna stray a little bit into met evaluation, because of the discussion we had yesterday about the evaluation of WRF data and its suitability.

So I am going to cover several things. One is why is evaluation important and why is it so hard? Little bit about Appendix W, Section 3.2.2.b, I'm going to focus on in this time.

The starting point of the Cox-Tikvart procedure, which was originally a 1990 Atmospheric Environment article, and then made its way into the 1992 Protocol, which has been sort of the Bible for doing this kind of analysis for the past 30 or so years. And James did provide a quick summary of that, and I will take a little bit of time to amplify that in just a bit.

I'm going to talk about looking,

probing, thinking, and understanding before you leap -- before you leap into statistics, as a way of examining the data sets that you are going to perform the evaluation on, understand them, their limitations, their strengths, before you get to the statistical part.

I will provide some illustrations of what I'm talking about. A lot of color plots, which I hope are meaningful and not just a pretty picture, but I will let you guys be the judge of that. And I have some concluding remarks.

Over my long career as an air quality modeler, from the time that I ran the VALLEY model on my abacus through the time graduating to the slide rule, and then to the mainframe, and then to a 200-pound portable computer, to a series of work stations and laptops, until today when we, apparently, can run AERMOD on your watch, as I understand, the question about modeling has been asked and answered many, many times, and I think it's important to keep asking that question and try to keep answering it in the best way we can.

Obviously, it's important for a couple of reasons. Individual cases with unique characteristics, you might need a different approach to a model. It's also important for advancing new and potentially improved techniques through the ALPHA/BETA regulatory process, which I think also is a good way to frame things. And, you know, we can have discussions about how fast it takes -- you know, how long it takes and what it takes to go through that process. That's -- that's another reason why model evaluation is important.

Well, why is it so hard? I mean, you have a model prediction, the monitor measurements. If they agree, it's good; if they don't agree, it's bad. There are a number of reasons why it's so hard. Dispersion is essentially a stochastic process, which means that it's essentially predictable as ensemble averages, but not for individual hours and paired in time and space. And that is a source of the -- or inability, I guess, to match model and monitor values in time and space.

Now, the AERMOD interface, which is an internal routine in AERMOD that creates a complete profile of turbulence, temperature, and winds up to 4,000 meters is a good thing, because it does allow for looking at layer averages of parameters instead of single-point averages, but it also cannot account for changes in wind, temperature, and turbulence over time and space.

Number of other reasons why it's hard. Regulatory use of models is, obviously, frequently focused on the upper end of concentration distribution where the uncertainties lurk most prominently. Monitoring is expensive, and data sets with long-term measurements frequently don't have any coverage to evaluate concentration gradients. So you take a look at the data sets we have used over the years, most of them are -- some of them are 1970s, some are 1980s, and it's -- you know, you keep using them, and they are all SO_2-based data sets, which make things a little bit easier, but it's -- again, monitoring is expensive, and we don't have enough monitoring and enough measurements, that is, to really satisfy the evaluation niche.

Source characterizations and emissions reports are not always available on an hourly basis, and they have their own degree of uncertainties. It's a lot easier for SO_2, a baseload plant. Sulfur goes in, SO_2 comes out. And it's really not -- again, it's a lot easier to characterize emissions for SO_2. There is a particular challenge with NO_x, as I said, because the whole business of what is the in-stack ratio between NO_2 and NO_x, and what is the -- you know, NO_x is obviously subject to transformation in the atmosphere, which we try to simulate.

Well, if it's so darn hard, what are we to do? I guess one answer is, well, let's just give up and do something simple and make sure we make no large mistakes. Apologies to Venky for stealing your solution to downwash.

But, actually, looking in a more serious vein, I wanted to talk a little about Section 3.2.2.b(2), which is the place where model is the most common goal. Not going to read this. It's in Appendix W. This is a source of the requirement to do a statistical evaluation, and it's also a source of a very important word "better," where in order to get an alternative model approved, it needs to be shown to be better than the applicable Appendix A model.

And then for that statistical evaluation, there is reference to the Cox-Tikvart protocol from 1992. There is also -- I just learned last night, that Reference 28 is actually

ASTM guidance for standard statistical evaluation of atmospheric dispersion model performance. I think Bret mentioned this in his talk. So I sort of scoured the internet last night and paid $56 to buy it, but I did. So I read through it real quick, and I got lost. There are some -- a lot of statistics, but I think, to me, the one emphasis that is in that document is -- I don't know the best way to express it -- understand your database. In other words, you know, look, probe, think, and understand your data set before you decide how you are going to evaluate it statistically.

The starting point, as James summarized in his introduction, is the 1992 Protocol, which just kind of follows the techniques outlined in the Atmospheric Environment paper. And it talks about a screening set, where you try to screen out the models that just have no chance of making it. It's often skipped and kind of go right to the sort of full-scale scientific operational parts.

The scientific part, again, is focused on one-hour concentrations at each monitor, different met conditions. The operational is focused on so-called design concentrations for 3-hour and 24-hour. The test statistic that is used throughout all of these is the robust high concentration. It's actually my favorite statistic, because it's easy to understand. If you create a ratio of the RHC for predictions to RHC for observations, again, it's pretty easy to understand. If it's 1, it's great; if it's greater than 1, one verdict; if it's less than 1, another verdict.

It is the basic building block of everything that comes next. In other words, the fractional bias, absolute fractional bias, the composite measure, the model comparison measure that James summarized, basically all rely on robust high concentration predictions from the various parts of the data set. And there is a bootstrap -- bootstrap procedure that is used or can be used to calculate significance levels, significance intervals, where you create many hundreds of thousands of realization bootstrap years by resetting the data set, so described every three days, and then doing the robust high concentration on each of those -- each of those 100 or 1,000 data sets.

Well, I'm personally an opponent of Monte Carlo-type, bootstrap-type techniques for evaluating intermittent emission sources. I'm not -- well, probably because I don't completely understand, but I'm not a big fan of this bootstrap technique. I think, when you sample many, many times, you sort of amplify the -- some of the uncertainties that are in the data set, because you end up with a number of bootstrap years that may contain none of the high values, and how should those fit into the overall statistics? So again, I will say, I'm not a statistician, and if I tried to explain in more detail what all of this -- all of these statistics, how they are calculated, it will become obvious pretty quickly that I'm not a statistician, but for the focus from here on in is my favorite metric, the one I can understand, which is the robust high concentration.

So my only, sort of, specific comment -- I guess there are two comments on the 1992 protocol -- is we do now have one hour of NAAQS, National Ambient Air Quality Standards, for SO_2 and NO_2. My thought is that the one-hour value should be used in an operational sense in addition to, not in place of, the specific evaluation. And consideration should be given to the form of that standard in deciding how to set up the statistics, how to set up the paired- or unpaired-in-space forms of the RHC.

So my -- this is my look, probe, think, understand before you leap section. The objective is to ensure that different parts of the data set are thoroughly understood before deciding how to construct the statistical performance.

Things to look at. The robust high concentration. How well is it predicted? Looking at the QQ plots and how well is it being -- robust high concentrations are performed? Do we need to choose a different N other than 26? Does it make sense to create the distributions based on the max data concentrations instead of -- the absolute guides might have several hours from a single day as part of the distribution. And again, you know, I think -- I want to emphasize that this is -- this is, you know, not -- this kind of evaluation is not meant to place or displace the statistical evaluation and the scientific evaluation, just something to do before setting up the statistics.

Diurnal patterns can sometimes tell you what we want. How the model is doing compared to the measurements. I will show you illustrations later. The met conditions. What are the met conditions that are associated with the high predicted concentrations? How do they compare to the met conditions that are associated with the high observed concentrations? Obviously, if they are in the same range, that's a good thing. Met conditions -- you know, the met conditions, themselves, you know, are there low wind speeds? Is the -- do you need to think about travel time? Is there enough distance between the source and the monitors under low-wind conditions that it takes more than an hour to get there? Is that something we should consider in setting up the statistics and figuring out which -- you know, how exactly to set up the redistributions to input to the statistics?

And then the spatial distribution of the measurements, but also the predictions. I have seen a couple of studies -- Allegheny County is one -- where a small set of receptors around each monitor is used to calculate the statistics, instead of a single -- single receptacle. And I will show a little bit later that looking at the spatial distribution can help you understand what it looks like and whether or not you should include a set of receptors around each monitored location.

I am gonna use a couple of the data sets for the illustrations I am talking about here. One is -- probably familiar to many of you is the Martins Creek Power Plant data set. The two -- 1993, two coal-fired power plants and one oil -- excuse me, two coal-fired units and one oil-fired unit. This is a picture of the plant as it existed back then. The plant has been -- since been demolished. There is a combustion turbine facility operation at that location. In the background, of course, you could see Scotts Mountain, which is the complex terrain that's involved in the study where the measurement stations were located.

This is a depiction of the terrain, very complex. The SO_2 stations, there were seven of them up on Scotts Mountain. The meteorological data was collected from a 10-meter tower and winds from a Doppler SODAR. The 10-meter tower included SIGMA-V. It didn't include any turbines. There were no temperature gradients that would be used to evaluate that stability.

This is a QQ plot of -- this is actually from a study that we did a couple of years ago with Model 6 -- 16216r. That's not an -- that's not an acronym. What do you call it, a palindrome, so I have a hard time remembering it. Anyway, we are looking at different options within AERMOD, ADJ U* at that time to LOWWIND3 at that time and combinations of those two.

This is the case where the relative high concentration behaves pretty well, in terms of describing the distribution. You can see at the bottom this is the -- again, my favorite statistic -- the relative high -- robust high concentration ratio predicted to observe, and for the ADJ U* -- the default model for the ADJ U* and ADJ -- the default model -- excuse me. I'm sorry. ADJ U* with LOWWIND3 that could predict it pretty well, the robust high concentration ratio was about 1. A little bit of overproduction with the other ones.

This is what I mean when it could be invaluable to look at a diagonal pattern. You don't need to pay attention to all the colors except for the orange colors where the pink is sort of around 10:00 in the morning, and at night concentrations tend to be much lower, and the other bigger bars are the modeled concentrations where all of the highest concentrations are at -- concentrations are at night, and has difficulty keeping up with the measurements during the daytime. What this would tell me is that there might be some issue going on with meander at night; low wind speeds, complex terrain, takes a little more than an hour for the plume to get to 2 and to the monitors. This, I think, would be ripe for using one of the ALPHA options. I'm not sure if meander is now something you can adjust in the ALPHA option, but whether it is or isn't, I think this would be ripe for testing and a different way of calculating meander at nighttime conditions. This would almost lead me to think that, you know, without some further work and without some further evaluation, that this would not be the best data set for all the evaluation.

Couple of slides. Basically scattered plots of different parameters. This is u*. From AERMOD during the top, I think it's 40 or so hours when AERMOD predicted the highest concentrations, and then the top u* value is from the top measured concentrations. Obviously, not a lot of correlation, but if you're generous to the data points, that there does seem to be some cluster here. Does seem to be a consistency between the two. I think the same can be said for Monin-Obukhov length. Again, not a lot of correlation, but some clustering that would seem to indicate a relatively small range within which the model predicts the Monin-Obukhov length and the model prediction high concentration, and the Monin-Obukhov length when the measurements are taken -- or the measurements are high.

Wind speed. A lot of, you know, very low wind speed cases in the observed data and with AERMOD, again, leading to some question or at least some need to investigate the meander compound with the AERMOD. So this is the kind of thing that I think can help you -- help you understand the data set, itself, and help you formulate ways in which the scientific evaluation, especially, can proceed.

I'm not asking you to read all these numbers. The -- this is just a way of looking at the combined measurement set that you would use in the RHC calculation and the QQ plots. Each individual station is shown with its individual. If you take all the data and just lump it into one bin, and sort that bin, you end up with concentration -- measured concentration values, many of which with the highest value at the respective monitor. So what you need to do instead is look across the first high values, take the --

take the highest of those. Look across the second high values, take the highest of those to create or to generate your distribution, and then apply the RHC to -- you even do the same thing for the model, of course, because the model will have the same kind of characteristics that has high concentrations at each of the monitors at different times. But if you lump it all into one bin and sort that, then you end up with something that is not right.

Again, lot of small numbers. I won't ask you to read all of these, but this is simply a look at the profile and surface data during a time when the highest concentration out of the entire data set is observed at one of the monitors. The -- I mentioned the data set consists of a 10-meter tower and winds from a SODAR. As you can see from the example -- you may not be able to see it, but the winds at 10 meters were missing, sigma-theta was available at 10 meters, no turbulence parameters were attempted from the SODAR, fortunately. But as you can see -- I will tell you that the wind direction changes significant in height, and once it was up near the plume height, it started to actually show the direction was in the direction of the monitors. The speeds were uniformly level all the way up. That's the 1 meter per second. Again, I'm getting back to the potential for looking at some sort of different way of characterizing meander.

Again, keeping with Martins Creek, these are the observed designed values, each of the seven monitors on Scotts Mountain. Fairly -- you know, I'd say some higher concentrations at higher elevations, but a fairly broad distribution of these values. And I have taken a look at some individual model predictions of these -- at these monitors. Well, actually, not necessarily at these monitors, but at the grid surrounding the monitors. And AERMOD does have a tendency to predict fairly narrow plumes under low-wind speeds.

This -- these spots are created for the different model combinations that if we looked at based on a grid of receptors on Scotts Mountain, not just individual points at the monitor locations. And I think that this -- what this shows is that, you know, for the cases where AERMOD was not successful in predicting the high concentration at the monitor, there is an equally high concentration nearby. And you ask yourself, well, is it fair to call that okay? I think there is some argument that can say, especially for a low wind, potential meandering conditions, is that maybe you should take a look at the spatial distributions in addition to the concentrations at the monitors.

Turning to Tracy data set, which James mentioned was a tracer -- tracer data set at Tracy in Nevada. A coal-fired power plant, that that was a tracer experiment, so it wasn't SF2, it was SF6. 128 hours, mostly at night. A lot of receptors located all over the mountains surrounding the facility, which looks like plenty of receptor locations, until you take a look at the potential extent of the plume that is predicted by AERMOD. This is, again, developed from 100-meter grid spacing across the domain. And this was -- these are examples of a couple of the hours out of the 128 hours. It's hard to see, I know, from the audience, but what it says is that frequently there is an equivalent or a higher concentration in the vicinity of some of these tracer measurement locations that might be legitimate to look at in terms of the evaluation and of the statistics, themselves.

Tracy is another one where the QQ plot with a relative high concentration follows the pattern of the QQ plot fairly well, and, you know, we are able to, you know -- personally, I think that this type of evaluation and the calculations of the statistic, the RHC ratio, is a -- is a powerful indicator that the model is doing well.

I'm going to turn to a discussion of met evaluation. Not exactly part of this panel's charge, but we had a discussion yesterday about, you know, validating or evaluating a WRF data set and their potential use for regulatory modeling.

This was a concept we were involved in a couple of years ago -- a few years ago, I think, at this point -- where a source in very complex terrain had no on-site data. We took a stab at running WRF at 150-meter resolution. When we do that, over on the left side of this picture, this is the -- what WRF sees, in terms of what the terrain shows at 150 meters. The right side of this picture is actual terrain elevations. So at least from a terrain perspective, WRF is seeing what it needs to see at this.

The thing that has always struck me about this case is that, if you look at wind roses at each of the 150-meter cell locations, you can see the channeling down at the bottom of the model, you can see that channeling kind of disappears as you go up and over the ridge, you can see the wind speed increases over the ridge. These are 10-meter wind roses. These are 120-meter wind roses. You can start to see the channeling fade a little bit. And when you get up to 240-meter, the pattern looks like sort of what the pattern in that area of the country looks like generally outside of the influence of terrain.

We did do some statistical comparisons of WRF for this project. Obviously, the statistical comparisons were made for airports far outside of this 110-meter -- 150-meter domain, but the point of that is, I think, you know, that if we are able to show good -- good performance there, at least we have the physics -- the choices of physics options pretty much -- pretty well. That, coupled with illustrations like this, I think, are one way to look at this. So you don't rely on the statistics alone, but you allow illustrations like this to help inform whether or not this is a good choice for the project. The project is out on hold, unfortunately. We didn't really pursue it, but we did talk to George briefly about this, if I remember -- it's three years ago. We even got a relatively favorable response, but we didn't actually get to the point of completing it.

In conclusion. My thoughts on Charge Question Number 1. I think it's important to incorporate 1-hour concentrations into the operation -- operational part of the evaluation, because we do have standards for 1-hour, 3-, and 24-hour standards. It's still important to look at those averaging periods, but they are no longer the controlling averaging periods. They are no longer the averaging periods that we make decisions on.

Look, probe, think, understand before you leap. Looking at the robust high concentration as appropriate, and possibly adjusting in if you need to to -- I guess the way I look at it is, if you are -- if your robust high concentration matches the design concentration well, what that means to me is that the upper end of the distribution is well behaved enough that the design concentration, itself, is a good measure of model performance and comparing design concentrations in that way. It's a good thing to do.

Alternative ways to conduct scientific

evaluations, including looking at met conditions underpredicted and observed values. Considering met conditions and the spatial distribution, which is always a useful tool in any evaluation, and possibly using an expanded receptor set as appropriate.

For tracer and episodic data sets, I think it's still appropriate to use tools like QQ plots and robust high concentration evaluations. Obviously, you can't go to the operational side of it, because it's a limited time scale, and there really are no concentrations that you would determine to be, you know, part of the decision-making process.

Charge Question 2, which I forget what the question was, but it relates to all of the above. I think those are maybe possibly alternative ways of doing things. These are not alternative statistics. They are just alternative ways of thinking about statistics.

And Charge Question Number 4. What are the characteristics of the data set? I think it's, you know, pretty evident that from long-term data sets there is a wish list, and that is good monitor coverage; onsite met, preferably a tall tower with temperature gradients and turbulence; well-defined source characteristics; and emissions on an hourly basis.

And episodic wish list. Obviously, more of a dense monitor coverage, met conditions of interest with stable conditions are what you are looking at to evaluate, then maybe need to do that only at night. And I think -- I think it was Bob that mentioned that, for those types of data sets, you may -- might be a legitimate thing to adjust some of the inputs to match what you see. And I believe that's it.

MR. THURMAN: Thanks, Mark. We will move on to Erik. And now we will listen to remarks from Erik.

MR. SNYDER: Okay. And I will provide, maybe, Region 6, and I do both photochemical and permit modeling, so I will kind of provide maybe a little different perspective as well.

First thing I think is just, you know, one of the old classics is all models are imperfect but some are useful. And so I think, from the standpoint of model performance, you know, that's the key thing, is figuring out what it's used -- what models are useful and what -- under what conditions and what analysis, what policy questions you are trying to answer.

You know, in PSD modeling for NAAQS, you are looking for the high distribution, so Cox-Tikvart has been a good mechanism to try to look at that. There is refinements that can be done, but I think as you look at the use of AERMOD or other models in other aspects, you know, when you are answering -- looking at toxics exposure, long-term toxics, or if you are looking at monitor siting for SO_2, there are some different, you know -- different paradigms, as far as you are looking for different policy question and answer to try to resolve the technical issue before you decide to monitor, or you know, is this neighborhood a risk level. And in risk level, you might be more interested in spatial accuracy versus temporal accuracy. You know, you look at both of those issues.

And so I think the key thing is is that each time you look at stuff, you need to start back and say, okay -- I think it's good periodically to look at things and say, okay, what are we trying to get? What answers are we trying to get with this model system? What are going to be the best ways to look at it? Is it going to be just look at the high distribution, is it going to be look at the high/moderate distributions, is it spatially -- is spatial issues more important than temporal, or is spatial and temporal both, or do those matter? So I think the thing is is -- and I will mention a couple of different analyses and how that varies.

For one we did, we worked on one of the first MMIF uses in redesignation per area, and that was designation in Arkansas. And from that perspective, you know, when you are looking at it, we looked at the evaluation of the MMIF data within the state of Arkansas and with the met stations we had, surface and some other air data in Little Rock and I think in Memphis. And so -- but we weren't as concerned about humidity or temperature bias issues as we were about wind speed and wind direction issues and atmospheric profile. And so from that perspective, you know, on the photochemical side, when you do met analysis, you focus on temperature as well, because of those impacts to mobile emissions are pretty great biogenics, you know.

I think the issue is that first understand what kind of policy questions you are trying to answer and technical issues, and then customize your statistical analysis, and your metrics, and spatial analyses that you look at. And so -- I mean, that, on the toxic side is a totally different -- building long-term exposure to certain toxins it's a totally different question.

And so, you know, when you look at the models, I think Bret mentioned, as far as some time in the past, the shotgun approach. I think in some ways it's good to do. You know, look at everything. But I think, at the same time, you also want to make sure you're focusing on the key things. And then the other thing is is how you -- if you come up with the RANK metric in between to try to measure things, you need to kind of customize that to the problem you are trying to solve and address as well. I think that, in general, is one of the big things on -- you know, WRF for ozone modeling or photochemical modeling we look at a lot of different things comparatively, compared to MMIF where you are just looking to stuff -- to the met station.

I would say that one of the things we looked at to try to validate, you know, for air, is we looked at data profiles and moisture and then tried to figure out where we were getting boundary level some days and some of the critical days in the model -- modeling period -- critical models primarily. Make sure we are getting those at least as accurate -- I mean, try to help them get fairly good performance on that. Never perfect, as I said.

I would say, you know, the '92 cup- -- '92 document does give you quite a bit of basis, and we've used that for quite a while, but did go back and look, and there is a number of documents on model evaluation in the mid '80s, '84 and '85, that talked about it and kind of looked at it from the bigger principle. Again, not just looking at it for one purpose only. Trying to say, okay, what are you trying to get to?

And so I would -- as this idea, if we are going to revisit Cox-Tikvart or long-range analyses techniques in the future and what to focus on, I think that's going back to some basic principles, like -- I do, you know -- sorry. I mean, one of the things from the ozone world, I would say, you know, we look -- one of the things that we look at -- and this -- there is a lot of different metrics to look at on ozone just related to time and space, specifically. Look at QQ plots, you know, both unpaired and time/space paired, and so it's got its flaws for certain -- when you are looking at some of the subspecies and time series. So you are not gonna do all that, necessarily, but I would say that one of the -- doing the QQ paired in time and paired in space, and paired in time and space give you some -- can you give you some information as far as how the model is performing.

I would say that, you know, I think, as we move forward, and I give the example on the MMIF situation we did with Arkansas, we worked with the EPA, we worked out a protocol with the applicant on how to -- what statistics we look at, what graphics to provide. And so I think the first step -- first figure out what the problem is you are trying to assess, develop a protocol, I mean, to do that, and then work through it, and, you know, sometimes you look at the data and there is adjustments and different things you want to look at, but that's how you get to it. And I think -- I mean, that's the current framework. We are pretty open on that for -- you know, it depends on -- you know, within AERMOD, specifically, I mean, we have got specific targets we are looking at, but I would say, you know, for increment, and like significant, the thing is we use the increment, like if you have an increment exceeds, you go back and look spatially and temporally in time, okay, what sources are impacting that, and you know, is this source getting permanent impacting? So you go and you're using models in want in space and time. So that's where I would say that, you know, assessing AERMOD with the space and time is set to get some benchmarks and how we are doing this, and the adjustments are being made in the model to see how those change as well. And, I mean, not just the concentration on getting the max. It could be beneficial. I don't think it's going to perform -- you know, everything -- as you scope down in your analysis to find your space and time, trying to replicate it, that's where you get more uncertainty from the standpoint you are just not going to be as accurate all the time. We have to try to, I think, start analyzing that somewhat to -- that's just, kind of, my opinion, to analyze it and set where we are now and how we can define that in the future as well, because that is critical sometimes with facilities getting permits. So I think that's pretty much what I had on 1 and 2.

I do think, on 4, I would say -- you know, I would echo a lot of the comments earlier. I would also say that, you know, there has been a lot of -- lot of field studies done and by -- there's been DOD work and Homeland Security things, and some of that -- I don't know how much of that ability we have on getting that data to be able to be used, but I think it would be good to do a -- you know, a new inventory of the data sets and see if there are some other data sets that could help improve what we use in the analysis.

And I think that if you look at those and you also characterize, okay, what data do you have? Is it long-range? Is it near-field? Is it -- what is the main strengths of it that you have, and weaknesses, and what type of analysis could you use it for? Is it more geared towards the max or more geared towards the spatial/temporal?

So -- I think that's pretty much my comments. It's -- you know, it would be nice to have more data sets, more modeling, data sets to evaluate with, but money is always an option to deal with. It's not easy.

MR. THURMAN: Okay. We want to thank

the panelists for their comments and presentations. We have time for a few questions.

Just state your name and affiliation.

MR. PORTER: Matt Porter, North Carolina DEQ. I guess, in general, my question -- or maybe point of clarification -- is what part of the Cox-Tikvart model performance evaluation addresses negative emission rates? I guess that would, you know, come into play for increment, or SILs modeling when you are trying to take advantage of some base case and identify spatially and temporally where you can refine your emission inventories and things. But it would seem to me that the lower-end distribution of model performance would be important for handling negative emission rate impacts or negative impacts.

MR. GARRISON: Is this on? Can you hear me now? That is an interesting question. Quite frankly, not one I have really thought about, but it seems to me that what that gets to is needing to be accurate in space and time, because if you're modeling a negative emission rate at the same time it's modeling a positive emission rate, you want to be sure that, at that time and at that location, that both are being modeled correctly. So I don't think the design necessarily matters, in terms of how that goes into modeling evaluations, because it would have a negative 10 grams per second. And you know in your model evaluation that a positive 10 grams per second does -- the model does pretty well. So I think that part is covered. But again, I think it's -- it gets to the question more of accuracy paired in time and space, and that's unfortunately where the models seem to break down a little bit. I honestly hadn't thought of that question before. Thank you for bringing it up.

MR. THURMAN: Any other questions? Going once?

MR. PAINE: Mark, you had mentioned -- this is Bob Paine at AECOM. Mark, you mentioned with the new one-hour standards with a form that is not the highest anymore, that the Cox-Tikvart method, as implemented, should incorporate a lower than 100th percentile percentile, and maybe one way to do that -- and the panel can comment -- is that, for example, for the SO_2, do the robust fourth highest concentration using daily maxes as the input. But I would like to see whether there is some -- that would be the right way or there is a different way.

MR. GARRISON: You didn't let me down, Bob. Thank you. I think there are a couple of ways to do that. One is to -- when you create your distribution, if each point of that distribution is a max daily point instead of just the single value in the measurement the event occurs. The second way is calculating the robust high concentration based on, let's say, the 4th through the 30th highest, bringing it down the distribution. So I think there are ways to accommodate that, but it does require some flexibility how you apply this statistic.

MR. THURMAN: Any other questions? Once? Twice? Sold.

I want to thank our panelists again. Let's give them a hand for coming up.

(Applause.)

MR. BRIDGERS: So if we look at our schedule, we have a break scheduled from 10:00 to 10:15. So let's go ahead and take a break until 10:05, because part of the surprise is time related, so we need to be back and going in the 10:00 hour. So take 15 minutes, be back 10:05. I'm suspending the public hearing for the break.

(At this time, a recess was taken from

9:48 a.m. to 10:08 a.m.)

MR. BRIDGERS: Now, we will transition from a series of expert panels, the six panels, and I have received a fair amount of positive feedback on those. Again, as I said this morning, I encourage feedback over the days and weeks to come, so in the future we can benefit from your thoughts and also improve these conferences in the future.

So next up we are going to have a series of presentations by EPA. We are going to start off with NO_2 and Dr. Chris Owen.

MR. OWEN: Thank you, George. Good morning, again. Welcome back. Glad you are here. Excited to talk to you about NO_2 modeling. If you get excited about NO_2 modeling, I hope you're excited as well.

So some background that probably most of us know, but the reason we're talking about NO_2 modeling, and the reason that we still have white papers on NO_2 modeling is that we still have a tiered screening approach in AERMOD and in Appendix W. And, of course, we were able to adopt some of the Tier 3 methods into the model as preferred modeling approaches, but they are still screening approaches, despite their detailed chemistry.

So, ultimately, on the topic of NO_2 modeling, we would like to get to where we have one technique that we believe performs the best so we could specify that as the technique, and we don't have to think between OLM and PVMRM. That's not to say that we would necessarily get rid of the tiered approach, because there is certainly usefulness in having reduced form methods. If you can get your NO_2 concentrations without having to get your background ozone and all the other features that are necessary sometimes for Tier 3 estimates, then that's good. But, ultimately, we still are working towards finding a best performing model for NO_2 conversion.

A little bit of news on NO_2 modeling that is useful, applicable, and again, exciting. And this is useful even if -- outside of the context of trying to identify a preferred model, and that's that we actually have some really important significant updates to our NO_2 and NO_x in-stack ratio database. It's been a couple of years since I said anything about it because it's been static for a couple of years, but we have some really useful updates.

So three -- three main updates. So,

first of all, our sort of preferred database that has lots of information in it, information that some folks were probably hesitant to share because it says "facility," and, you know, it identifies a lot about where that data comes from. We have had data added to that database just in the last couple of months. Sent to me in the last couple of months. I added it in the last few days, but it is now in that database available for usage. And thank you, Leiran, for facilitating that. And if -- the individuals that were also part that, I thank you as well, but I don't remember all the names on -- that were on the email, so -- but I appreciate that.

We also have some data from several industry trade groups, and these are more -- these are survey data that they compiled from their member facilities, and this information from both of these trade groups is available in a summary report as well as the detailed data, so more information on that.

So first off, there is a report and there is some data available from the PRCI, and the -- I think -- is that the right group? Okay. Because there was a lot of groups involved.

Pipeline Research Council International; is that the group, Jeff? All right. You got it. So they did a member survey, and they got something like 5,000 or 6,000 data points in their database that they've compiled. The title of their report is, "Summary of NO_2-NO_x Ratio" -- I'm not gonna read all of it, but that's the title of the report on that first sub-bullet there. Here's the website for that report, but I think, most importantly, is that the data will be added to EPA's database in the next week or so. I have gotten written permission to add that, and so that data will be posted, and we will send an announcement out when that's posted.

The other report is from EPRI, Electric Power Research Institute, and they also conducted a member survey, collected a whole lot of data, and they also released a report that's come out really in just the last week. So you could see the title of the report there, the website for that report. The report is free, and it's fairly detailed, and I think useful, but Eladio has told me that they are getting the data to us as well. So we could post that data on the EPA website.

So that -- the reports are kind of

summaries of categories, averages, standard deviations, which is helpful, but I prefer seeing all the data, which is why I begged them over and over to have all the data. And I think some of you-all will find all the data useful as well. So a big thanks to those efforts, but also, you know, just emphasize that this is a living topic. It's been a few years since we have gotten data, but I encourage you to keep this in the back of your mind as you have facilities that are collecting this data. We do have the sort of preferred database that has a lot of details, but these surveyed data sets that we have got from these two groups do not have all that information, and so what I want to emphasize is that, you know, if there are some concerns about sharing sort of facility information and all the other stuff that's associated with that, we can work around that and get the data out to the public. And so, you know, if you have something that you think might work, please talk to me about it, and we could probably figure out something that we could do to get this data out to the public.

All right. So back to some of the scientific updates and potential considerations for future revisions to AERMOD. This has been ongoing for a few years. There has been a new Tier 3 method that's been under development. This has been -- American Petroleum Institute has been working with CERC, which is the company in the UK that developed the ADMS model. So the work there has been to bring one of the NO_2 schemes from ADMS into AERMOD. The method is called the Atmospheric Dispersion Model Method, ADMSM. I'm not sure where the S comes into the acronym, but that is the name. Scratched my head about that for a little bit while I was putting the slides together.

It's pretty similar to PVMRM. It accounts for the plume volumes, estimates the amount of ozone that should be available for NO to NO_2 conversion, but it limits the ozone availability a little bit more than PVMRM does by doing a different calculation for the cross-sectional area of the plume to see how much ozone is actually in the terrain. So limits the amount of ozone in the center of the plume.

But I think the biggest difference between PVMRM is it adds a -- what they describe as a post-chemistry equilibrium calculation. And this is just to say that they do consider the steady state between NO and NO_2 that is reached during sunlight conditions so that you do have conversion of NO_2 back to NO. So you will have a lower NO_2 to NO_x ratio in the atmosphere during daytime -- during daytime conditions due to consideration of that photochemical equilibrium.

The downside to this method is that, in addition to background ozone, it requires background NO_x and background NO_2 concentrations as well. Sort of Venky's point yesterday, we can do more complicated stuff. We'll have to figure out whether or not that more complicated stuff helps us or not.

So the next slide here, I do want to show a little bit of a difference between PVMRM, OLM, and this new ADMSM method. So I grabbed a couple of figures here from a paper that CERC published a few years ago in JAWMA. So just to clarify what we're looking at, we've got, on the left-hand side of these two sets of figures is the QQ plot of the NO_x. So, to basically give you an idea of how the dispersion model is performing. Something that is occasionally overlooked when we are doing an NO_2 evaluation to make sure our NO_x is making sense and we're getting the right reason --

the right answer for the right reason and the wrong answer for the right reason, or however that combines for your data set.

So we've got the NO_x on the left-hand panel, and then on the right-hand panel we have the NO_2 QQ plots from the three different methods. So OLM is in green, PVMRM is in red, and if you're red/green colorblind, I apologize, I didn't make these figures. And then ADMSM is in blue. And, of course, they are all dots, so you can't even differentiate from shape. OLM is on top. I will just tell you that, in general, and so hopefully there is a difference between red and blue. OLM you can see is overpredicting despite an underprediction of NO_x, and I think, in general, we expect OLM to have higher concentrations because it accounts for more ozone availability.

For this case, PVMRM, too, looks really good if you just look at the NO_2, but of course the NO_x is underpredicted. So we are getting sort of the right answer for the wrong reason. As opposed to ADMSM, you can see there is a pretty significant difference. Underpredicting on the NO_2 but sort of underpredicting by the same order of magnitude with respect to the NO_x concentration. So suggesting pretty good performance for ADMSM for this particular case, which is the wild NO_2 data set.

And then just to kind of contrast how sometimes it can be different and sometimes it can be the same. I have got the Empire Abo South monitored data set over here on the right-hand side. You can see the NO_x is actually pretty good, except, you know, for the top four or five data points there. OLM is, again, overpredicting. And this time PVMRM and ADMSM are pretty similar to one another. A little bit of divergency on the top on the eight or ten concentrations, but.

So you can get really different results with ADMSM or you can get really similar results, and it just depends on the particular situation you are modeling. So it's -- it will be an important Tier 3 method for us to continue to evaluate. It's certainly more scientifically robust than PVMRM, but we'll have to see if that really gets us to where we need to be. And is the additional complexity using those options getting us something that we are benefitting from in the model?

Another scientific update that's in the works is a new Tier 2 method that I have been chatting with folks with for about a year, and we finally did put together a white paper in the last week, and so if you get the link for the AERMOD development website that I showed you yesterday, you could see the white paper that's there for that. And that's -- again, these are all living documents, so that white paper will continue to be developed and improved, but this method is fundamentally considering the reaction rate limits for conversion of NO to NO_2, and that fundamentally takes some time for that NO to ozone chem- -- NO and ozone chemistry to happen before you start making NO_2. So it's a pretty simple reduction of well-known NO_x chemistry formulas to get the NO as a function of travel time, function of ozone, and a function of the initial NO concentration. It's pretty simple on its face. It's easy to think about for a single source. Just like OLM or PVMRM, it's complicated to think about multiple sources and how we combine those, and some of those issues are discussed in the white paper; though, as folks have been talking just this morning, I have been sort of processing what they have been saying and adding to how much more complex it will be to put this in considerable multiple sources.

Another thing that I put in the white

paper as a consideration, you can see the graph here for the percent of NO converted to NO_2. So you could also think of this as the NO_2 to NO_x ratio, that you start out assuming that you have no NO_2, that you have zero percent NO_2 to NO_x ratio, and then, as you travel downwind, you have more reaction time, you have a greater percentage of NO_2. And, of course, if are you familiar with our NO_2 options, you know that we generally cap those at 90 percent as sort of a generic, average, maximum NO_2 to NO_x ratio, again, based on that equilibrium between NO and NO_2. So I have thrown in there, we could consider this is obviously going to 100 percent, which folks aren't going to be happy about, necessarily. We could just cap it at 90 like we have done with other situations, or we could actually do the calculation for determining that NO_2 to NO_x ratio equilibrium based on the ozone and the sunlight that's available for those particular hours that we are doing those calculations.

So I look forward to hearing from you on your thoughts on that particular method and, you know, I sort of envision a world where maybe some of these things collide, where maybe some part of this gets combined with PVMRM and have taken a limiting function between different pieces of these. And so I think there is an interesting pathway forward here on NO_2 chemistry, and hopefully by the next proposal we will have something that is moving this forward significantly.

And then just a little bit about evaluation databases. A lot of these or all of these have been talked about for a number of years, so I'm not gonna spend a whole lot of time on the ones I'm presenting on, although I am going to share the podium here with my colleague, Jeff Panek, who is going to talk a little bit more about one of the databases he's talking about.

So, quickly, two new databases, Las Vegas and Detroit, and then two stationary source databases, one in Colorado and the other in Oklahoma.

The Las Vegas field study was conducted jointly by EPA and Federal Highway. It was conducted primarily 2009. You see December 2008 to January 2010. Data was actually a little sketchy in those two end months. So about a year's data. We have a lot of measurements, and this is really useful, I think, both for the dispersion model evaluation, but also for NO_2 model evaluation, because we have NO_x up here, which the instruments are recording NO_x, NO, and NO_2, so we can evaluate this from several different perspectives. And what's really nice about it is that we do have monitors on both sides of the roadway. This is typically called upwind monitor based on the average meteorological condition and three downwind monitors so we could take out background to really get the roadway increment so we don't have go guess from other monitors in the area what our roadway impacts are and really a clear and correct calculation of the impacts from the monitor and the ambient data.

Detroit field study is effectively the same. It's about a year's worth of data. Same instruments, actually, were deployed. The monitoring situation is similar: 100-meter upwind, 10-meter downwind, 100-meter downwind, 300-meter downwind. We don't have sort of the nice alignment. There is a nice straight line between monitors in Las Vegas, not so much in Detroit. The roadway is not quite as uniform either. You can see down here by the 3 -- 100, 300 downwind that there is some off exit ramps and some other things going on to make it a little more complicated. But, again, useful study.

Some things to consider about this, though, is that emissions are based on vehicle counts, and those emissions, of course, don't have a sense of all the vehicles that are out there. So there is uncertainty in emissions. That's a little bit counterweighted by some of the simplicities in looking at line source modeling, that we don't have to wait for SIGMA-V, it's more about SIGMA-Z, and if we can think about modeling in a little bit more abstract way than we typically do, I think we can extract some interesting information about these field studies, despite some uncertainty in the emissions.

For NO_2 evaluations, unfortunately, there is not any onsite ozone monitoring. So that is a pretty significant consideration. But again, if we think about profiles and we think about changes with distance downwind and what relative responses should be between model and monitor, and I think we can learn some things about the ambient data and the model performance from these data sets.

Again, clear delineation of background -- and we have also done a lot of work with these data sets as well, just based on the ambient data. So one of the things we've already published a paper on is NO to NO_2 conversion rate just based on the ambient data. So we have some good characterizations of what's happening in the field so we can look at that compared to the model data as well.

Little bit about the stationary source modeling -- or, excuse me, monitoring that was conducted in Colorado. We were discussing this yesterday. We actually had a team meeting at lunch about this yesterday. What's the name of the study? The Colorado Study? The Colorado Data Study? I have been calling it the Denver-Julesburg Basin, sort of out here east of the Rocky Mountains' oil and gas development that's common out there. Not a lot of other activity in the area.

This was an extremely collaborative effort, both on the funding as well as the man-time that was put into this. API and BLM sort of were the initial funders for this. Anadarko contributed time to this. ERM, AECOM, US EPA have all put in time and effort into this as well.

So this is a short-term intensive field study. If you think about with respect to our discussion on model evaluation, this doesn't fit under Cox-Tikvart, because it's only about a month and a few days of data. So it's difficult to analyze from that perspective. But it is intensive that we have a lot of air quality monitors. Instead of looking at the words, we will just jump to the slide that has the information as well.

The study was conducted at two different well pads, and so the first well pad it was on site for a few weeks, and then just based on the drilling operations, they moved to this other pad across the, quote, unquote, street here. And so we moved the 12 monitors that we had initially arrayed in this configuration and moved them over here for the second half.

So we've got roughly two weeks of sampling at each location. We actually -- you could see there is a 6b, a 2a. We moved some of these monitors around based on, sort of, real-time analysis in the met conditions that were ongoing.

So we are this close (indicating) to being done with developing the database. We hope to have it posted on SCRAM for folks to start looking at in a few -- the next few weeks. The workgroup that has been working on this -- I will jump to the workgroup slide -- will continue to work on this after the database has been developed. If you have interest in analyzing this with us, certainly let one of us know.

So, since I have the workgroup slide up here, I will acknowledge sort of the vast array of folks that have been working on this. This has been sort of a decision-making by committee, but we have had Rebecca Matichuk from Region 8 has been the lead for this workgroup that has really pushed us forward, but I would really like to also acknowledge Mark Garrison from this list of folks who has done a lot of the work, the data analysis, putting reports together and stuff for us as well. So significant acknowledgements to our extensive list of workgroup members.

Jumping back to this slide, I just wanted to give a flavor of some of the information that's here. We, of course, have SIMS data for these facilities so that we have good emissions. And so since we had new NO_2 to NO_x ratio -- in-stack ratio data, I thought it would be interesting to put up from this study what some of the in-stack NO_2 to NO_x ratio data looks like for some of the different stacks that are on site. You can see these are colored by different, actually, units. And then the x-axis here is just the emission rates. That's sort of the load that's being put on these units. And you could see the amount of scatter that occurs in some of these. The green and the blue here, there is a lot of scatter over not necessarily a lot of range for load, versus the pink and red where the in-stack ratio's fairly consistent despite a fairly large range of loads. And so I think there will be some interesting things coming out of these field studies, not just from analyzing AERMOD performance, but also sort of understanding some of our input data a little bit better. And as we look at the database -- you know, the in-stack ratio database, that I think we'll have some things to learn from some of these intensive field studies that have this information at a very high frequency for longer periods of time.

Last slide here is just really to introduce and transition to Jeff Panek who is going to tell you about this Oklahoma field study, and I am letting Jeff talk about it because, while this has been collaborative work, and Jeff and his group have spoken with us frequently about planning and analysis, this has been a little bit more in-house work that they have done versus the work in Colorado, and I just have this one figure up here that -- I think the site is in here, but if I pulled up the right -- you know, right place in Oklahoma that the site was, you wouldn't be able to tell the difference, but I just kind of wanted to give you a sense of how remote it is, but great because there is no interference from background sources.

So I am going to stop and turn things over to Jeff until we have to pause again. Let's see if this works. And Jeff, if you want, there is a pointer.

MR. PANEK: Thank you. My name is Jeff Panek. I work for Innovative Environmental Solutions, and I was the principle investigator here for the PRCI project here to go out and collect some data with the main function and purpose of trying to evaluate AERMOD performance and maybe make some improvements. So on behalf of

PRCI and the member companies, I would like to thank EPA for the opportunity here to make this presentation and hopefully to tie together a lot of discussion items that we've heard over the last day and a half here.

So our project participants here were Pipeline Research Consortium International, which is a research arm here for the pipeline industry. We had various trade associations and member companies here participating. And as Chris mentioned here, we did consult with EPA here and worked with EPA early on in the program as we designed and implemented this research program to gather some data.

Study objectives really were born out of the new one-hour NO_2 standard, and we looked pretty extensively at the databases for evaluating AERMOD, and most of those databases turned out to be EGU, taller stack, bigger type of emission sources, SO_2-derived, and really we were looking for a database that had three solid legs of the stool. We were looking for solid met, solid emissions, and solid ambient data. And really, as we started poking around, even if I looked at the Empire Abo data sets or the Alaskan data sets, there were always something that was a little bit weaker. So we were trying to go out and collect a fairly robust data set here for the purpose of really evaluating the model.

So, as Chris mentioned here, we are kind of in the middle of nowhere, and that was kind of by design as well. We were looking for -- trying to really find the typical compressor station that we could go out and do some measurement. So this is a natural gas compressor station. We are looking at some fairly decent-sized engines that compress the gas and push it down the pipeline. We are looking to try to stay away from other large nearby sources that would give us compounding information and make us sort out what the contributions of those sources were. So having that fairly isolated source was, indeed, a plus. We are also out of an urban area, so we don't have any of the urban ozone influences or those types of influences that we have to separate out from what is going on.

So we also looked at, very closely, run times on the station, because we really did want to get a compressor station with some data and try to pull some data out. So we looked at the couple of previous years, and it ran a decent amount for compressor stations, so we are fairly optimistic. But as in all research programs, you have to adapt to the outcome of what happens, and we didn't quite get the runtime on the engines we were hoping for. In fact, we had -- and I will show a little bit -- one of the engines was actually down the entire study period. But we did -- we did make up a lot of data here in the last bit, and you will see that in a little while.

So this compressor station had three compressor drivers and an emergency engine. As I said just a bit ago, Engine 8 here did not run during the entire duration. They kept promising to bring it back up, but it never came back into service during our study period. We actually went 13 months on this program, so we had a 13-month monitoring program. So this kind of gives you the idea of these two sources that were really out there monitoring, which is the Clark TCV-12, fairly decent-size engine, not well controlled. But we have the bigger Cooper-Bessemer, and you'll see a picture in a second. Much taller stack, much better control.

So we are, indeed, looking at all of the wonderful things that make modeling a challenge, including downwash, chemistry, and all of the other interactions here in the model.

Here are the three stacks. We have got the Clark building with the two Clark engines, TCV-12 being slightly larger than the other Clark engine, and the Cooper, a much taller engine. They -- based on how compressor stations work, all the stacks are usually out one side of the building, they nicely align. But as you can see here, we have some fairly short stacks, and that is not very uncommon in the compressor industry. This is just the way things had been done. So this is an older station. You can tell a little bit by the rustier old stacks here on the Clarks, but everything nicely aligns when we see a figure a little bit later north/south. So we do have a predominant wind, and do have some monitors sited to capture some of these impacts.

I really don't intend on you to look at this, but we have a three-level tower. We actually put it up on their communications tower that existed. So I had 2 to 10 solar rad/delta-T, and then we had a 30-meter ultrasonic. It failed twice on us. After it failed the second time, I replaced it with a traditional cup and vane, and we just went forward. The thought was, with the taller Cooper stack, we wanted to make sure we have decent met at the taller level as well, so we just did wind speed, wind reaction at the 30-meter.

So here's a comparison. When we did the siting study and we did our initial work, we used the NWS Hooker, Oklahoma, station, and on the other side here you can actually see the wind rose from the study from the on-site data, and you can see we did a fairly decent job. The met is a little bit different. We have a stronger south-southwest component for the 10-meter on-site data than we did out of the Hooker data set, but it did well enough, and I will show in a minute how we actually compare it to our siting.

So here's the overview of the actual facility. You can see the red there is the property line. So one happens to be a field monitor. It's located -- again, the stacks are oriented north-south along the two compressor buildings here. So these are the two compressor buildings. The stacks are lining up on the west side of the building here. So we sited 1 and 2 really to get the dispersion between and see how well the dispersion and the chemistry were occurring between those two monitors. We did the east fence there. The number 3 was really sited primarily for a downwash consideration. And the fourth monitor there is really kind of a background monitor, and that's down by the communication tower and the met data. So to give you kind of an idea here, the monitor 3 is about 350 feet east of that, and we did pick up some downwash, and I will talk about downwash here in a little bit.

So the monitor stations here, we were monitoring NO_x and ozone. We collected on-site data for those. Here's a little bit about the ambient monitoring hours that we had, total hours, the invalidate hours for missing data calibration, whatever event was occurring here, and our validation. We did have some challenges with some of this equipment, but we did, overall, get a fairly robust, decent data set out of our monitoring data.

Here's a look at trying to understand a little bit about how many event hours we actually had, so that when you actually do an analysis, you could figure out, how much data do I have? What is the breadth of that data set? So we looked at a 45 degree cone and we looked at when we had alignment with one --

MR. BRIDGERS: So I mentioned that there was going to be a surprise. This is sort of like the Spanish Inquisition, so it's like, surprise, I never suspected.

So we have the distinct pleasure this morning -- we thought it was going to be yesterday, but it is today -- that our Acting Deputy Administrator for OAR, I said that right, Ms. Anne? So I'm gonna offer the podium. No walk up introduction and walk up music, but Anne Idsal, please take the podium.

MS. IDSAL: Thank you.

MR. BRIDGERS: Thank you for coming this morning.

(Applause.)

MS. IDSAL: Good looking crowd and a pretty full room. Thank you-all so much for joining us. It is a real pleasure to be here. I know that this conference is held once every three years, and it's a really important one by virtue of the fact that what we do when it comes to air quality monitoring is the basis of a lot of rulemakings, a lot of actions that are taken, guidance that's changed and tweaked over time based on the new modeling methodologies that are coming out and the work that you-all do. And so much of it is truly bottom up from, you know, local municipalities, tribes, states, you name it. So I just wanted to thank you-all so much for taking the time to be here, for engaging with one another. From what I have already heard, you-all have had some really solid conversations. I would encourage you-all to keep that up.

So to just say a couple of quick things, as you-all know, the 2017 revisions to the Guideline on Air Quality Monitoring [sic] addressed a number of key concerns brought forth by y'all, the stakeholder community, through conferences just like this one, some related workshops, meetings, as well as just some direct experience and model use under the Clean Air Act programs.

So in an effort to facilitate that continual improvement in our models and methods, we have provided clear and transparent identification to the stakeholder community on areas of EPA focus for some additional model development evaluations through a series of white papers, which you-all are very familiar with. And as you can see, through this 12th Conference, you know we are actively seeking your feedback, if it's to that, any additional feedback you might have, and be prepared to provide input from the external community on these areas and any other areas of significant need that have not already been identified within the white paper. So this is a real opportunity to engage, to give us feedback, to give us comments, good, bad, otherwise. We need to know what you-all are dealing with on the ground, what you're seeing, and how things are changing.

EPA certainly views air quality modeling development as a collaborative enterprise. This is an iterative process, and it involves a lot of engagement. It should not be a one-sided conversation. It ought to be a dialogue. And we really value your input. So please continue to bring that to bear throughout the course of this conference, and quite frankly, once you leave RTP. I know there is a lot to gain from these ongoing conversations. Communication is absolutely key, so please use the public feedback session this afternoon, as well as the public comment docket. As you-all know, this is all transcribed because it is a public hearing. So again, just this forum, the conversations you have, the comments you provide, go -- really go a tremendously long way to making sure that, as we move forward, we do so with the best information that's out there with your continued input and collaboration, and I cannot thank you enough for that. And with that, I will turn it back over to the gentleman who I so rudely interrupted.

Thank you-all very much. Appreciate it.

(Applause.)

MR. BRIDGERS: Thank you, Anne. I apologize to everyone. Anne's on a very tight schedule today, and so this was the walk in. She was actually going to be our keynote yesterday, but her schedule changed. So, Jeff, let me see if I can find your presentation again. I should be able to. Is this where you were?

MR. PANEK: That's where I was.

MR. BRIDGERS: Awesome.

MR. PANEK: So, to reiterate, this slide is trying to just show how many decent event hours we have for evaluating the -- when the engine was operating, when we had impacts at the monitor, when we have data actually available to do the analysis. We do have a little bit of double counting I want to point out, because when I have a south wind, I'm getting both that north fence and the field monitor count in there. So you get a little bit of double counting, but as you are looking at the data set, you can see we had very low runtimes and we weren't getting much data, kind of in the middle of the project. As we continued to ask for runtime on these engines and to get operations to actually schedule some operation, we did pick up quite a bit from kind of that September-through-December time frame, and we made up a lot of ground with a lot of additional data.

So I said earlier we did a post-evaluation using the onsite met and looked at where we were. Did we site things properly? About mid-project we looked at this as well to say, gee, did we get it right? Do we have to move the monitors? What should we contemplate here, as far as the locations? And having looked at the isopleths here and what we had done, it turned out we did a pretty decent job of siting. So AERMOD and NWS data did a pretty decent job of giving us some good siting data.

So here's a summary of the monitoring data. So I would like to first point out that there is a main difference here between a permitting modeling approach here where I am going to be using NWS data, and I don't have any of this on-site data. That would exacerbate things here, but the facility here passes using one year of monitoring data. We would have demonstrated a compliance. However, if we are using PVMRM and five years of that offsite data, we are not going to pass. And even for a facility as simple as this. So taking a look at this, we see that that north fence gave us our highest impact of 109.8. So we are slightly over the standard, about 10 percent.

So again, looking at a permitting analysis, and going through it on that basis, I presented here the Tier 1, 2, 3 data results for permitting analysis and then compared that to the highest observed here. So we did model that TCV-10, which is not going to be reflected in the monitored data, because that engine didn't run, but during a permitting analysis, I would have been required to include it. So for the purpose of comparison here, we placed that data in there.

So looking at a refined analysis actually using that on-site data now, going through and using our PEMS data, so we had a parametric emissions data set developed back based on trapped equivalent ratios, and I'm not going to go into any detail on that. There is plenty of data and report information on TER and that PEMS system available, but the two-stroke engines uniquely gave us an opportunity here to use a PEMS system and get decent data, and we did source test these several times to get some comfort with the data that we have for the emissions. So I think it's worthwhile mentioning also that this data was archived down to the one-minute level. So we have one-minute data for analysis.

So looking at the comparison here, using the refined data, we get a much better comparison, but you can still see that PVMRM is still overpredicting and showing some violations, whereas we did not see that in the data.

So we have done a number of different analyses in the reports, and we are hoping to make all of that available to EPA to present on their website along with this data set that others can use to conduct analyses on their own. That should be available here -- we are hoping here in a couple of weeks when Chris is able to compile it all and then put it up for the SCRAM website.

So we are currently looking at a number of different things, including on the chemistry here, and I think it was said yesterday that nobody wants to look at debug files. Well, I kind of agree with that, but we are forced to look at the debug file, because we are really trying to get at looking at that plume volume, plume rise, make sure that the available moles of ozone that are available for that conversion all make sense. So we are in the process right now of going through and compiling that data for various events in -- in the model that we have and taking a look at things.

So the events that we are focusing on really are looking at some differences here between that north fence and the field monitor where we have a south wind. We want to make sure that that engine was running by itself. I didn't want a boiler or the emergency generator if it was operating during that hour again to confound things. We are trying to keep it simple to start. The Cooper, the boiler emergency generator, we are trying to get those out of there.

The one other comment I will make is the Cooper and the Clark were not coincident impacts.

When I do modeling and take a look at it from there, the taller stack, more controlled, additional dispersion on that Cooper engine, I wasn't getting joint impacts. So the one downside to the study is we really didn't have merged plume data, which we were really hoping to have, but that second Clark engine never came back on.

So we've run the model with and without downwash. We are running that model for NO_x so I could look at the dispersion portion and NO_2 so we can look at the chemistry portion and isolate those. We are also digging into the one-minute data underneath to take a look at, for that individual hour for that event, what that looks like, and we are also doing some manual plume rise, going back to the good old days of pulling out Gary Briggs' calculations for plume rise. And I think it was also stated that nobody ever uses SCREEN anymore. Unfortunately, I did for the plume rise, because it was calculated for me, and I didn't have to struggle to do it. So SCREEN does still have some functions. Chris might disagree.

I'm not gonna read these to you, but these are the parameters that you get out of the debug and that were pulling out for both the north fence and the field.

So one of the other activities that we have engaged in is our team brought Ron Peterson from Peterson Consulting on board, and Ron's been part of all the new downwash, and he's gone through this. Here are the various options. I present this slide so that the next one makes sense so you can understand what the nomenclature is when I show you the actual summary of the data and the results. So Ron's used this data set with that east monitor really to pull out and look at and see how the downwash is performing.

So we did look at the robust high concentrations, and we were using NO_x only, so we eliminated the chemistry portion or any bias from the chemistry. And the conclusion here is NO_x is overpredicted by 1.8 to 3.25. And again, the various modeling scenarios -- and I will go back up, and these are the various new BETA options and how we looked at each one relative to this data set and taking a look at the data set.

Similarly, here's the QQ plot for that east fence monitor and taking a look at each one of those types of analyses, and you can see we are well above the over 2 -- factor of 2 overprediction here. It's showing quite a bit of overprediction from this. And when digging back into this a little bit further -- and we are doing additional analyses to try to understand this better -- it does look as if the plume rise is not correctly calculated, and that we're not getting the plume rise correct.

So in conclusion, I really wanted to make you aware of the data set, make you aware of this data to actually do some NO_2 work for further evaluation and model improvement, and hopefully it will be the basis for evaluating some of the BETA options and the new model provisions that we are bringing in for chemistry.

The simplistic model chemistry here and some of the assumptions here I think are leading to overprediction, especially in the near-field. One of our comments has been that the assumption here, and it's a simplifying assumption from the modeling standpoint, is that we have a well-mixed ozone within the plume for that conversion is just clearly not the case, and there is a delay to get it mixed in to make that conversion.

Ambient ratios here from the in-stack to the field show very little chemistry occurring, you know, in that initial plume and that initial downwind transport. So one of the conclusions so far has been maybe it's best to turn the chemistry off in the very near-field, and we don't know what that distance means yet, because we don't -- we don't have enough of the data analyzed, but certainly out to that north fence it -- we are not seeing the chemistry occur from the monitoring data, but the model does employ chemistry.

So one-hour invariant met and emissions data here also cause or contribute to what we are seeing, as far as the overpredictions, and obviously downwashes is clearly another topic that we need to further investigate.

So the data are available currently on the PRCI website. This data set is available for some nominal fee. I believe that it will go up onto the -- and I have to check with the project team to make sure I have permission to do this, but if they can put it up on the SCRAM site, I think it will have more use and more access for folks. There is a lot of other information out there. There is reports, there is all the QQ plots and analysis, so I welcome you to take a look at that, and review it, and give us some feedback.

Ongoing project is still going on this year, and we are trying to complete a couple of heavier analyses here with the downwash, so stay tuned, we should be publishing here shortly on the downwash. Also, the near-field chemistry work with the debug files. And one other thing that hasn't come up much in the discussions that I picked up on from the conference here is we're really using one-hour invariant parameters, both on the emission side and the met side, for estimating a one-hour concentration. So that seems that we should be using a smaller time step here for actually trying to understand what that hour is. So we're getting some of that variability accounted for. So that is also something we are looking into, since we have the data down to one minute. And I'm not at all suggesting 1-minute data are needed, but maybe 15-minute data, maybe some smaller time step, so that when we are estimating that hour, we are picking up some of these variances.

There is the project content -- contacts and the PRCI project manager. This would be part of the docket, so you will have access to that contact information, and if you are wanting to discuss this any further, please reach out and let us know. Thank you.

(Applause.)

MR. OWENS: And George, I think we are actually going to put our presentations on the conference website as well, right, eventually?

MR. BRIDGERS: Chris, that is correct. We will have the presentations posted hopefully by the middle of next week at the same time that I load them into the docket. I just want to make sure that we have the final correct versions of the presentations and we will PDF them up. And again, Jeff, wherever Jeff got to, apologies that we interrupted you with -- he walked out of the room.

MR. OWEN: He was done with us.

MR. BRIDGERS: Someone texted me when I didn't do the Monty Python skit correct, because I didn't do it in the voice of the Spanish Inquisition. I didn't have my red uniform on, so I apologize for that, but it was an honor to have Anne slip through. So I will offline apologize to Jeff for his interruption.

MR. OWENS: All right. Somehow we are on time. 11:00 was our start time for the plume rise, and I also want to thank Jeff, because he said plume rise about eight times in his last three slides, so it gives some relevance to my relatively short slide deck on what ultimately is a simple concept but nonetheless challenging us to appropriately parameterize in all situations, so.

So I kind of have an array of topics here, and I apologize if -- if it's difficult to connect all the pieces, but the connecting theme is the plume rise. So we do have a current white paper on saturated plumes. So the details on this white paper is simply that plumes that have a high moisture content can have an increase in plume rise. And this is often the case with facilities that have NO_x and SO_x controls that are doing wet scrubber, and so they can have additional moisture in that plume that is not maybe typical, and maybe not something that we were thinking about 20 or 30 years ago when we built -- developed the model. But that's not considering our current formulation for plume rise. That -- our current plume rise formulation accounts for the momentums of just the speed of the emissions coming out of the stack, as well as the thermal buoyancy of the current temperature, but again you don't take into account any additional heat inputs; i.e., heat of condensation.

So the white paper discusses a PLURIS plume rise model, generic plume rise model that has been identified as potentially providing some pathway for considering additional plume rise from so-called wet plumes. Also discusses a preprocessor that has been recommended for addressing the situation, sort of an outside-of-the-model framework. And that may be okay for particular applications, but ultimately, again, as we are talking about updates to AERMOD, we need to bring these concepts somewhere into the model framework. That plume rise is a dispersion aspect that we need to account for in the model, and certainly would be a new formulation if we bring this feature into the model. So it's one of the things that we need to think about with respect to this particular topic. The other thing is performance evaluations, and there has been some evaluations. I don't think -- there has certainly not been the evaluation of what we would eventually put in the model, because what we are going to put in the model doesn't exist yet. But again, data sets are going to be crucial to moving this particular topic forward and future versions in the model.

All right. Another plume rise topic, buoyant line plumes, formerly known as BLP, currently exist as BUOYLINE in AERMOD. So EPA incorporated the BLP model into AERMOD. It's part of our Appendix W update in 2017. BLP was integrated as is, and as is means that it was a PG model. It means that the downwash calculations that were done were -- well, we will say they weren't PRIME. They are significantly reduced, in terms of calculating downwash. So what we have in AERMOD right now is that the AERMOD met is converted to PG stability class so that we could do those plume rise dispersion calculations of the BUOYLINE model in AERMOD. And so the thing here about going forward is sort of an open question of do we want or need to do the work with this BLP specific parameterization to take this into certain modern dispersion theory? Do we need to move -- do we need to replace the PG parameterizations that are there? If we do that, we need the data sets to do it. And that was one of the things that really held us up going into the proposal of doing anything other than bringing it in as is, is that we didn't really feel like we had sufficient data sets to do that evaluation moving forward. So hopefully, as we continue to collect data information, then we can identify appropriate data sets to do additional scientific development on those fronts.

BLP was specifically formulated for roof vents, smelter facilities. And we have a figure on the next page that will make it a little bit more clear, but some of the specific details of this formulation is that these -- this plume rise was a buoyancy-only plume rise. There is no momentum calculation, certainly no moist plume calculation. The plume rise is calculated in BLP. It is nice, in that it has wind-angle specific entrainment. So if the wind is along the length of the building, BLP will take into account that that plume will sort of be like a merge plume and it will have some enhanced plume rise for that. So there are definitely good features of BLP that are not available for other source types and air modeling.

Because of the overall description, though, of the BLPs for long, hot sources, BLP has been applied for a number of long, hot sources, even if those are not the roof vent type scenarios that it was originally formulated for. And I will explain that a little bit more in a couple of slides, but just to -- we have tools that sometimes fit the scenario and sometimes not. And this is, again, a case where we consider future developments.

So this is a couple of figures from the BLP User's Guide. Again, shows the roof vent. This is meant to be a very long building. You can see the figure here, long building with a vent on the roof that all of the emissions from the activities on this side of the building are leaking out. And again, there is no momentum component of the plume rise as calculated in BLP because the expectation is that this is all heat driven emissions off the roof of a building. Of course, hot air is rising, rather than an industrial process that is pushing air through a system, so there is a particular speed. And, of course, the roof vents are covered so that you don't have, like, a stack where you are just going up in the air. The idea is that air that's coming out doesn't have a lot of vertical speed to begin with.

Over here on the right-hand side, I've got the equations for the buoyancy flux calculated BLP and also AERMOD. And just wanted to point out sort of simply that they are effectively the same formula. It's a flux through it, so it's a temperature differential over an area. So it's the length times the width of the source. Calculate that surface area that that flux is going through. Whereas for AERMOD for point source, it's r^2. So otherwise the terms are effectively the same. Temperature differential between the air and the plume divided by the temperature of the plume. So there is a lot of similarity, and I think that, as you look at buoyancy flux, there is not a lot of different approaches here, theoretically. Of course, maybe J. PLURIS model does something different, but I think there is similarity here that provides synergy as we consider what we can do for different sources and different combinations of addressing the source types going forward.

So I mentioned that BLP has been applied for sources that maybe don't fix the box of a smelter with a roof vent. So there's actually been three Model Clearinghouse actions in the last couple of years. And, you know, I think the Model Clearinghouse is our test bed for identifying where model improvements are needed. So that's why I'm looking here, Model Clearinghouse actions, to show where we can consider future updates to the model.

So these three Model Clearinghouse actions actually have the same title for all of them, BLP/AERMOD Hybrid Approach for the Buoyant Fugitives in Complex Terrain. If you go in MCHISRS, if you just search for BLP, you'll find them. There is three actions with actually two different facilities, one in Allegheny County in Pennsylvania and the other in Follansbee, West Virginia. Interesting, both of these facilities were the subject of Model Clearinghouse records back in the '90s as well, the last time they went through major permitting or regulatory actions. So these things have been there for a long time, and despite sort of identifying that we needed improvements, we still have need for improvement on these source types.

So the hybrid approach that's been used for these two facilities, you know, seeks to maximize the scientific benefits from the BLP model, and that it has an enhanced consideration for plume rise from a source with this type of configuration, but gets better dispersion estimates. So again, the question of, do we need to look at Monin-Obukhov dispersion estimates from these source types that are available in AERMOD?

So I have a figure here. If you are not familiar with coke ovens -- I was not familiar with coke ovens before I started working on these actions. So the figure here is one oven. This is one oven in this long series of dozens or hundreds of these ovens. And each of these little ovens has basically coal that's on fire in an oxygen-limited environment so they could remove impurities. And these things will, quote, unquote, cook for a day, two days. And so the activities at these facilities are moving up and down this two or three football field long building and opening these doors, pulling out this really hot stuff, moving it over to a place to cool it. And so there is not a stack here. There is not a roof vent. Instead, there is this giant hot thing with even hotter stuff leaking out of it.

And so I have two figures here from original risk assessment EPA did in 2003 that just kind of show some of the different pieces of buoyancy and emissions from a coke oven. And so, you know, it's this long building, the whole thing is hot, there are parts on the top where you open it up and you put the coal in, the doors on the side where you open the doors and push the coal out. I mentioned there is a thing called a quench car that goes up and down and gets the hot coke and takes it over to this other building, I guess pour water on it or maybe it's oil. I didn't get that far in the details of the industrial process, but there is this nice little railcar driving up and down with stuff that's like 1,000 degrees, and maybe leaking SO_2, I don't know. I'm more concerned about the plume rise right now, rather than quantifying the emissions. But the bottom line is it's a hot mess, so to speak.

And I know Tim Leon-Guerrero is probably sitting back there feeling vindicated that I'm venting for him as he's tried to characterize these source types and others in the past who have done the same. But, you know, it represents a source type that is not well represented in any of the current models that we have, and so I think it's important for us to consider it, and as I have looked at these, it's kind of brought my mind to other plume rise issues.

And so just to summarize some things I said about how coke ovens are difficult, the surface temperatures on the door's about 450 degrees, but if you open it up and let some of the air out, it's actually 1,800 degrees. You know, if you look at the formula for calculating the buoyancy flux, you only have one emissions temperature you get to choose from. So, you know, how do you pick from that?

I said I didn't want to get into the emissions, but trying to balance fugitive emissions versus actual direct emissions from some of the piping that occurs is complicated.

And just in general, back to the plume rise aspect, you know, the buoyancy flux here is difficult to calculate, and it's not -- it's not one hot source. You know, it's not like we could just take that 450-degree temperature and sort of calculate heat transfer, but the RRA did calculate heat transfer from just the surface, and then it calculated buoyancy flux from doors opening up and down. So there are ways to look at this that are interesting.

But, what it brings to light is that, you know, buoyancy from fugitives can be really important for some sources. Buoyancy from generally hot facilities that we maybe don't capture in a stack exit temperature can be important. And so those are things that we need to think about as well.

Plume merging. You know, I talk about that there is different doors open. So we've got the big hot oven -- big hot oven door, and that's combining with the overall buoyancy for the facility. And so sort of plume merging is something that's been highlighted in my own mind looking at these facilities as well.

So, again, just some topics that we can think about as we talk about plume rises. Relatively simple hot-air-rises concepts that we learn as children, close the door because you are letting the hot air out, is not necessarily easy and straightforward to model. And while we have made an effort with a lot of our updates now to sort of look at them independently, plume rise is certainty calculated independent of other model features, but they are not independent in reality.

And so as we talk about plume rise, we probably have a building, there is a stack, and so downwash is potentially important to the point that Jeff was making in his slide deck. Those two things play together, and other features of the model parameterization. And so I was just giving acknowledgement of the white paper that was submitted recently, which is titled "Penetrated Plumes," but you don't have a plume that's penetrating a boundary layer if it doesn't have a plume rise. So I've -- I've categorized it over here in plume rise, and Bob will tell you more about it, I think, later in the day. But just the point being that these things all fit together. And as we look at individual model updates, it helps us to think about how these things work and how they are done in the model, but, ultimately, when we get to doing testing and evaluation, and looking at these data sets, we are going to have to turn all these things on or off to come up with the solutions that together work to improve the modeling system. So I think it just underlines the effort of collaboration among topics, much less among the different entities doing this work. So while PRIME2 committee may be focused on downwash, the PRCI Plume Rise Committee is going to have to work with them going forward so that we could all make sure that we are looking at the same thing. PRCI has done that already by hiring Ron, apparently, so good job.

All right. That's the end of my slide deck, and I'm going to turn things over to James now who will -- on the exciting topic of deposition.

MR. THURMAN: So I'm going to talk a few minutes about deposition AERMOD. It's kind of a topic that has not been discussed a lot since AERMOD's been promulgated. So why are we talking about it? There has been recent interest in AERMOD deposition due to the polyfluoroalkyl sulfonate, perfluorooctanoic acid and perfluorooctanesulfonic acid. Bet you didn't think I could say that. So PFAS, PFOA, and PFOS were in the news recently. For those in North Carolina, this would be like GenX you've heard about. So there has been a lot of work -- interest in those chemicals. Also mercury deposition and ammonia deposition recently using AERMOD.

So AERMOD does incorporate dry and wet deposition from particles and gases. Generally is not used for regulatory applications but can be incorporated if important, and that's in Section 7.2.1.3 of the Guideline.

So I'm gonna talk about the two dep- -- two deposition schemes -- well, there's actually three, one is for gas and two for particle. With this latest release of AERMOD 19191, we set the gas deposition, went from nondefault to ALPHA as we investigate it -- and we'll talk about that more. Gas deposition was added in the early 2000s, the Wesely, et al. 2002 paper. That was some work done by Argonne National Lab. It was meant for ISC, but then brought into AERMOD when AERMOD was promulgated.

Gas depositions, not easy to put in AER- -- to implement AERMOD. There's a lot of inputs you have to know. These inputs include a land use around the source. You have to do the 36 sectors of land use around the source. It's not -- the AERSURFACE-type land uses, specific land use categories for AERMOD in the User's Guide. Seasonal/month assignments for each month, and it's called GDSEASON. Then properties of the gas include diffusivity in air and in water, a cuticular resistance to uptake by lipids, and then Henry's Law constant.

Then optional user-supplied deposition velocity in -- but you can't calculate deposition outputs. You can't use the depos and keyword or it won't output that, but it will include depletion. And the User's Guide says to use that with caution, because you are actually saying I know the deposition velocity. So here are the AERMOD User's Guide references 3.2.2.12 to 14 and 3.3.3.

So deposition for particles, there are two methods. Great names, Method 1 and 2. Method 1 is default that was brought up from ISC based on Pleim's work for the Acid Deposition Oxidant Model. This one you give inputs by size bin. You give by diameter, the mass fraction, and density of each bin of sizes for the partial distribution.

Method 2 was added at the same time as the gas deposition based on the same work. It's a simplified approach when you don't really know the particle size distribution, and like gas deposition, this was previously nondefault, but we made it into an ALPHA option as we investigated it more. The inputs are much simpler. Just give a fine mass fraction from 0 to 1 and the mean particle diameter of the fine mass fraction.

So when do you use Method 1 versus 2? Method 1 you would use when you have a significant fraction, more than 10 percent of the total particulate mass has a diameter of 10 microns or larger, or you do know the particle size distribution. Method 2 would be used when you don't really know the particle size distribution and when a small fraction of the total mass is 10 microns or larger. So most of your mass would be in the fine range. And then here's the 3.3.4 of AERMOD User's Guide section that discusses these two methods.

So just to look at the differences between these two methods. There is gravitation settling velocity is one difference. For Method 1 you calculate it by each bin. Method 2 we -- you assume that the fine mode is 0 meters per second for the gravitational velocity, and the coarse mode is a 0.002 fixed number, and that's reasonable compared to Method 1 for coarse particles for the 5 to 7 micron range.

Also, Method 2 doesn't -- for the deposition velocity, doesn't have a phoretic effect, whereas Method 1 does. That was brought over from ISC. Here you can see the gravitational -- the gravitational settling velocity equation for Method 1, which is size dependent.

And then here's the deposition velocity equations. Method 1 you have all these terms, these resistance terms, and then this V_g -- the gravitation velocity here and here, and then this is this phoretic effect, pretty small, 0.0001 meters per second, you know, is not going to make much difference. You see Method 2 is -- you can see where, for the fine mass fraction, V_g, goes away because it's 0; and then for the coarse mode deposition velocity, there's that 0.002 here and here, and the resistance terms, and then the total deposition velocity for Method 2 is weighted based on the fine mass fraction of the fine and coarse. And you could see that equation at the bottom.

Some more differences are the resistance to particle deposition in the quasi-laminar sublayer enveloping the surface elements. That term is calculated differently for Method 1 and 2. Method 1 is a diameter-dependent calculation, whereas Method 2 is stability dependent. You have one term for stable and one calculation for unstable, where u* is brought in both -- u* is used in both equations.

So just an update on what we did. Like I said, Method 2, gas depositions were nondefault, but we made those ALPHA options because they really haven't been evaluated much. They are not used for regulatory applications, they are not really used, so we don't know a whole lot, so we're evaluating those methods now and comparing to other models, such as CMAQ, talking with the ORD colleagues about the deposition they're doing in CMAQ. You know, do we bring CMAQ over if it's different? You know, what can we do?

Method 1 is unchanged. You could still use it with a default keyword. It seems to be based on pretty sound science. So I think it's okay. And then always consult with the appropriate reviewing authority on deposition use.

And here are some links. The ISC User's Guide has information about Method 1. The AERMOD User's Guide, obviously. There's the AERMOD deposition algorithms document draft, pretty good. The actual deposition report from Argonne is in a ZIP file. It has multiple appendices. And then also I gave a presentation at a 2018 workshop in Boston. It has more details about Method 1 and 2, particle deposition as well as wet deposition, and it has some examples, and there is the link to that presentation. So I think that is it for deposition.

MR. BRIDGERS: Thank you, James. So lastly before lunch I get to present on -- a real quick update on the Model Clearinghouse. You heard it mentioned a couple of times this morning.

A few of you will have seen parts of this presentation we gave at Seattle earlier in the spring, but we thought it was important to update the stakeholders, since the stakeholders weren't in the room in Seattle. Along that note, we fully intend next year that the annual workshop will have a stakeholder day. We have not set the date or location.

Many will know that we hosted a Model Clearinghouse LEAN project a number of years -- well, last year in April. We gathered a collection of regional office staff, headquarters staff, and staff from state and local agencies to come together in the spirit of the new LEAN processes that are going on with the EPA. And on the onset -- and I think I had mentioned this to this -- to members of this group in the past -- there was a little confusion on my part, because I thought the Clearinghouse was a pretty good process, and that's a myopic view, because I was looking at it from my roles and responsibilities and those immediately around me, and wasn't looking at it from a holistic perspective, and this is where I'm going to change things that are on the slide to the alternative model process -- the alternative model approval process.

So my focus was the operation of Clearinghouse, receiving information, processing it, and doing my bid per Section 3.2 of Appendix W. But what needed to be leaned was the whole process, from the point that an applicant has something that's not working and they need to do something different to the end when that applicant gets the approval from the regional office to use an alternative model.

And so the goal was to streamline that process. There were -- you know, historically, we got some -- and I am gonna put air quotes around Clearinghouse actions. Again, the alternative models are approved by the regional office. The Clearinghouse is just a cog in the process. But there were a number from years past that had taken multiple years to go through the full process, and largely that's unacceptable for the applicant, and it looks bad for the agency when processes take that long.

So the leaning process is one that I think that there are certain companies 3M probably sponsors, because you are gonna use a lot of

Post-it Notes if you are not familiar with the LEAN process, right? You start out -- and it's a valuable exercise, even if you are not leaning something, is to go through and try to figure out what is your current state. How do you do business? And not just have you define it. Have your colleagues and peers that are interacting with you all try to define this current state. And it's -- you know, when you think of the forming and the storming processes when you are doing business management, this is really a storming process, because everybody has a different perspective, and you are going to peel and stick, and peel and stick those Post-it Notes. And even today, I imagine, if I could assemble the same group, we could go upstairs to the room that we did this, I guarantee if we tried to remap the current state that we were operating under, we would come up with something entirely different yet again, because those perspectives change.

But nonetheless, we stormed out the current state, and trying to define that, you also get a lot of parking lot -- if you understand the nomenclature, you get a lot of parking lot issues, because that's where you disagree. And that's where you get the opportunity to start looking at, okay, if we all disagree on all these parts, and there is all these things over here in the parking lot that we all have to get accomplished, what is our -- we call it the unicorn, but it's called the future state. What do we want in the future? And so we map those out. And it was a great process. And again, this was beginning to end, from the point the applicant has a twinkle in their eye that they are going to do something that's alternative, all the way to the end where the State is issuing that permit, we want to see the whole thing and its -- all its warts.

And so when we came out of this process -- and it was just a couple of days -- you see this is the 24th to the 27th of April -- we had sort of four main areas that we thought that we needed to implement moving forward, and they have morphed a bit as we've moved forward. And I'm going to do them a little bit -- I didn't put them on the screen here in order, but really one of the first things is we need to emphasize the ALPHA and BETA options in AERMOD. And we were going to use the communication pathway of the AERMOD Development Update Plan. That's still not readily available.

You've seen the white papers. Ultimately, in the next short bit we will have that plan out, and that's where the white papers will also coexist, but as has been seen in the 19191 release of AERMOD and has been talked about over the last day and a half, is that the ALPHAs and BETAs are here. We are really pushing that now.

And Chris did an excellent job with his presentation yesterday talking about the red, the yellow, and the green, and the stop, the caution, and the go. So please refer back to that, but that is something that is sort of central now to our moving forward, and it plays into how this leaned Model Clearinghouse Operational Plan is going to work. Those BETA options, those ALPHA options -- primarily the BETAs, though -- give us what we are calling off-ramps, and I will get to that in a minute.

So along with that new emphasis, we also wanted to talk about the -- you know, process of developing more training materials and infrastructure to better facilitate, one, educating everybody in the process, but also tracking the process. And we really didn't have a good mechanism, other than my email and kludging together emails from the region to fully track everything. And management had a desire, and we also had the desire, to be able to more efficiently track the process.

And in all of this -- and this is why this was out of order, because once we put all these pieces in place, then we could talk about revising the Model Clearinghouse Operational Plan, which up to now has been focused on just one part of the whole process to be more expansive and inclusive of the alternate model approval process. And then we also, in this updating the Operational Plan, the thoughts of establishing this through joint coordination so we could explore other possible solutions, because what we find when we talk early on the front end, there is often solutions that don't require you to go through the entire process to even get an alternative model approval, and that's another off-ramp.

So there is a report that we gave last year at the workshop, and also represented in Seattle if anybody is interested, at the bottom of the screen.

So putting our money where our mouth is, Chet Wayland, who was in here briefly earlier when

Anne was here, was posed with the situation that this whole leaning process is something that Henry Darwin brought to the agency over the last couple of years. Well, Henry wanted to make sure that senior management was taking it to heart, so he is requiring all of the SES senior management to adopt as a part of their performance plan, an A3 project. And Chet comes knocking on the door and says, "George, I think -- I really believe in what you guys are doing with the Model Clearinghouse leaning. I want to make that part of my A3 project." Well, that's great. I loved it. But at the same time, our success hinges -- or Chet's performance hinges on our success, and that's also daunting. So we tied it, and over the last probably six months, we have been working very closely with Chet and going through a process of implementing a tracking system.

If anybody is not familiar with the A3 process, if you are familiar with 6 SIGMA, there are other management techniques out there, but the A3 comes from the perspective of using A3 paper size, and you plot everything out on A3 paper, and that's the background on it. But it's very much about visual management. And that's something, back to the tracking, we didn't have. We had a lot of, you know, technical kludged together details, we had MCHISRS, but, you know, who goes and looks at MCHISRS.

Anyway, we are sitting here -- what's today, the 3rd of October -- so I am two days past helping Chet meet his deadline of the A3 project. Fortunately, Henry gave him a one-month extension. Actually, gave all managers a one-month extension. But I'm happy to report that we are there with what we are trying to do. And what we did -- and Chet -- this is pretty much the first perspective Chet wanted to talk about, the tracking and the coordination. Phase 2 I won't talk about today, but there is actually -- this is going to be an ongoing thing. Chet's building this over a number of years. So this is a philosophical thing on Chet's side, and this is proof positive that we are going to continue to move this process forward.

But we were really trying to focus in on the tracking. And at the time, at our disposal, we have this sharing process, this SharePoint Microsoft web-based collaboration platform. So that's where we started, because that's what we had. SharePoint is -- you know, a lot of websites -- honestly, it's sort of a front end for databases to sit behind it. I can sit here and say it's clunky, but I'm on the record, and I'm already on the record for talking about, what, beer, Monty Python, Boy Scouts, and I think my son wanted me to also put in something about Pokémon, so. So all that's on the record, but I'm not going to sit here and call out SharePoint as being something that's not always the most efficient and the best, but it has its warts. We adopted to it. We brought it in, we started creating SharePoint sites for the Clearinghouse, we started creating subsites for the -- as they were popping up, the alternative model processes that were starting. And Chet's perspective was we had to accomplish two before September 30th. So that was dependent on you guys. We needed you guys to bring us problems, and we did have a few.

Somewhere along the way, over the last couple of months, though, Chet put me in contact with somebody up in D.C., and the agency is implementing Microsoft Teams. And Microsoft Teams, there are several software packages out there, a common one in the external community is Slack. There are a few others. They are collaboration platforms. Honestly, it's a front end for SharePoint, but the beauty of it is it takes a lot of the clunkiness out of it. It doesn't have as many bells and whistles, but sometimes easier is better. But it also offers us the opportunity, back on the visual management perspective, to have a storyboard where I could track individual processes with the -- whose responsibility it is, the deadline of what's due, if times are missed. And that's the kind of thing that Chet can look at. One screen, he can see where all these projects are. Oh, they are these projects, they are in this stage, this stage, or this stage. Here's who is responsible for it, here's the due date. And if there are other questions, and he needs to drill down -- and since this is on the record, Chet, if you get to where you need to drill down, contact one of us. Don't drill down in Microsoft Teams. But it is something that all the regional offices will have access to, all the staff here in headquarters will have access to, and the management. Right now, we don't anticipate extending much of the team's environment out to the external community, because we do have CBI and other types of things that we need to be weary of.

It's an internal process.

So coming out of the LEAN process, we talked about the mapping of the future and the current process. We started with 30ish steps, and that was up to debate. We ended up with 23. I know some people say, well, that's not a big time savings. It will, actually, because the big part of it was further defining the roles and responsibilities in a very clear and concise way. We were thinking where we had some processes that we're taking up to two years, we are probably down to four to six months on the ones that can take the BETA option off-ramps to no more than a year for a process that's coming in that doesn't fit in a BETA world where you are kind of starting from scratch. I'm not putting those -- it's not etched in stone. Some will take longer, some will be shorter.

Weaknesses are all identified, and one of those -- and this goes to the training -- you know, a lot of people are just not familiar with the process. They come with misconceptions. Even people within the agency that worked in the agency for a number of years don't fully understand the process. That's why training is something we are going to be emphasizing. The communications were a problem. And then there were just things that were unnecessary or just superfluous that didn't need to be part of the process.

So what the teams environment, what we are trying to do with the -- and everybody's heard this big-call mentality, as we head toward more collaboration, is transparency. Transparency, focusing on efficiency, going through the process with the training so that everybody's clear on what we are doing, and we think that's going to get us most of the way there.

All of this we didn't have. I talked about the Clearinghouse Operational Plan. It really talked internally of how we did a few things for the Clearinghouse cog, but the rest of the process on how applicants talk to the states, and how the states talk to the region, how the region talks to the Clearinghouse, that wasn't well defined. On the back end, once we give the Clearinghouse concurrence, how the regions are formalizing and finalizing approval, and then ultimately going to the state or the reviewing authority, and for the final approval of the applicant, it wasn't well defined.

So what do we need? SOPs. Yeah, that's

bureaucratic, but in this environment, this is exactly what we needed. So establishing uniform procedures all the way through the process, the roles and responsibilities are critical. And this is where we get the efficiency from. I won't read all the data points here, you know, because this is typical SOP nomenclature, but you know, focusing on procedures, and how we are going to record things, and the database. So this is all something that we have mapped out.

It's busy. The slide that I have in front of you now I have to give credit to Rebecca Matichuk in the back of the room from Region 8. But this is the 23 steps. These may end up being 24, they may end up being 22 when everything is finally said. This is the basic world. And we ended up with five, sort of, basic hoppers.

You've got the preliminary area where this is -- if you want to call it -- if you are going to do the four stages of management, this is the forming place where you've got an issue, we don't quite know what's going on with that issue, there is a bunch of discussions that are going on between the applicant and with the permit-reviewing authority, and the region is just learning about it.

Once the thing is a thing -- and see the time scale here is literally a month. There should be kind of a quick turnaround. We've got an issue, we want to elevate it up. Well then the drafting step, that may be misnamed a little bit, but this is -- we are starting to get to the storming area, because this is where the big call happens. And this is where we are trying to really push the applicants, the state, or try with whatever the reviewing authority is, the regional office and headquarters, we are all talking, because we are storming about ideas. We are going through the process of figuring out, how can we tackle this thing.

And there may be off-ramps here. We may come out of a call and, "Hey, guys, have you considered this? This is a way you could do it." It's a source characterization issue, it's meteorology, what have you. It's not a formulation thing. You are done. No alternative approval is needed. Or have you considered this? And that puts us back in this other hopper, because we may throw some ideas out and change the course of the way the applicant is looking at a project. That sort of resets the clock, because they are storming and then back to forming again.

But once a thing is a thing, we all agree we are moving forward, there is really not an initial off-ramp, then we move over into -- so forming, storming, norming. So now we know we've got a thing, and so this is where we are actually starting the bureaucratic process of writing reports, writing requests for approval, things are coming to the Clearinghouse, the justifications are coming together. And then these final steps, the final two, are the performing part, because that's where all the approvals happen and things move downstream.

But all of that mapping out had never been done. We are in the process of finishing this up, and once we -- once the internal team of the LEAN participants, once we are happy with where we are, this is going to go out for review. We are going to accept the informal comment on this, and then it will be integrated into the Model Clearinghouse Operational Plan. Along with that, an ops plan, we are going to have a checklist. Again, the roles and responsibilities, the procedures people will follow. And we are hoping to have a series of templates, because the more templates that we can build, just sort of faster efficiency, things that are built in the process so the states will know exactly what blanks to fill in, the regions will understand what blanks to fill in. So that will expedite the process.

And then lastly, I wanted to really quickly, not hold lunch up too much, but just talk about the training. We kind of see the training three phase. I don't know why you always have to do things in three, but we are doing it in three. We kind of see the internal training with the regions. We've got a lot of turnover in staff. I have heard the number of at least 10 percent turnover in EPA staff now is what we're averaging. A lot of people -- I'm not stopping. I'm the MC. I have time. But the regional offices, we have got a lot of staff turnover, and we've got a lot of new people coming in. So anybody -- everybody within the regional offices on the level playing field, all of us with the same knowledge base, and then having that training component in place for when new people come in, that's critical.

Additionally, because we are talking

about the whole process from beginning to end, talk about turnover in EPA, I think about the turnover in all these reviewing authorities. I mean, that is -- that is even more so constant, because we are talking about a large number of agencies across the country. And so through the state organizations, through our annual workshop, just through some of the training opportunities that we have in the agency, we want to make sure there is a good training package out there for the reviewing authorities. And then finally, we would like to host some training for the applicants as well. Because again, if everybody understands the process or remains a participant in that process, then we are just going to make it more efficient.

So I have some slides here that will just be in the record. I don't want to belabor your lunch. It actually talks about different components within each of the training modules that we are trying to put together. So I am going to step through those.

And last thing I wanted to do was thank -- because there are several -- I want you to stand up. So, Rebecca, are you in the room? Please be in the room. You can raise your hand.

Rebecca is back there. I think I have seen John Glass. Dave Healy wanted to be there. Ashley's in the back. Annamaria is somewhere right up here in the front. Who else am I missing? Oh, Chris. Chris, Chris. This is our all-star team. And I talked about many hands making light work. I will tell you, just like I gave kudos to Rebecca a little bit earlier, I'm tremendously busy, and I know all of you are tremendously busy, and this is one of those opportunities -- oh, Leiran is here too. Sorry to be flighty. Leiran is in the back. You are not forgotten, Region 1. But at times, I'm extremely busy, sometimes those guys are, and they've all stepped up, and they've been tremendous supporters of this process, and I greatly appreciate it, and Chet greatly appreciates it as he gets his checkmark this year. So thank you to everybody.

And with that, my slides are done, and also -- three minutes ahead of schedule -- we will break for lunch. And so we are going to take an hour and 15 like yesterday. So I ask for everybody to be back in the room at 1:00, and the focus is going to shift just a little bit. We are going to have a couple more EPA presentations, and then we'll get into the public comment part. So I hereby suspend the public hearing until 1:00.

(At this time, a recess was taken from 11:42 a.m. to 1:00 p.m.)

MR. BRIDGERS: Okay. Well, it looks like it's 1:00, so I will reconvene the hearing. We have a few more presentations from EPA staff, and then we will transition into public comment portion of the conference. So thank you for finding your way back from lunch.

The next three presentations are all kludged together between now and 1:00 -- excuse me, between now and 2:00, focused on assessing impacts from ozone and $PM_{2.5}$.

So without further ado, I am going to call to the podium Kirk Baker with the Air Quality Monitoring Group.

MR. BAKER: Thank you, George. I'm here to transition us into the last afternoon. Also going to be helping transition the EPA staff into a less formal attire. So sorry I didn't wear a tie today. I'll talk a little bit about doing single-source assessments for secondary pollutants.

As part of the 2016 revisions to the Guideline on Air Quality Models, our Appendix W, we put forth this two-tier type of demonstration approach for doing single-source impacts for ozone secondary $PM_{2.5}$ where the first tier would be trying to take advantage of relevant existing technical information that would relate precursor emissions to downwind secondary impacts. The second tier would be involving more case-specific situations where a model would need to be run for a specific situation.

One thing we want to point out with this new section that we put into the revision to the Guideline, Section 5, which focuses on secondary impacts for single sources, is that that section does not provide any type of requirement for chemical transport modeling, but we do believe that, if someone were going to do that type of demonstration and do some modeling for a particular permit application, that photochemical grid models would be the most appropriate tool to use for that purpose, simply because these tools provide a spatially and temporally dynamic and realistic chemical and physical environment for the plume to exist in. A lot of the important secondary formation is going to happen on the edges of the plumes when these plumes start to interact with the surrounding environment. So it's important that the surrounding environment is realistic.

Lagrangian models by SCICHEM, when they are applied with a realistic three-dimensional field of chemical species, could also be used to support single-source ozone or secondary $PM_{2.5}$ assessments.

So modeled emission rates for precursors, or MERPs, can be viewed as a type of Tier 1 demonstration where they are just relating precursor emissions to secondary downwind impacts. And for PSD, we would be thinking about something like MERPs for each pollutant to the secondary -- for each precursor to secondary pollutant. So there would be a MERP for VOC to ozone, NO_x to ozone. And similarly for $PM_{2.5}$, SO_2 to $PM_{2.5}$, NO_x to $PM_{2.5}$.

We provided a guidance document for Tier 1 demonstrations, and got the link and the title for that as part of this bullet. So we've recently finalized that and made that available on SCRAM in 20- -- April 2019. In addition to the Guidance document being published online, we've got a separate Excel spreadsheet available with all the hypothetical single-source information that we generated as part of developing that Guidance document. So that's there as well, and it makes it a lot easier to sort through and find information, as opposed to the original draft version of Guidance, where we had it all listed out in appendices.

Some of the notable changes from the draft version of that guidance document is that we added a lot of additional hypothetical sources to the final revision. We got a lot of comments that there were parts of the country that didn't have any information. So we tried to start filling in some of those gaps. And we also provided more detail on how to use existing modeling for different types of NAAQS demonstrations and make that more clear.

This is a schematic from the Guidance document to kind of -- it kind of helps provide this road map. So when you are doing a PSD demonstration, first you would do a SIL type of demonstration, then it would be project impacts are greater than the SIL, move on to a cumulative analysis, and separately there would be a PSD Class 1 increment type of analysis. And we didn't really speak much to that in the draft version. So

I think we have got a lot more complete information this time around as to how people might want to go about using existing credible information for these different types of demonstrations.

The Tier 1 guidance document provides impacts estimated with a photochemical grid model for a variety of different hypothetical sources. These hypothetical single sources that we modeled were not intended to represent any specific sources or types of industry, but we just wanted to kind of provide some context about what types of secondary impacts might you see from different types of precursors and amounts in different parts of the country, just because we didn't have a lot of information about how much -- 500 tons of NO_x, how much $PM_{2.5}$ might that form in the atmosphere. And how might that change in different parts of the country. So we wanted to be able to provide people some idea about what types of impacts might be reasonable if they saw some new modeling come in as part of the PSD permit applications.

And in addition, in some situations, the information that we develop as part of this process in making the guidance document could be used to support an actual Tier 1 demonstration, and we have been seeing some of that.

On the right, I have got a map of the hypothetical sources that we modeled and are part of the final version of the guidance document. Those are all colored in blue. And we've got a new effort underway to add even more sources, and those are shown in red. So we are going to be adding even more sources to the database. We are not gonna be redoing the Guidance document and republishing that, but we do envision the hypothetical source impact database being much more fluid and periodically being updated as newer and maybe better information becomes available that people might want to be able to use.

This is a plot of MERPs or $PM_{2.5}$, daily $PM_{2.5}$ on the left columns, annual in the center, and ozone on the right. Basically just illustrating that there is -- there is a lot of differences regionally, in terms of how much secondary plumes get formed from different precursors. So it is important to have a good, robust database to draw upon for different types of -- for future demonstrations.

We got a lot of comments from people in the draft guidance about why some sources, even when they are very close to each other, we get very different responses for secondary $PM_{2.5}$, and so in the revised version of the Guidance document we get into that in a little bit more detail.

An example of how that might come to be. So what I'm showing here are two hypothetical sources we modeled in western North Dakota. They are pretty close together, but, you know, when we did these hypothetical sources, we had kind of a generic algorithm that was just putting them somewhat near existing industrial point sources, and we didn't think a whole lot about where they were actually at and look at every one of them. And in this situation, one of the hypothetical sources is located right next to an enormous confined animal operation. So there is a continuous huge emissions source of ammonia there.

So depending on the meteorology, these two sources, even though they are close to each other, one is right next to a confined animal operation with a lot of fresh available ammonia, and they both have a relatively close proximity to the Butkin Oil Shell with a lot of fresh NO_x emissions. So depending on how the winds are blowing, you could get pretty different impacts downwind from these two sources, even though they would be -- they are hypothetically emitting the same amount of emissions into the -- a pretty similar general region.

Tier 2 demonstrations. Just want to point out that a Tier 1 demonstration is not a requirement before doing a Tier 2 demonstration. We don't anticipate a lot of actual case-specific Tier 2 demonstrations. So far we have seen quite a few Tier 1's and we have not seen any Tier 2. But if someone was in a situation where a Tier 2 demonstration would be of interest to somebody, they wanted to do that, we do have a Guidance document available, and I have got that listed out here, that talks about how you would set up a model to do that, configure it, apply it, and look at the results in a way that would be consistent for this type of purpose. And I also want to point out that, even within this second tier, we tried to afford a lot of flexibility in the guidance document.

So if you -- depending on the complexity of the model application, you can be -- you have some room to work with, in terms of which model predictions are being compared against a SIL and

NAAQS. So if you do a very complex application, you might not need to use the most conservative estimate coming out of the model, and do something a little less conservative. So we try to afford flexibility even within this particular tier.

This is a list of all the different applicable guidance documents. The red ones are the ones that are published, and the one on the bottom is in preparation. I think George is going to talk more about that next.

We have prepared a memorandum that shows that CAMx and CMAQ photochemical models are appropriate for the purposes of estimating ozone and secondary $PM_{2.5}$ for permit-related demonstrations.

The Guideline outlines that -- the elements that are needed to provide an alternative model demonstration in situations where no preferred model exists, which would be the situation here for secondary impacts. So we wanted to go ahead and just develop a memorandum for these photochemical models so that people could point to them as part of -- for purpose component of the alternative model demonstration. This doesn't replace the need to provide project-specific evaluations that focus on how well the model is performing around the project source and your key receptor locations, but it does provide that fit for purpose component so that everyone doesn't have to do that separately.

In addition, if people do get in a situation where they want to do a case-specific type of demonstration, we provided some tools or developed some tools that could hopefully be a starting point to help people take an existing modeling platform that maybe you get from a state as part of an attainment demonstration or an MJO and then add in your hypothetical -- or your new source, your modified source. So we've got some tools to try to make that a little bit easier and available in GitHub.

I think there is a lot of platforms that are available out there to do Tier 2 demonstrations on, or even as a platform to do your own Tier 1 type of demonstration where you could make your own MERPs on top of a database that might have already been generated for another type of purpose like regional haze or ozone, $PM_{2.5}$ SIP demonstrations.

And this is just a list of some of the multi-jurisdictional organizations that have familiarity with photochemical grid modeling, and if they don't have modeling themselves, they could probably point you to someone in the region or area that would have something that might be relevant or a good starting point for use.

So we have got a few different talks during this particular hour. So I kind of wanted to just provide some background on what we are doing for the guidance for the Tier 1 and Tier 2, and then we have got two people following me that are going to get into more case-specific samples. Because I think, at this point in the process, that's really the more interesting part of this, and we want to focus more of the time on that particular aspect of this.

So I'm gonna turn it over to Leiran next to talk about one of the samples he has. I don't quite see what's going on here with the laptop, so I will let them figure out how to get the presentation.

MR. BITON: All right. Thanks, Kirk. So I'm going to be going through an example, like Kirk mentioned, for applying this type of approach for a single source on -- for $PM_{2.5}$ only, for a remote Class 1 area. So looking at the Class 1 area SILs -- and throughout this example, I will be -- I'm referring to an example source. That's this orange blob in the corner. I will represent it on the map. The emissions profile of this source is 100 tons per year of $PM_{2.5}$ and 3,000 tons per year of NO_x. This is a source located on the outer continental shelf. I will just note that that level of emissions represents one year of emissions, and I'm not gonna get into the details of this, but OCS permitting regulations require treatment of construction and installation emissions, as well as transportation emissions, in the permitting process. So that's why this type of source profile exists in the modeling here for an OCS source. And apologies to Joe Sabato in the audience here for any similarities this source may have to a project that he may have worked on. I will also just note that this is 300 km from the nearest Class 1 area. And Section 4.2 of Appendix W outlines the types of assessments that you can have for addressing single-source impacts on remote Class 1 areas, so long-range transport.

The first level of assessment is assessing impacts at the 50 km distance using the tools that we have and are all familiar with. And the second-level assessment is addressing those impacts in -- typically the Guideline says you would use the Lagrangian model. In this case, we are using information from the illustrative CMAQ and CAMx modeling from the Guidance, April 2019 Guidance, to inform that second-level assessment. So I'll just focus first on secondary impacts.

For both the first-level and second-level assessment we are using the information from the MERPs modeling, and we are just gonna look at one hypothetical source from the MERPs modeling in particular, and that's this green star, which throughout the rest of the presentation I will represent as the green star on the map as well. That's a 500-tons-per-year NO_x source.

So the concentration gradient that you see here on this map represents the impacts from that hypothetical source on the region, and you can see that there is, you know, an interaction between, obviously, the terrain and other meteorological features, other emitting sources that result in, you know, a unique distribution of concentrations around that hypothetical source. And you wouldn't necessarily expect, even if that hypothetical source is representative of your sample source, that distribution to be exactly the same around your example source. So that's why we look at impacts as a function of distance overall rather than, you know, looking at the certain direction that you would have emissions going to around from the example source to the area of interest, which here on this map is -- the Class 1 area is that little yellow blob in southeastern Vermont.

So returning back to this impacts by distance, this is -- and Mike will go into this in greater detail -- this is the approach that we use to identify the impacts at various distance measures. So at 50 km you can see there is kind of a dip in the hypothetical source's impact profile, but that actually picks up due to, you know, whatever factors in the modeling led to higher concentrations at a 90 km distance. So we select that value from 90 km to be appropriately representative of the impacts at 50. So that value is 0.032 micrograms per cubic meter. Our example source is 3,000 tons per year of NO_x compared to the 500 tons per year of NO_x. So we take the simple ratios of those values, 3,500 -- that's 6 for those counting -- multiply that by 0.032 to get the secondary impact value of 0.192. That is representative of the 50 km impacts of our example source.

For primary source, it's easy. You run OCD. You are out on -- over water. It's appropriate to run that model. Everyone knows you can just plug the numbers in. Out pops your, in this case, 0.2 micrograms per cubic meter, a number I made up for this example. No, in all seriousness, OCD is a -- can be, obviously, a major modeling effort, and that is the resulting impact. To get the total impact, you then sum primary and secondary to get a value of 0.392 micrograms per cubic meter, that exceeds the Class 1 area SIL for $PM_{2.5}$, that value, 0.27.

So -- now that would require a second-level assessment. So how do we do that? We are now looking at the distance representative of the distance from the sample source to the Class 1 area. So that's 300 km, as I said before. So looking at our impacts by distance little profile here, again, there is a little dip at 300, so we are going to look just beyond it to 310 km and find an impact level of 0.01 micrograms per cubic meter. We'll apply the same linear scaling factor of 3,000 over 500, multiply by 6 to get secondary impact of 0.06. Okay, well, hopefully everyone's with me so far, but how do we get primary impacts? Now, as I said before, typically one would do -- in the Guideline it states typically a Lagrangian analysis. That is an option. However, I encourage everyone to look at the table provided in the April 2019 Guidance, Table 4-2, which provides, certainly for $PM_{2.5}$ -- I don't know about other pollutants, because I didn't review it that carefully -- an array of different emission rates, distances from areas of interest, 100, 200, and 300 km distances for tall stack and surface releases.

So, in this case, we have 100 ton per year -- again, this is the direct $PM_{2.5}$ impacts -- 100-ton-per-year source, releasing near the surface, so target in our table a value of 0.023. There is no scaling necessary, because conveniently our emission rate matches -- for the source matches the value presented in the table, but otherwise you could do some scaling here to get that number. And then you add these values 0.02 -- 0.0123 plus 0.06 gets you 0.0723, and that would pass the significance screening approach of 0.027 [sic] for the source.

Now, I will note, just before I hand the podium over to Mike, that there was no OCD modeling for this second-level assessment. One does not necessarily need to go through a first-tier screening assessment -- or first-level assessment. If you have the information you need to go straight directly into a second-level assessment, in consultation with the reviewing authority in your regional office, I don't see a reason why that need not be -- you know, that wouldn't be an option. So with that, I will hand it over to Mike.

MR. MOELLER: Great. Thank you. Hi, everybody. My name is Mike Moeller. I'm currently in the modeler Region 4. And I am going to go over a presentation that, unfortunately, if you attended the RSL Modeler's Conference in Seattle, this is going to be very, very, very similar. And also this is actually on a MERP webinar that we had done with Kirk and Ron as well, so for those of you, the slides will be nearly identical. So for that, I apologize, but what will be unique about this for those who have seen it is we are going to do a demo in the end of a new application that I was working with Kirk Baker on that I think will be possibly a very helpful tool for showing demonstrations moving forward. So, again, I will cover that in the end.

So here I'm going to go through a Tier 1 $PM_{2.5}$ MERP demonstration through an example, a step-by-step how to apply it, and particularly for a Class 2 analysis. So Leiran really covered a good example for Class 1 and then sort of a far afield. Here I am going to look for just pretty much Class 2 only.

So again, this is for pretty much the prescriptive process that we, in Region 4, especially, for our applicants, we suggest they go through when using -- again, showing demonstration of a hypothetical MERPs. And that is first, you know, when addressing secondary $PM_{2.5}$ to do this.

So first start off just looking at the lowest, mostly conservative illustrative MERP that is the current MERPs guidance, and that's what you see in Table 4-1. Those are the illustrative MERPs which are listed out by climate zone, and then you can see in here in 3-4 that is the climate zone breakdown that is currently listed for describing the guidance.

And so here what you do is, you know, wherever your source is located, you know, and whatever climate zone that is, start there, and look at what the illustrative MERP is. So, you know, for example, in the Southeast, if it's in Georgia, you pick the Southeast climate zone and then look at the corresponding -- you know, in this case, $PM_{2.5}$ for the illustrative MERP. And we use that and see when addressing, you know, calculating the secondary component based on NO_x SO_2 emissions that that, in conjunction with your primary, to see how -- where that gets you. And really, at that point, is to see is that too conservative, or would that -- you know, if it is conservative anyway, if that is enough to satisfy your below the SIL, because in that case, it's a very easy demonstration to do. It's very easy to document, and then you are good to go and you no longer need to move on. So that's why we recommend just starting there on step 1. But for many, that may or may not work. There are certainly instances where some of those are very conservative and don't -- are not representative or apply to all, you know, projects in a rather larger region.

So that's where in that case we would move on to step 2. And step 2 would be pretty much to just sort of isolate and look at the closest nearby hypothetical sources to your project source.

So here, you know, you can sort of think of it as -- so you have your project source, and you would just screen the closest two or three. You know, just pick an imaginary circle and just sort of expand it and see which ones, you know, are captured by that. And so here, again, you are trying to just really hone in on more of the representative sources that are nearby the project or the applicant source.

So here, once you've narrowed those down to two or three, what you then would do is to just, of those two or three, pick the most conservative. So instead of doing any further analysis, just grab those two or three. Look back at the -- in this case, you would actually go in and look at the Excel spreadsheet that Kirk had mentioned is on SCRAM, and you look up specifically those sources, you know, what are their MERPs values, and then you would calculate it. You know, you calculate your secondary component as you have done in step 1. Add it to your primary, and see where that gets you. At this point, you know, again, you can see it shows that, you know, above or below the SIL, and then based on that is really whether or not you go to step 3.

And so, at this point, if you had done this analysis and found that you were still above -- you were actually above the SIL, but you felt that the nearest -- you know, the most conservative nearby one was still too conservative, you felt that it wasn't representative, is where you would go to this step 3. And that's where, again, you look at those same nearby sources, but you feel that one, maybe it's a little further away, or maybe something was conservative, but you feel that it's most representative. And this is where now you would go ahead and, you know, pick that source, that MERP source that you, again think is most representative and provide some information and some justification to actually use that, you know, and really hear what I'm trying to outline as information that can be used. It's some of the things we look for in Region 4 in our application to, again, provide a justification as to why you are selecting a nearby source, but it's not the most conservative. And so some of the things here -- again, it's not an exhaustive list nor is it necessarily ranked in order of importance, but some of the big ones that jump out are at least terrain. You know, the terrain features; is there anything unique with the project source that is more representative than another hypothetical source? The rural or urban nature between the two, that's a big one, as well as the nearby sources of pollution. You look at the NEI and do even a basic county-level emission breakdown of the, say, NO_x and SO_2 or $PM_{2.5}$ and see the distribution between the sources and see where that compares. And then there is other things too, like climatological parameters as well as ambient concentrations of other background pollutants where available.

So it's really just creating an argument to say, hey, look, this is not the most conservative year by MERP, but we feel it is most representative, and this is why, A, B, and C. We had several applicants in Region 4 do that successfully where they haven't chosen the most conservative, but there was a good argument, there was a more representative one, and they were able to use that.

And then, obviously, if neither of the steps work, then you just need to take -- account for the secondary and then move on to a full cumulative analysis, but also send your information forward. So this is just, again, step-by-step process of how we view the MERPs Tier 1 demonstrations.

And what I will do next is just go over sort of a brief really simplified example of how to use those steps. And again, I will just sort of -- some calculations on how they are done and things like that and how it looks like. So in this case we are just gonna say it's a fictional project source. We are going to say it's in central Florida. To make it easy, I say it was 100 tons per year of NO_x and SO_2, and it modeled -- you know, we assumed it modeled the primary $PM_{2.5}$ at 1 microgram. And again, we are comparing against the 24-hour Class 2 SILs. You can do it for annual as well, but here we are just going to do a class -- a 24-hour Class 2 SIL analysis.

So here I was just reiterating there is several ways to really assess or to calculate using the MERPs. You can use it pretty much calculated in the form of a percentage of the SIL. If you want to calculate, you know, convert the primary to the percentage of the SIL, and then as well as the secondary based off the MERPs, and again, you calculate a percentage, add it up, and if it's below the SIL is how you know if you need to go on to do cumulative or not. Or you could convert it into ug/m^3 or ppb if are you doing ozone or vice versa. So it's just a way to show you, you see some algebra and just whatever form is easiest for you to understand and do. It's just that you can play with it, and there is not one, you know, specific way of representing it.

So here I'm going to go over that step 1. Like I said, you would use the lowest -- the illustrative MERP from the Southeast climate zone, since we are looking at Florida. So you would pull that table that I had. And so what we are asking here is using that conservative illustrative MERP for the climate zone as the primary and secondary grid in the SIL. And so that's where I am going through here. It's just a step by step. I know there is a lot of things on there to be distracted by, but really, again, I just extracted, you'll see in the top right, that's the illustrative MERP for the region. You take that, and you are just going to divide your emissions total -- you know, your project emissions, the 100 tons divided by the MERPs value to grab from there. And here is representative, it's either a percentage, 50 percent, or as a -- if you multiply by the SIL you'll get an actual ug/m^3. And at that point, you know, at the bottom here, we are just then summing that with the primary component. And you can see it's above the SIL. So using the most conservative -- conservative MERP from the Southeast region, you can see you are above. So if you were to stop here, it would indicate you do a cumulative analysis. But in this case, for this source, they will leave going to step 2 and want to look at a more refined, you know, let's say the closest nearby sources.

So here, again, as you are saying, okay, no, step 1 didn't work, so we are going on to step 2. Like I said, we are going to look at the lowest conservative MERP from nearby sources -- hypothetical sources.

So here now doing that -- and I have already done an extraction. Like I said, you put a sort of imaginary circle, you know, kind of around your project source so you have it in central Florida, and here it said, okay, it was the three sources there, which are in Bay County, Tallapoosa, and Autauga from Alabama. And so there you do what I have highlighted. I pulled this out from the Excel on the far right. This is from the MERPs spreadsheet that's on SCRAM. Pulled out, you know, what is the most conservative MERP for those three, and it happens to be the Bay County, Florida. And so as you can see, it's in the panhandle there. And if you use that MERP, what you'll find, unfortunately, is that it's actually the same exact values that we'll go over real quick, that you will see it's the same exact numbers. And that is actually due to the fact that this source is actually setting the illustrative MERP for the southeast region.

So that happens to be -- unfortunately, for this project case, that happens to be the most conservative for the region, so step 2 does not help. But that does leave the final step, and that is where, in this case -- again, here showing that didn't work. Step 3 is to look at, okay, well, is one of those other three that are nearby -- is one more representative? Is it clearly, you know, that Bay County is not representative, another one is, and see what will work with that.

And so here -- you know, I'm gonna kind of skip -- this is information that could be used, and I had mentioned it earlier, and I didn't provide a write-up or anything like that that everybody could see, but I think even just doing a quick review of this, there is actually almost a logical way of seeing how the Bay County one wouldn't necessarily be representative. And that's just due to the fact that, if you see our project source, it's in central Florida, but Bay County actually happens to be right on the coast. So right off the bat you have a good argument saying you have this hypothetical source that's right on the panhandle and coast. There is likely some sort of, you know, ocean/land interface going on. You know, the terrain is obviously just likely very different.

And so that -- I don't know if that's the reason why it's setting, you know, the MERP value so low, but you have a good argument right off the -- again, right off the bat that that is -- Bay County likely isn't the most representative for this particular case. And so that's why I'm just saying here, for this instance, without going any deeper than that, you know, very broad terrain overview, that we are going to say that Tallapoosa was -- and bear with me -- and we will agree that it is. And I can confirm that it's in a similar rural area and there's not a lot of emissions or

industry or
rural -- urban is very similar.

But if you redo that calculation now with Tallapoosa, and assuming you did your justification, you redo that analysis, you can see now, when you add your secondary plus your primary, that you are actually below the Class 2 SIL. So in this case, you would actually satisfy, you know, the requirement, and addressing that without needing to do a cumulative analysis.

So here, by going through this and providing the justification, you know, in Region 4, especially, which, again, we have seen this, you know, we would -- as long as we agree with your write-up and justification for it, I do agree with that, and agree that is satisfied addressing the secondary component of $PM_{2.5}$. And, again, that's just showing you reached that and you are good to go.

And then, lastly, this is just sort of a quick, just, diagram to illustrate the exact process I went through. And this is just a summary for everybody. And I think it's -- everyone's well aware of this now, but, you know, really, it's just to highlight the fact that you really -- in the beginning, you just got to make sure you address secondary component. And really, you address it in all stages. You know, for example, you got to address it during the SIL analysis, and that's Class 2 and Class 1. I know we just covered Class 2, but here that is what I am asking. And so is it -- is it less than the SIL? And then you would have satisfied that, you know, in this case, the daily $PM_{2.5}$ analysis. But if you are above, then you do have to do cumulative. And when you do that cumulative, it's important to make sure you incorporate secondary and all cumulative analysis. So if it were increment and a NAAQS, whatever your model primary is and in your background for the NAAQS, you also need to address the secondary component as well, using the similar steps we just went through. So it doesn't go away, even if you do or do not. I'm sure you will go above the SIL.

So at that point, I think that's -- okay. So that's all the -- yeah. That's the previous presentation I think you may have seen, but that covers sort of a quick example. So we are going to talk about next, actually, is something that is new, and again, working with OAQPS and especially Kirk on this paper, sort of develop a tool that might make it more accessible to access a lot of this MERP information. Luckily, now having it as a spreadsheet is very helpful, as Kirk has presented, but we were looking for even a better way to visualize it or to quickly access what an end user might want.

And so we developed this based on the ClickUp software. And I don't know if many of you are familiar with it or not. It was actually my first time using it, but it actually more or less worked out okay. It does definitely make it easy -- or easier to sort of program for a web-based application. And so we pretty much used this, again, software develop a way that really accesses just the MERPs data that is currently available as well as more refined data. As Leiran was showing his presentation, where you are looking at those far fields, you are looking at distances beyond 50 km on the concentrations, where if you are looking at Class 1 analyses, we found this is a good way, as we think, to provide this information and to demonstrate it.

So right now we are pretty much done with it. We just, you know, we have to touch it up a bit. I know there is a whole process to getting it accessible to the public and through, you know, all the protocol that goes with government and getting those things accessible. But hopefully, if I just click this, it will take you directly to the app. It might take a little bit to load. And hopefully, when it is published, it won't take a while to load. I'm not sure. I don't think it will show Click like that. I have seen many other EPA actually -- programs actually use this for -- I think NEI had used it in some cases and other tools where it won't necessarily look like this. This is sort of the behind-the-scenes developer sort of view, and so you've got to load in, and it's kind of slow and clunky. So this isn't what it would finally look like, but this is a -- a good view of -- all the features should stay the same and it would just visually look a little more polished.

Excuse me. So here we have -- in this case we are just gonna -- just start here, and it may look something similar to this. It might have a title screen, but this is pretty much one of the main screens you will see. So I might use some Post-its mostly there.

So here we have is -- you always see in the center you have this interactive map. And really what this is highlighting is each one of these little blue dots is actually a hypothetical MERP source. So what you have here is just off the bat, if you just wanted to look up -- you will see to the right, sorry, you have a table of the MERP values, themselves. So you actually have it listed out by the state, the county, the specific form of the NO_x you are looking for and emissions. And then you could actually scroll this table. It's hard to see. Also on this laptop, because it's projecting it. So I don't know if I could scroll over it very easily. Just for instance, I will just play with it a bit. In case you are just curious, okay, St. Louis, if you just click on one of them -- as soon as you click it, you see it already highlights and filters to your right, the table. And again, it just happen -- here we go, it showed up. So what you can see here is the full data. You could just scroll over, and you can see the emissions. This is your scenarios. This is your -- the stack heights, the low or high, and it's giving you the MERP value right here. So you could literally just grab it instead of having to go -- whoops. I didn't mean to do that one, but it shows you the fact that you could easily just grab and play with the data, you know, instead of going through a spreadsheet or getting confused with that. I mean, you could exit out of a selection there and it will just undo it.

And what it also actually had -- and I will touch upon in a little more detail on it, but it has sort of what Leiran was mentioning in his Class 1 longer-distance analysis is you have this table on the right where it actually lists out the maximum concentration here greater than 50 km. This is sort of that first step when you are doing, again, a Class 1, you are looking well beyond -- or beyond 50 km for a secondary component. Here you have sort of that first step 1 analysis where you are looking at the far afield results in concentration. So it's sort of a quick way to grab it. I didn't mean to highlight that, but let me get rid of it.

So here again, it's listing for the source all the different stacks and all the different parameters, but you could easily also go over here and say, okay, you only care about the low stack, sure. You know, you only care about NO_x in this case, and you just hit these checkmarks. And it will further and further filter it for you on the right to get exactly what you want. So you either click through the table or you can click through, again, the drop-downs. And then what you can also do in the end is actually just print this as a -- I believe it's a PDF or an Excel. I don't know how to do it easily here with this. Well, there is an option on here. I forget if you right-click one of these, and you could actually just download this specifically as a CSV and -- to manipulate and play with it. And so -- unfortunately, this sidebar is gone, so I can't scroll down, but if you were able to scroll down, I could clear this. Maybe if I -- that seemed to give a little bit. I could clear all now. That helps to just reset everything. You know, if you get narrowed down, you could do that, or at the top, you could exit out of it.

That's one feature of it. You know, another, if you were curious, okay, you want to see a select few of them, there is actually a tool in here. This is like a little selection you could turn on, circle selection it's called. Let's say you want to see, you know, your project source in the Northwest, and you want to grab a couple of these. So you just do -- okay, I want to just do this. And it's gonna select them for you and then filter out all the data on the right. So again, just another way to parse your data to look at specifically what you want to grab.

And then, similarly, you can also do like a lasso I think it's called here. You could just go and you want to do something crazy, you could just draw your own little polygon or something and grab it, and it will allow you to hit accept, and it will, again, filter it and zoom in. And so again, it's a great way to -- if you were looking at specific sources, a way to narrow them.

And then I could just highlight this now. You can toggle between, again, sort of -- the base map, which is, you know, just sort of a national map, but here's actually a terrain map. It doesn't really give you terrain heights or anything, necessarily, but you could sort of see some of what the terrain is. It sort of gives you a little bit of a feel to compare, I guess, broadly what some of the terrain looks like nearby. And especially if you zoom in on some of these, you know, it will look a little more -- it will give you just a little more detail to help you determine comparing other sources and others.

And also, similarly to that, when you are comparing other sources, you could also click this metadata tab, and what that's going to do is take your sources selected and it's gonna give you just more information. So this is information that's currently available on the MERPs spreadsheet that's on SCRAM, but it's just -- I'm just here including it as secondary. So it's just showing you what the mean -- you know, what the modeling is associated in. It's going to give you the FIPS code, in case you want to grab the county or something. It's going to give you the climate zone, and then it's also, I think, just gonna give you a few other -- latitude and longitude, and the terrain height average, and the nearby urban, I guess, the maximum, I think, percentage. And that's, again, from the SCRAM -- the MERPs spreadsheet. But it's just highlighted here in case you want to compare some metadata.

So that's a cool way, again, to grab -- that's the illustrated MERPs, and that's the same exact info that's in the spreadsheet, but it's just another way to visualize it here and to extract the data.

And so what I will show next is -- is

sort of the other piece, which is sort of the refined data, again, that Leiron was going into a lot of, and -- let me select a source now. So you could select one of these sources, and let's say you wanted to know -- you know, you have a Class 1 area that's, you know, 200 km away, and you want some refined data, and there just happens to be a source, what you can do is go up here at the top in the AQ data, and so -- for air quality -- and you click that, it's gonna change -- it's gonna keep the same exact map, you have the same exact drop-down, but what it's going to do is give you on the right -- and if I could scroll over, it's gonna give you that distance base concentration for each hypothetical source.

So what you are gonna see here is -- let me find the distance -- so it shows -- you see this distance tab. So now it's gonna prescribe at every 10 km interval, whichever source you click, it's gonna give you the maximum concentration from that pollutant, whether it's NO_x or SO_2 from $PM_{2.5}$ out to 300 km. And so that's if, let's say, you know, you are looking at a specific one where you need to look at, you know, beyond 200 km impacts, so your Class 1 analysis, you would go down to 200 km or, you know, let's just say 250, and you can extract your concentration, which is over here (indicating). And so this gives you a way -- I mean, I had previously provided this to Region 4 applicants, provided a PDF sort of table, but in this case, you can actually go in and extract it or at least compare it for yourself as well. And I wish it would just show me how to extract it, because it's really simple. You look -- here you go, export, and you would export as a PDF as it asks for the date of the CSV, and it will just grab whatever you guys selected, it was easily exported for you to play with on your own.

And then I guess the other thing to touch upon here is if I can -- sort of these charts on the bottom. You can see they are also interactive, and they have been moving as I filter things. But here's the way I sort of visualize -- and, unfortunately, on the bottom, everything important about the legend is cut off, but what it is showing you is -- and I wish it wouldn't cut off -- is just ways to look -- visualize the data. So what it is showing is -- or if I even back all the way out, because I had 260 selected -- but here's where the specific source, it's giving you bar charts of, in this case, it's actually distance versus $PM_{2.5}$ concentration, but I selected the first one, so it's by NO_x and SO_2. So it's giving you, you know, pretty much the concentration from each pollutant by distance. And again, if you could see the legend it would show you that, you know, I believe the blue is NO_x and the yellow is SO_2. Just so you could see for yourself, and you could scroll or go all the way out to 300 km. And again, you would see, you know, pretty much the contribution for each -- from each pollutant. Here's -- oh, wait, sorry, I had that wrong. This is my precursor. So this is by NO_x. The first one was by scenario. So if this one is just 500- and 1,000-ton scenario, so this is showing you the difference between, again, each ton per year, so whether it goes up to 500, 1,000 or 3,000, it will show you what the magnitude by difference is by distance. And this one is between NO_x and SO_2. So, obviously -- I don't know which is which because this is cut off, but, obviously, this is predominantly leading to either sulfate or nitrate is the predominant form here for $PM_{2.5}$, and again, you carry that by distance.

And lastly, is just to view it by stack.

If you are curious how it changed versus similar scenarios, how it differed between a high stack or a low stack, again, you can compare here and look out by distance as well to see how that varied in case you're curious how the terrain affects -- or things like that were impacting it.

And this similarly will show -- if I exit out completely, it will zoom all the way out, and it will, again, reset those charts. So this is obviously -- this is going to give you the maximum concentration of all the hypothetical sources. So that may not necessarily be really helpful, but if you select a few of them, you can look at those charts and establish source is contributing to which to kind of again help you maybe determine which source might be more representative or just for your own information it could be useful.

So I think that is everything I wanted to cover on this. Again, as you can see, unfortunately, in this form it cuts some things off, and I can't even scroll down for some reason, but that's just little things that we are going to work with George and Kurt and get -- and to work out and hopefully publish. But this is how we view it, hopefully others will enjoy a more interactive and easier way to check data instead of requesting, you know, a PDF form, or some tables to look up, or an Excel spreadsheet. This might be, again, more attractive and more useful, but I think that concludes the demo.

MR. BRIDGERS: So since we don't generally have these three gentlemen together, and Mike is soon to make a transition here to RTP in a different position, I'm going to open the floor if there are any clarifying questions for the three presentations we just saw, but sort of like ground rules yesterday, if we can kind of keep them high level, otherwise you can catch the guys off in the hall. So nothing permit specific, but are there any questions for Kirk or Leiron, or Mike? Just make sure you identify yourself.

MS. KAUTZMAN: Rheanna Kautzman, North Dakota Department of Environmental Quality. This was for Kirk. I think there is an error in your presentation. There is no large cable in the area, and that area that you had as high ammonia is a coal gasification plant that now makes fertilizer.

MR. BAKER: Okay. Thanks.

MR. BRIDGERS: I guess should have said

are there other corrections to make.

MS. WALSH: Heather Walsh from Florida DEP. Kirk, you mentioned that there was some upcoming additional hypothetical sources going to be modeled for MERPs purposes. Do you have any expected timelines for those?

MR. BAKER: Yeah. That's a great question I was actually thinking about. I should have mentioned this. I'm kind of targeting the end of this calendar year to have that information available, so by the end of -- I was hoping late December maybe early January we will have more information available to people from that additional group of sources, which obviously would benefit you-all, because you are kind of in that no man -- there is not really much information there from that first round.

MR. BRIDGERS: As we have done for each of our panels, I think we owe these three gentlemen a round of applause.

(Applause.)

MR. BRIDGERS: This brings us to our last presentation before we get to the full public hearing portion for the public comments. As Kirk alluded to, there is guidance forthcoming. When we originally scheduled the 15 minutes for this update, there certainly was a thought that the Guidance for Ozone and $PM_{2.5}$ Permit Modeling would be out. I stood in front of this audience in different flavors for several years now, and so we are going to give an update, and you can take my word for whatever you would like to take my word that we have Guidance forthcoming, but wanted to give everyone a status update of where things stand. And the title was generic, but the intention all along was this was going to be the Ozone and $PM_{2.5}$ Permit Modeling Guidance talk.

So just, since this is on the record, I wanted to go through a real quick history lesson, how we got to where we are. So this, as many know, started many moons ago. Back in 2010, there was a petition that was granted by the EPA with the Sierra Club. And that ultimately set in motion a lot of things, including the revisions to the Guideline in 2017. But in specific with this petition was the focus on the tools and techniques that we need to demonstrate compliance with ozone, which up to this time has been done helter-skelter in the states, and with $PM_{2.5}$, specifically the secondary formation of $PM_{2.5}$, and the time here lines up with when, in that following year, the PM_{10} surrogate policy ended. And so for over a decade we had coasted with the surrogate policy and really not had to demonstrate compliance with the 2.5, especially the secondary formation part. And so now we are confronted with needing the pieces to come together so that we could demonstrate compliance.

There was a revision of the $PM_{2.5}$ NAAQS that plays into this, a little slightly more stringent standard. And then we had this -- what at the time seemed a little bit problematic, the vacatur of the SMCs and then some changes with the aspects of the SILs for $PM_{2.5}$, but that also, as I try to do with the Boy Scouts, is challenges are opportunities. And so when you are trying to tell the boys, and now girls, you know, just look at the situation and make the best of it. Losing the SMCs seemed kind of like a big deal at first. But then on the flip side of it, it also guaranteed that we would always have background monitoring moving forward, so it was an opportunity.

The same with the SILs. We've got 30 or 40 years of SIL, you know, usage in this agency, but we had not put forth the effort to do the technical background, the work that Chris Owen and others in our group and in our office have done to put forth a really strong underpinning to the SILs. It was something that was needed, and obviously, we are well aware there is litigation ongoing with that. But those opportunities also set us up to start building these tools into a better Guidance document.

In 2014, we updated -- and this was through a very iterative process. NACAA was involved, other states outside of NACAA were involved, the regional offices were involved to form the Guidance on $PM_{2.5}$ Permit Modeling in 2014, which a lot of us are still using because it's the guidance document that's out there.

I mentioned that we revised the Guideline in 2017. And Kirk and others have just presented on some of the flavors of this is what happened with Section 5, and how we updated it, and there is now this two-tiered approach for addressing the secondary formation of ozone in $PM_{2.5}$ in recommendation and not requirement. And there was a reason behind doing that, because we just weren't in a place to put specific pencil-point requirements on this yet. But along the way we also, with these Guideline updates, had other pieces that came in, and these, I think, are fundamental, and have allowed us -- I won't say stopgap -- probably the wrong way to categorize it -- but they have allowed us to move forward in the absence of the updated permit guidance, these pieces like the MERPs guidance that was finalized just recently. And then more importantly, you know, this aspect of the single-source guidance and information for secondary formation, because, as Kirk had explained, part of our revisions of the Guideline was bringing focus that these tools that we used for years, and years, and years for SIP development are also applicable for single sources. So we are getting all these pieces together.

We talked about the SILs. There's a lot of work going on. The SILs guidance was finalized last year, and that's, again, given us a tremendous tool to build upon. Hopefully it sticks around. And then, you know, we talked about Kirk's presentation just a minute ago. The MERP guidance was finalized just a short period ago.

So what is the status of the Guidance? If you are playing bingo with what were this conference -- you know how sometimes you play bingo with things that are on television? I talked about beer, I've talked about Boy Scouts, I've talked about Monty Python -- what else? I've thrown one other thing out. Oh, Pokémon. So now I'm going to throw out unicorn. So bingo. By the way, unicorns are my mascot of my high school.

It exists. This is the only one. It exists. It's here. But in all seriousness, there have been starts, and stops, and fits with the Guidance document. As I said, I have given this kind of presentation several times now. There is a presentation I gave in 2018 in Boston that I'm not going to spend any time focused on right now that a lot of people took as direction for where the Guidance was going. Probably a good idea at the time. But there was also some storming -- since I was using the forming, and the storming, and norming earlier -- once I got back to RTP and the word spread around from that presentation. And so there was discussions at the senior management level, between policy division, between the technical division that I'm in, trying to make things align, appropriately so. And we realized that it was going to have to be advanced up the ladder to OAR, and before -- it was nice enough that Anne was to come in to speak, but previous to her was Bill Wehrum. And so there was a lot of discussions with Bill. Assistant Administrator Wehrum, I should say, versus Bill. I didn't know him personally. And we came to a resolution, and that resolution was finalized earlier in the summer, and so I have been, along with the policy staff and the Office of General Counsel, trying to take those final decisions and bring it to one final guidance document.

So where we stand -- there is a unicorn -- actually, it exists electronically too, obviously, and we are very close -- very, very close to having it ready to hit the street. The SILs litigation and the work that we have been doing with our Office of General Counsel there has slowed some things just because of kind of sequencing things. And Tyler made me pull it out, but I'm gonna say it, the shutdown did affect us. It kind of slowed some of the discussions down and kind of backed things up a little bit, so -- not making excuses, but that shutdown did have an impact even on this Guidance.

I hope -- sincerely hope that, in the next few weeks, we are going to have it ready for prime time. And when I mean the next few weeks, prior to Halloween. And the first step will be to share it with regional offices and gain their feedback on a very short, couple-week turnaround. And then, as we head toward Thanksgiving, unless Tyler pushes even harder, to have it ready to release to the public.

It's going to go out just like the 2014 Guidance went out for PM -- Permit Modeling Guidance, it's going to go out as an informal document for comment. So there will be no docket. I will be the one receiving the comments. We are not doing a summary of comments document, but we will receive your feedback, and then we'll look at that over the holiday season as we get into early 2020 and hopefully ahead of -- well ahead of the workshop -- the annual workshop that we do that -- we'll have air quotes around the words final -- final version of the documents out there.

And so I am going to first say, one, thank you for your patience; but two, I also want to offer my appreciation for all the comments that we are going to receive once it hits the street, because it's through your feedback that we are going to make a better and more usable Guidance document.

So how to proceed in the interim. First and foremost -- and this is kind of my pat saying is, if you have questions, then reach out to the appropriate reviewing authority if you are an applicant. If you are a state and you have questions, reach out to your appropriate regional office. Since I am kind of the chief document person for this Guidance document, you can always contact me if you have questions, but if it's specifically permit related, I am going kind of to push you back to talk to your reviewing authority and the regional office first. That's sort of the normal flow of information. I would gladly be part of the conversation, but I just have to make sure the right people are on the phone.

What I can say, we are not, at this point, recommending the holistic approach that we put forth in that presentation that I gave in Boston in 2018. So this engagement with the reviewing authority is what we are really stressing. You can read whatever you want to between the lines, but if you are dealing with the secondary formation of $PM_{2.5}$, you have significant levels of SO_2, or NO_x, or VOC, whichever pollutant you are thinking about, ozone or $PM_{2.5}$, just reach out and have the conversation. We can kind of fill in between the lines, and it could be, by the time that we have these conversations, the draft Guidance will be out on the street.

Finally -- and this was sort of directed at some things that we saw happening in the, sort of, purgatory that we have been existing without the Guidance document out there, is that if you are using some type of scaling technique for the direct $PM_{2.5}$, the primary $PM_{2.5}$, stop. Section 4.2.3.5 of Appendix W clearly says, if you are trying to assess direct $PM_{2.5}$, that you use the Appendix A model for near-field modeling, which is -- near-field modeling, which is AERMOD. So we have seen some creative things out there to try to address this, but if you're not using AERSCREEN from a SCREEN perspective, or AERMOD from a refined modeling perspective, and you are looking at direct $PM_{2.5}$ or primary 2.5, you are doing it wrong, from a PSD major facility perspective. If there are other questions on that, feel free to ask through your permit -- through your reviewing authority and regional office to us, and we could certainly have those conversations offline.

So I know this was sort of a short and sweet presentation. I think that's the end of it. I am going to hide this now, because you know it exists, and I don't need anybody picking it up, but it will be in your hands, I really really hope, before we get to the middle of November. And so with that, I am done, and we will take just a short minute of recess, and then we will start the public comments portion of the Conference.

(At this time, a recess was taken from 2:01 p.m. to 2:03 p.m.)

MR. BRIDGERS: So we have a series of eight talks that are starting now, and these are external community stakeholders that have requested time, and we have allotted approximately 10 minutes per talk. Mike, you need to go -- please, we are going to start with Michael Hammer, and he is going to start on behalf of the Air and Waste Management Association, the -- what used to be the AB3 Committee, but now it's the APM Committee. So Mike -- Michael, you have the floor.

MR. HAMMER: Thank you, George, and thank you to the EPA for allowing us to present our committee's comments on everything we have heard here at the 12th Modeling Conference. My name is

Michael Hammer. I'm a certified consulting meteorologist from Lakes Environmental Software, and I am the current chair of the International Air and Waste Management Association's Technical Coordinating Committee on Atmospheric Modeling and Meteorology, APM, because we are part of AWMA's atmospheric processes division.

A little bit of background, for those of you who are not familiar with AWMA, the International AWMA's charge is to provide a neutral forum for stakeholders, for academia, for the regulatory community to come together and exchange information, exchange data, and discuss important matters of air quality and waste management. Specifically, our committee is the technical coordinating committee for issues related to air quality modeling and meteorology, of course. There are about 150 committee members at this time. Many of you here are members of our committee, and we are thankful for your participation.

The committee's objectives include a number of different things, but we mainly provide technical support to the greater association for matters related to modeling and meteorology with our support of specialty conferences and workshops.

Just this past March, in fact, we held a specialty conference on air quality modeling just up the road in RTP here. We also contribute to other technical programs holding webinars on items important to our committee for the broader community to review and discuss, and then we provide instructive technical comments and review of regulatory issues related to modeling to the agency, such as our participation here today.

These comments were primarily put together by our ad hoc review subcommittee. I, of course, am the chair, as I mentioned. Sergio Guerra is our vice chair of the committee, and Abhishek Bhat is our secretary, and Tony Schroeder of Trinity Consultants is the ad hoc review committee chair, along with the other people mentioned here. Some of the names you may recognize as members of the panels we've had here, so we are very involved in this modeling community together. And then the greater member base was also solicited for these comments.

So on the issues pertaining to this 12th Conference on Air Quality Modeling, first addressing just the general outreach of the EPA. Our committee greatly appreciates all of the outreach efforts taken by the EPA within the past several years to address the ongoing development of the AERMOD model and other issues related to air quality modeling and meteorology, such as the publishing of the system update -- excuse me, system development and update plan, the continued development of the AERMOD white papers, the LEAN implementation for the Model Clearinghouse. All of these outreach efforts have been greatly appreciated, and we are thankful for the ability to participate in the outreach efforts and provide our comments on all these different areas.

One suggestion that came up from the committee was potentially the resumption of periodic conference calls with trade organizations and the modeling community to discuss the ongoing research and model development to provide a more direct forum for our feedback on these items. Additionally, emails for announcements that are made on SCRAM to members of these communities could also be helpful for effectively and efficiently disseminating these information pieces to everyone in the modeling community. I know numerous times there have been announcements made on SCRAM that have, kind of, flown over people's heads because we get so buried on our own tasks.

For the downwash algorithms. As you're all aware by the nature of the keyword description AWMA downwash new, we have been actively participating in the formulation of new downwash algorithms through our PRIME2 subcommittee headed up by Ron Peterson and Sergio Guerra. We have been very thankful for this opportunity, and we look forward to continuing to collaborate with EPA on the testing and validation of the PRIME2 options that have been incorporated into the model.

As Sergio mentioned in his presentation yesterday, there are, of course, ongoing improvements being developed and evaluated, and you will be able to see those in the presentation as it is posted, and we look forward to continuing our participation and our collaboration with EPA on incorporating those new developments.

With respect to mobile source modeling, the panel was appreciated for all the information that we got from our panelists on the topic of the RLINE integration into AERMOD. Of course, from the history, most of us are well aware that the 2017 Appendix W revisions made AERMOD the preferred model for refined modeling of mobile source applications, replacing the previous CALINE3, and a three-year transition period was allowed before AERMOD became mandatory for these applications. Looking at the calendar, we are now about three months away from that transition period ending.

Because RLINE is still a BETA option, as of the AERMOD 19191 release, and work is ongoing to improve its performance, we would suggest considering an extension to that transition period on the exclusive use of AERMOD for the transportation conformity, until such time that perhaps RLINE can become a regulatory default option in the model. One of our members pointed out that a recent FHWA-funded study demonstrated better performance from CALINE for a straight-line highway situation when compared to AERMOD. So we think it merits continued analysis and review of the RLINE source implementation into AERMOD before maybe that transition period is fully closed.

On the topic of performance model evaluations, the AERMOD development plan provides guidance in Section 7.3 regarding the expectation for the internal and external model performance evaluations. Historically, guidance on this topic has been sparse. So we are thankful for the additional information that has been provided, though there are still areas where we would like to see additional guidance and information supplied. One specific instance mentioned the distribution of receptors at monitoring locations. Mark's presentation this morning I thought was very helpful in getting that idea across that, when we have these individual monitored locations to be reviewed, placing one receptor or multiple receptors around there, we would like to see some additional guidance on how that could be effectively managed.

And Chris had a presentation today on plume rise in which he touched on the BUOYLINE source within AERMOD. We suggest that some additional review be given to the source type. And it sounds like, from Chris' presentation, that there is going to be ongoing review of it. Particularly, we noted that if you look in MCHISRS -- somebody is using it, George -- there have been five Model Clearinghouse decisions that have been published since the Appendix W promulgation back in 2017. Every single one of these was related to the BUOYLINE source applications, four of them approving the use of hybrid BLP AERMOD model usage, and then one on an alternative technique for using the BUOYLINE source within AERMOD. We think that these collective decisions kind of show that, while BLP, itself, was a preferred model, and it was just kind of whole-hog stuck into the AERMOD model, it still merits further review to overcome some of the many limitations that are presented in its current form, such that it can be used as a full regulatory default option without needing to go through some of the additional Model Clearinghouse process.

And then looking ahead, the AERMOD development plan is, of course, very beneficial for everyone to understand what EPA's current efforts are on model improvement. It is great to have that written down. It's something that we could reference and look to for guidance on what is coming up. However, we feel a more long-range outline for future regulatory modeling would be welcomed and may be warranted, considering that development of AERMOD and planning for it began in the early 1990s. We would like to see, perhaps, a development of more long-range plans for potential replacement of AERMOD or its continued development into more long-range applications.

Some of the questions that arose was if ORD is working on implementation of any next-generation models that could be considered, any sort of internal plans that are currently going through EPA regarding forward thinking into the air quality modeling, it will be helpful for the public to understand this information and know what is going on, such that we could also continue to support these efforts through our own research and development. And, of course, we do look forward to continuing to participate alongside EPA in promoting all the state-of-science advances to air quality modeling.

And finally, just on behalf of all our committee members, we would like to express our gratitude to EPA for being able to present at this conference today. Thank you.

MR. BRIDGERS: Thank you, Michael, and thank you to the Air & Waste Management Association for their comments.

So, at this time, I will call to the podium Chris Rabideau.

MR. RABIDEAU: Just like George has to make sure he puts certain things in the record, I put my disclaimer in. My name is Chris Rabideau.

I am from Chevron, but I am presenting today as the chair of the API Air Modeling Group. So keeping everybody happy.

API does support the -- you know, supports the improving of the science that EPA has been working on, and we have been doing that ourselves along with EPA, so we do appreciate the willingness to work with the public to improve the science. Again, just some of the things we have done through API, through their modeling group over the last, you know, 8 to 10 years or so, it's just been something that we have been working on has been, obviously, improving the NO_2/NO chemistry; you know, the development of ARM2; some of the PVMRM improvements; and, you know, we actually did do some CALPUFF chemistry improvements many years ago, and then somebody decided to pull that from the approved list, so that was kind of --

We have also worked on low wind speed. Again, a lot of these things have come up in previous presentations over the last day and a half, and also currently working on building downwash as well.

So just for today, I am going to cover some of the issues that we are currently working on, as well as a couple of other things, and then -- obviously, there is a lot of our issues that are being addressed that we'll cover in our written comments, just so that EPA knows, you know, you will be getting a nice big packet of stuff from us as well.

So like I said, we have been doing a lot of work with NO_2 and trying to improve the conversions a number of different ways, and just some of the things that we still -- what's still out there, we have noticed -- we did do some PVMRM improvements or suggestions that did get put into the last round, but there are still some things in there in the 1999 Hanrahan paper that does mention the issue of a finite time that's needs for NO/NO_2. That's still not accounted for. So -- and I don't know the potential for at least the factual prediction. So the question we are going to ask, and we are asking in our comments, is that potentially something that could be put in as a BETA option in the next release, maybe putting the time -- finite time conversion in there?

As Chris Owen mentioned this morning, we are working with Cambridge Environmental Research Consultants to work on another Tier 3 option, the

ADMS method. And again, since Chris actually did a pretty good job for us, putting everything out there this morning, I'm just going to go to the next.

And this was some of the results -- Chris showed some of the results from the paper that was done and was published in 2017. This is some results that CERC actually presented at the Air and Waste Specialty Conference in March of this year using the compressor station data set that Jeff Panek was describing earlier this morning.

So again, what I wanted to show here is that just to pull some of the -- some of the graphs that came out of the conclusions from that presentation from CERC, but you -- and Chris Owen mentioned this. You can see that, if you look at the north fence, for example, you know, the model was underpredicted. But then when you look at the NO_2, you look at PVMRM or OLM, it's performing great, but I think it's performing great for the wrong reason, because the NO_x, itself, was willfully unpredicted. So you kind of look at the results where, you know, if the NO_x is good, then we are looking, okay, what -- how were the tools for the chemistry working? And you can see, when you look at the east fencing, and the field, and the tower site not as much, because it is underpredicted there too, most cases PVMRM and ADMS are -- obviously, they are performing better than OLM, and that's not surprising, I don't think, just because of what is -- the inputs into those -- into those processors.

PVMRM and ADMS are broadly replicating the near-field ratios. PVMRM does predict some higher NO_2 concentrations exceeding that upper bound OLM. You could see that on a couple of the -- at least on the north fence. And when you look at the full -- full statistics, at least for this data set, the ADMSM statistics are a little more consistent with the NO_x than the PVMRM.

The next thing we want to do on this is actually then take the drill rig data set that's going to be coming out in the next few weeks, month or so, and also do this same analysis with that data to see how ADMS also works with that, because we want to -- we want to make sure we use both of the -- both of the data sets to make sure we are getting an approved -- improved Tier 3 model on that one. So more to come on this one.

I think we've mentioned before, we have also been working on the LOWWIND field for some years. The ADJ U* was part of -- one of the co-funders that was working that a few years ago. Again, there are still some issues, and I think all of this got discussed fairly well yesterday during the panels. So I think we are just going to -- you know, we are going to comment again that there is -- there is some issues with meandering. There is the coherent versus the pancake plume, there's updates that are going to be needed for that. And I think -- I think Bob Paine suggested this during the wind panel on maybe there is some consideration for some -- for minimum values of SIGMA-V and from SIGMA-W that could be used. Again, we will have some more information in our written comments on that as well, based on what we heard at the panel discussion.

We are working the building downwash, working the PRIME2. So, again -- again, a lot of this has been covered already, things that we are working on, things that have been noted from the panel discussion. So again, just something more that is being worked, and we will -- we are gonna keep funding. I think we got some potential issues for some additional work on this. So more to come again, as I think everything has been -- again, this is just some of the results that we have seen. This is some graphics from Ron Peterson that he provided to just show some of the results that is going on with PRIME2 work.

Offshore modeling. This was, again, discussed yesterday, and this is one area that we haven't been doing a lot of work on. And you'll notice the last question on here is, "Is there a role for API?" Obviously, a lot of the offshore remodeling refinement work is just due to oil and gas off-shore. And there are a lot of challenges. I mean, these were all identified yesterday with the shoreline geometry, the inclusion of thermal internal boundary layer, complex terrain near the shoreline, and then the inventory of the evaluation database is obviously limited.

So there is a need to get this added to AERMOD, and I guess I'm asking the question, is there a role for API, and if there is, are there certain areas that need research and funding? And if there is, people can contact either me or Cathy Kalisz. She was the API modeling group staffer, and let us know, because we are -- we do

-- we do a research on trying to improve the designs, and if there is things out there that need to be worked on that aren't being worked on -- we don't want to get involved in something that maybe already is being worked. But if there is something that's sitting out there that needs work, let us know, and we will look into potentially doing some additional research on those things.

Something I just discussed with the modeling of the secondary $PM_{2.5}$ and ozone. Again, we would appreciate the additional clarification. That did come out in April 2019 MERP guidance, and I guess we put this comment in here before about the helpful if EPA posted the distance the $PM_{2.5}$ CAMx results, but I think that might have been what the app tool was that was just presented. So I think that one was addressed, so that's great.

And again, I think George, as you said, that you made comments about the guidance being out there before. I think you made the same comment before, that we were looking forward to commenting on that, so we will say the same thing again too.

And then other issues that are in the -- for comment that we are not gonna get into here, but we are definitely gonna be addressing in our written comments, but there is the discussion about the model evaluation procedures, the surface roughness concerns, modeling of sources with partial or variable emissions, RLINE and roadway, and then additional feedback from the panel discussions. And then, dare to ask, but is it time for EPA to consider an eventual replacement of AERMOD, just because of all the changes, and additions, and dropping of things into and out of, and it's been around 20 or some years, and I think that is the length of ISC, and it's like, you know, is it time for the next one? So we just kind of put that out there, and I think that was it. Yes.

MR. BRIDGERS: Thank you, Chris, and thank you, API, for your comments. I wish I could be announcing AERMOD X. So up next we are going to have two different presentations, both focused on penetrated plumes. We are going to start off with Bob Paine with AECOM.

MR. PAINE: Thank you, George. This is a photo of a suspended -- you can see it's a suspended plume matter which isn't coming down to the ground, and that's part of the whole purpose of this talk.

And, Chris, I want to mention that the

penetrated plume issue has been submitted as a potential or white paper issue for improvement in AERMOD.

So I am going to review what is this thing called penetrated plume, and what's the history of its treatment over the years, decades; the current issue in AERMOD; what we have seen in field studies; and a suggested approach for addressing this issue.

This is -- this has been in various training presentations for AERMOD, but in convective conditions, you can see that the mixing height is up here, is denoted here, and plume material that is fairly low with -- well within the mixed layer. Here you can see a very low source that's totally within, and that's the green plume. That's the direct material. It doesn't even interact with the mixing lid. And then indirect material bumps up against -- it's almost like a balloon hitting that ceiling. And if you can crash through that glass ceiling, you are in the penetrated plume material. And that's what we are going to discuss, the crashing through the glass ceiling.

Now, another figure from the AERMOD

formulation document indicates that the SIGMA-W or the -- you know, the SIGMA-W profile in the x-axis is the SIGMA-W normalized by something that -- Chris Owen and I are saying you can't measure W_*, but W_* is a parameter. And so this is just -- the x-axis is basically a scaling of the vertical turbulence, and this axis is another dimensionless quantity, the height divided by the convective mixing layer.

So within the convective mixing layer you rapidly ramp up in the first tenth of the mixed layer to a fairly constant and high value of the vertical turbulence, and then it drops off fairly rapidly. The penetrated plume is generally up here. Let's say it's maybe only a third or so, that SIGMA-W versus most of the depth of this mixing layer, and assume that the receptor is at the ground. So this is the basic thing. How do you get the plume from way up here to the ground?

But we have lots of experience with the counterintuitive result that somehow that penetrated plume material mixes to the ground rapidly and can result in the highest concentration during the daytime, and, in fact, that happens really early in the morning when the convective mixed layer is still well below that plume height, the penetrated plume height, that is.

We would expect that this would -- this penetrated plume material would mix to the ground after the mixing height rises to intercept it. And I recall, in the days of ISC-ST3, that the penetrated plume never got to the ground. So we would expect, just from intuition, that there would be minimal mixing of a penetrated plume to the ground before it was intercepted by the mixed layer.

We have got some enhanced debugging information that we developed. I worked with Carlos Szembek on this for EPRI. It's basically -- it's actually downloadable, at least in some previous version of AERMOD. But you basically get the information for each hour for the mechanical and convective mixing layer. In this case, we haven't exactly -- you probably can't see these numbers, but I will read them off. 256 meters for the convective mixed layer. The plume height is 350-some-odd meters. So it's above the convective mixed layer. And the penetrated plume fraction is about 0.9. So most of the plume material is penetrated. And you get a high concentration. So the question is, why is that?

And now I looked at some EPRI field study data where they actually had LIDAR measurements of the actual plume material. What you see here is these contours are plume material in parts per billion, and they are basically SF6 plumes.

On this day in October of -- October 4, 1982, between 8 or 9 a.m., the plume -- a core concentration of, what, 1,000 ppb, but the mixing height was well below that, and I think the ground-level concentration of Chi/q was pretty low, and between 10 and 20, as we are going to see, until the mixed layer rose up.

In the next couple hours, the plume is still about the same height. You can see the height in 200-meter increments here. Still about 1,000 ppb. Didn't get down to the ground very much. And later on in the morning, near noon, still about 1,000 ppb at the core, and the concentration of the ground was still on the order of 10 to 20 Chi/q units. But then once the mixing height intercepted the plume, what happened was the plume center line concentration dropped by a factor of 4, and the ground level concentration rose by about a factor of 4. This was the -- the so-called classic fumigation -- daytime fumigation. And not until then did the penetrated plume get to the ground in any consequential amount.

So -- and this is typical of what we have been seeing, but the model somehow gets high impacts from this penetrated plume too early in the day according to our research in view of debugging input. Too many hours too much of the time, and then leads to the controlling concentration. What we have seen is that there is -- there is an issue with the mixing.

I am going to go back to the slide here, slide 4. If you -- but the trouble is with the AERMOD formulation. And I don't know what AERMIC was thinking at the time, but we basically said, okay, let's have an effective SIGMA-W that goes from the plume center line to the receptor height. But we didn't realize, well, you know, we're actually vertically averaging over a large discontinuity, and now we realize we shouldn't have been doing that, but that's what their model does. It basically says, well, the effective SIGMA-W, instead of being much lower than this level, it averages this, and you could get a little higher level of SIGMA-W bringing that plume to the ground inappropriately early.

Okay. I am going to go back to slide 10 now. So I think this is a formulation bug that needs to be fixed, and I will take my portion of the blame as a member of AERMIC. Weil, who is another member of AERMIC, who should have realized this too, had a paper on this too, and basically, the fix is to basically keep the effective height of the SIGMA-W, and the SIGMA-V, and all the effective parameters for the penetrated plume limited to very locally until the mixing height reaches the plume, as we saw in the actual LIDAR data. To do this, AERMOD could be modified, and the next speaker will indicate how he actually did it. Look ahead to the next hour. Next hour is mixing height. See if it actually rises above the height of the current hour's penetrated plume. If it does not, keep that very limited depth for the effective parameters, but if it does rise to capture the plume, then do the current procedure for the fraction of the hour that the plume was, in fact, within the convective mixed layer.

And now, that's my lead-in to the next speaker.

MR. BRIDGERS: Thank you, Bob, and AECOM for setting the stage. Next up, we have Ken Anderson at Ameren.

MR. ANDERSON: The database that I used to evaluate what Bob was talking about is a Labadie Energy Center, which is an Ameren facility in eastern Missouri about 33 miles or so outside -- west of St. Louis. A couple of years ago, Ameren installed two monitor networks around there to evaluate its SO_2 impacts, the current situation -- I will make some comments here in a minute. I think there was four SO_2 monitoring sites, there's two 10-meter towers, one in the valley, one out of the valley, and it's typically intermittent wind speed, wind directions, vertical wind speed, SIGMA-THETA, and SIGMA-W. And we'd also have a SODAR system there in the valley.

The next slide shows the actual location of the monitors. Two of the monitors were installed in April of 2015, and that's the northwest site and the valley site. In early 2017, or actually January '17, part of the DRR rule, two more monitors were put in, and that's the southwest monitor and the north monitor. So you've got pretty good coverage for all of this. The only problem we have had is in '15 Missouri River really flooded, and we had our SODAR located at our valley site, so we lost it for a while. We moved it to the current site, which is now elevated out of the floodplain, so we are, so far, happy, but we lost data just because of that. And it also flooded again back in June of '16. And, of course, this last year, we were underwater from May through August, effectively, for the valley site. So it was out of commission.

Anyway, I didn't really start out this work to look at penetrated plume. What I was trying to do was run AERMOD and find out what combination of meteorology would best simulate the monitoring concentrations that we had. And I listed five of them over here. There is probably 10 more that I actually did. What we came up with was that the best actual performing meteorology for AERMOD, its default mode was the value 10-meter data with turbulence and the wind speed direction from the actual SODAR.

But we went through and evaluated, as Bob mentioned, the debug, we call distance debug. This is a listing of the top 10 concentrations out of using one of our simulations, just a valley met tower, itself, with turbulence. And all 10 -- all 10 concentrations are all dominated by the penetrated plume. I apologize for the small numbers, but if you look at the actual observed values that occurred, there is no or little penetrated plume impact on these. It's all under higher mixing heights and earlier hours during the day, and this next figure really shows that.

This is a plot of where the orange or red triangles are the AERMOD calculations and the blue dots are the observed values. On the left-hand side we have hour of day, and you can see AERMOD predicts these penetrated plumes earlier in the day than are actually being observed from the monitors, as well as under very -- under lower-mixing heights than when the observed values were listed.

So this got me into looking and talking with Bob about what can we do to rectify this. We had a lot of discussions about that. And Bob's already mentioned what we have done to do that. AERMOD's current work, which I guess Bob has already described it, it actually takes the effective values at the penetrated plume height, calculates a SIGMA-Z value, and then recalculates the effective values for that SIGMA-Z value 2.15 down to the SIGMA-Z value. So it has a tendency to produce higher concentrations earlier in the day.

So, anyway, we came up with -- I reprogrammed AERMOD to actually look at a couple of different situations where the -- we have a penetrated plume, the next hour's mixing height is still below the center penetrated plume. AERMOD would adjust the effective values at the penetrated plume height and do its calculations and concentrations in that way, but for the next hour actually exceed the penetrated plume height. Then we would do a weighted average of the effective values at the penetrated plume height and the AERMOD's typical calculation that I described earlier, weighted on the time that the mixing height actually reaches the penetrated plume center line, assuming that the mixing height is linear from hour to hour going up.

So I put together a bunch of statistics, and this is just some of them. And I know some other folks earlier today also talked about some of these things. And all of the statistics, except for the one thing at the end here that I'm going to talk about, looks at just the max daily values.

So the first plot I'm going to show here is a QQ plot where the blue dots in this case are AERMOD's predictions and the orange triangles are the prediction with what we call PENMOD, modification of the penetrated plume. You could see that AERMOD has a fairly -- fair amount of overprediction. It's still within a factor of 2, but the PENMOD does much much better than the default AERMOD is doing.

Also took a look at the actual design values you would get over this three-year period. I should mention -- I mentioned this before, I probably should go back -- I developed another three-year period of the most complete data set I could from what we had measured. So that happened to be May through -- excuse me, May '16 through April '19. So these are the design values, and the blue are the observed values for each one of the four sites that we have. The orange or red is actually AERMOD -- default AERMOD implementation, and the yellow is the PENMOD.

Now, you can see, in each case, for the design values, the PENMOD is doing better than AERMOD, and it's still somewhat conservative in terms of implementations. Does better at different markers and worse at others.

Also took a look at robust highest concentration at each one of the monitors. Again, this is robust high concentration for the max daily values, not the other values. So you see only at the value site is it slightly underpredict. The other two sites, PENMOD does better than the AERMOD with the same colors. If you look at the highest values at each -- each of the four sites for each PENMOD, and the observed, and the default value, it actually does pretty well overall across the whole network of samplers.

We also did what's called a fourth -- robust fourth highest value, which Mark Garrison talked about this morning, where you throw out the first top three values and start the fourth value and look at the next 26 values. And by the way, [indiscernible] use 26 for the numbers. You could see, in this case, the robust highest concentrations, the PENMOD's got a normal of all the other sites, except for the northwest and southwest sites, but still better than what AERMOD was producing.

Also took a look at fractional bias. And again, this is for the max daily concentrations. And you can -- and also I did a ratio of the average of the top 25 monitored and measured -- measured values, or -- yeah. And so you can see, with the fractional bias -- I don't know how familiar you are with fractional bias, but the more negative it is, the higher the prediction is. And you can see that the PENMOD does much better in the fractional bias area, and, of course, it would do much better in the ratio model verses OBS.

My last plot here for -- at least for the Labadie Power Station, this is the -- the EPA's MEM software, which does the Cox-Tikvart stuff. Now, this does use hour-by-hour values as opposed to max daily. And it got the MCM for each monitor as well as the combined MCM. And it looks like the -- well, the idea is you want the thing to not cross zero for combined MCM, and it looks like it's touching the axis, but it's just barely like 10 to the minus 3 plus. So it's pretty -- it is statistically significantly different -- our two models are statistically different.

Anyway, the operational diag is 1. We also used a combination of wind speed and stability class as a diag thing. There are three categories that we use.

In the interim, I also took a look at this -- tried to find this technique for some other EPA databases. Baldwin Energy Center, which has 10 monitors, relatively flat for a year's worth of data; Gibson Energy Center has three years of data, 2018. We processed the meteorological data for both of these through AERMET, used the ASOS data that was available for the Gibson Energy Center. And so just had one little short figure here that shows the difference between the default AERMOD and PENMOD. You can see it makes a significant difference in very close observations. This is the fourth highest max, by the way -- daily max. Does really good at Baldwin for the year. Not quite as well at Gibson, but still a little better than AERMOD.

And so I just have a few conclusions here. It appears, and as Bob had mentioned, the penetrated plume treatment dominates the higher concentrations while, in our case, for this study, the observed concentrations are generated under different conditions than what the model is frequently showing.

The PENMOD modification reduces the

overprediction somewhat and gives some credence to what the next hour mixing height is going to be, so you could determine whether it is going to be entrained or not be entrained.

This database, at least at the Labadie Energy Center, is evolving and continues to operate. We are going to continue evaluating this technique with that, as well as other databases.

So that's all I have got. I want to say thanks for the presentation.

MR. BRIDGERS: So thank you, Ken, and thank you to Ameren also for the comments that were provided. We are running a few minutes ahead of the schedule that you have in front of you, but what I'm going to do now is allow us -- so we had a mutinous break a little bit earlier, but we will have the real break now. I will give you 20 minutes. So 3:05 is your target time to be back. So I will suspend the public hearing until 3:05.

(At this time, a recess was taken from 2:45 p.m. to 3:05 p.m.)

MR. BRIDGERS: If we could have everyone go ahead and take your seats, please, and start the last session. Again, if we could have everyone take their seats, please. As everyone's taking their seats, I will call the public hearing back to order. This time we have four more requested public presentations, and then we will have our open public hearing. So up next, representing the American Iron and Steel Institute, Bob Paine is going to present some comments.

MR. PAINE: Thank you. The American Iron and Steel Institute will also have written comments as of November 4th, but these are preliminary comments for this particular conference.

We would like to acknowledge the achievements and advances with the 2017 Appendix W, for example the -- some LOWWIND improvements, the recognition of urban effects in the large industrialized sources, and basically the issue is source characterization. How to model emissions of nearby sources with somewhat more realistic emission rates and some advances in NO_2 modeling.

Now, areas where more work is needed we would say -- that is, we being AISI -- would be additional progress with LOWWIND improvements, which we discussed a lot. More source characterization improvements, like the plume rise type of things. NO_2 modeling improvements that have been discussed. And, of course, we are waiting for that ever present, almost released Guidance on secondary $PM_{2.5}$ and ozone formation. There is still issues with haul road modeling and also modeling of sources with infrequent emissions or highly variable emissions.

Just getting into what was accomplished, we did get the ADJ U* option implemented. I was supportive of that. There was a -- I would say a last-minute bug fix that was sort of awkward in our view, because it never underwent public review, but it's good.

The issue of the fact that a source -- a source's heat can influence its dispersion environment was an important step forward with now the more acceptable adoption of urban large industrial area dispersion characterizations. And there were advances in the Tier 2 and Tier 3 NO_2 modeling that were approved. More realisms, as I said, in modeling emissions from nearby sources.

Now, areas where further progress is needed. LOWWIND improvements we have been talking about quite a bit, so I will very briefly indicate that one thing we haven't discussed a lot, but that was in the modeling workshop this year -- I wasn't there because I wasn't allowed to be there -- was the minimum Monin-Obukhov length. But I think we discussed that in AERMIC and never got to implement the fact that we wanted to do some sort of up, over, and down type of characterization where you characterize the planetary boundary layer at the anemometer site, but you know that's not where the source is, and then you go up to the planetary boundary layer and over to where the source is and go down to where the source is and you say, oh, it's rougher now, so I'm going to modify the planetary boundary layer. Well, that's never gotten implemented. But a minimum Monin-Obukhov length would be helpful. And I know Roger Brode was working on in the -- 20 years ago, the vertical potential temperature gradient parameterization, and that still needs attention. Of course, additional model evaluation work will be needed for all of this.

One of the American Iron and Steel Institute's favorite issues for source characterization is what they call LIFTOFF. It's basically a fugitive, and Chris Owen was discussing this before. You've got hot sources, very uncharacteristic sources that have a lot of heat that weren't envisioned when, you know, these large tall-stack power plants were doing their field studies. These are unique sources, and they -- their heat influences the dispersion environment. And in the paper that's footnoted in the bottom here, which is a peer-reviewed paper in Atmospheric Environment, we describe implementation of a Hanna-Briggs-Chang approach that takes the buoyancy flux due to this fugitive heat, in addition to the wind speed, and adjusts the amount of downwash that can occur. There was actually a four-month field study where this was demonstrated to be an improvement. So we will -- I will advise AISI to work with EPA to advance this and other concepts like it forward.

And Chris Owen had some good news on his work on the Tier 2 approach on the fact that NO does not instantaneously convert to NO_2, and he had some nice graphs on this, and we hope the next revision -- the next release of AERMOD will have this in it, and it might even be a BETA option, because it has an important effect of the impacts at the fence line which can be very limiting. And right now I believe there could be on the order of a factor of 2 overprediction of the NO_2 formation.

We are awaiting the modeling guidance for the secondarily formed ozone and $PM_{2.5}$. That's been discussed. One issue -- and I was glad to see that the website -- that has all of the distance information, and what we hoped to do is -- and also George mentioned that, at the 2018 modeling workshop, there was a change of guidance, seemingly, that if you had significant secondary emissions but you had insignificant primary emissions, you still had to model both of them. But since they don't often impact at the same place, it seemed to be very conservative. Maybe that will be addressed if we have a way to characterize -- there is a function of distance, the impacts of direct and indirect that is directed secondary PM formation using the tools we have available, but I think we have to look into how well can we do that and put forth a process for doing that.

Mobile sources and haul road modeling. RLINE is an advancement, but there are further issues for review. I think we were hoping to get some sort of evaluation for Las Vegas, but I don't think it has been released yet. RLINE versus AERMOD run with the current approach, with the previous approach, with volume and area sources all strung together.

What about traffic-caused turbulence? When the wind goes to zero, but you have got cars going 65 miles an hour, doesn't that -- what does that do to the turbulence, and is that incorporated into the model?

Roadway barriers, like NOAA did. Apparently, that's been at least looked at, but -- vegetation screens have been looked at too. I think we would like to -- AISI would like to have EPA pay attention to that and try to accommodate, especially for haul road emissions, a way to characterize the effective, you know, reduction of concentrations due to these barriers. And that came back to the -- Chat Cowherd's presentation. And at the 10th Conference he focused on the same thing, and we are still hoping for someday having this accommodated in our Guidance.

Okay. Modeling of sources with variable emissions. Right now, the permit modeling typically requires that sources that are nearby are soon to be operating all the time, which is very conservative. Sometimes sources operate very infrequently, or they have unscheduled elevated emissions, but AERMOD doesn't model very easily. Random elevated emissions are very sporadic, you know, operation sources.

Now, I would say EPA should really consider accepting a modeling of actual hourly emissions if this scenario was likely to be conservative for future operations. So I'm throwing that out as a suggestion. An alternative approach would be to use -- and this has been -- this is alluded to in Appendix B in the April 23, 2014, SO_2 non-attainment guidance, that a randomly reassigned emission approach could be used on random sequences of hourly emissions. That's a more extensive amount of modeling than the modeling of actual hourly emissions, but these are two approaches to be considered for sources that have infrequent operation.

Now, let's go to that Appendix W, Table 8-1. What was changed in here -- and, you know, the nearby sources at the bottom -- my bottom bullet should include sources even at the same facility that are not being affected by a proposed permit change. But the -- if you just address the minimum Btu per hour factor, which is this middle factor, the trouble is that these are not generally independent. When one is high, one could be low. And so I would recommend that you combine these three factors into a simple pound per hour emission rate that you might vary by season and hour, like regional background is variable by season and hour. Why not do it with nearby source emission rates? You just can't focus on one parameter, because they are not truly independent.

And my last issue, I think this was brought up by somebody yesterday about the issue with the cavity -- and I'm gonna sort of dwell on this for a couple of minutes. Let's say you have a wind going from left to right and you have a stack in the middle of this building. The cavity concentration pattern is lined with the far wake concentration pattern, but when you have a building on the -- that has a stack on the south side of the building -- it's hard to see -- but you have got -- the cavity concentration pattern is pulled toward the center of the building where the far wake is aligned with the stack. Similarly with the stack on the north end of the building, the cavity is brought into the building wake toward the center of the building and the -- you know, the far wake is aligned with the stack. And so when you add one at the north and south ends, you get this highly skeptical magnification of concentration followed by a deficit, and then concentration. It's like a fork. This is what the model is really doing now. And I don't know if this is realistic. I think Dave Heist was alluding to this. Hopefully ORD is going to tackle this and maybe, I don't know, the sidewash -- downwash whole thing. But it's currently an issue where you have many stacks on a long building, you can get this very strange amplification factor that seems to me to violate the second law of thermodynamics. And I think that is my last slide. Yup. Good.

MR. BRIDGERS: Thank you again, Bob, and thanks to the American Iron and Steel Institute for their comments. Next up we have Chris DesAutels with Exponent, and he's going to present on CALPUFF. So, Chris.

MR. DESAUTELS: Thank you, George. My name is Chris DesAutels. I work with Exponent, and I want to take us on a little side trip to talk about nonsteady state modeling. We have had -- CALPUFF, specifically, has had quite a number of decades, three or four decades of development, and historically has been used in a number of both regulatory and nonregulatory environments. We have a pretty long history of its use in a variety of situations. And I would say it is still available as an alternative model. We are still supporting model and developing model, so Exponent continues to maintain and support the CALPUFF model.

We are now distributing a new version of model. We posted it recently this week. It includes -- this is specifically on the Version 7. As many of you are aware, there are two versions of CALPUFF. One, the EPA-approved version of the CALPUFF model. The second will be considered the more developmental version of the model, which is currently known as Version 7. This is a new release of the Version 7 model. It includes a couple of small bug fixes that relate to some very specific situations. One related to sub-hourly emissions and external variable files, another related to the use of AERMET .SFC and .PFL files, especially with on-site data and vertical temperature profiles from .PFL files.

But the -- probably the most noticeable addition in the new model release is the introduction of a new AGDISP coupled agricultural spray source in CALPUFF. This is work that was done between the CALPUFF development team, AGDISP team, and the U.S. Forest Service.

In addition, we also have posted updates of post-processing utilities, specifically to handle the new source type, mainly just for header record reading. There's really no change in the formulation there. There is an update to CALWRF to correct a bug related to precipitation processing, specifically the first hour in transition between two separate WRF out-files, and we have also posted some new documentation for the features that are in the Version 7 model which include not only the agricultural spraying option but the roadway and flaring, and some of the other utilities like CALMAX, CALRANK, and CALAVE that didn't previously have as much documentation available. There is a new Version 7 User Guide Addendum for user instructions for those options. So that's all on the website at src.com now.

And as I mentioned, the Version 5 version of the model, EPA-recommended version, remains unchanged, so there is no update to that at this point.

I think it's useful to kind of look at the nonsteady state approach still. A lot of the conversations we have been having over the past couple of days involve some very challenging situations, places where we are pushing limits of some of our modeling formulations, low wind speed, long-range transport, complex terrain, over-water dispersion, sub-hourly emissions, sub-hourly dispersion considerations. And these are places we are looking at other model formulations, potentially, including nonsteady state formulations could provide some good structural means to answer questions that are important to the modeling community.

The balance of the presentation I have is actually going to look at this new spray model, because it is, I think, a useful example of some of the capabilities and applications of the specialized case. It may not fall strictly within a lot of the regulatory applications, but I think it is still illustrative, and I have got some pretty pictures too, so.

As background, this was developed as a linkage between AGDISP and CALPUFF. The near-field turbulent mixing of -- this is representing agricultural spray from an aircraft. So AGDISP will calculate the near-field turbulence of the spray droplets that are released from the aircraft and calculate for wind vortexes and evaporation, droplet breakup, and other properties. And then the goal was to have further transport handled by CALPUFF.

There was an agreement between all parties that we wanted to do this as part of an external handoff file with the goal of not producing any Frankenstein model that would result in maintenance issues going forward. We wanted to have each model independently taking care of its part of the business and hand off an agreed format in the middle, so that when CALPUFF had additions or AGDISP had additions, you wouldn't have to go back and reassemble the combined link model.

The work involved team -- Milt Keske of Continuum Dynamics. I'm with Exponent. Harold Thistle of the Forest Service was coordinating that effort.

And this kind of just illustrates, you know, the serial nature that was being followed. AGDISP calculates the near-field impacts related to aircraft, droplet dispersion, droplet deposition and evaporation. So the on-target deposition of droplets onto the agricultural field. What's left over gets written out to an external file of time during records, including droplet sizes and positions, which are then picked up by CALPUFF.

So to take an even further site, I have a couple slides talking about AGDISP, just so you understand how this all fits together, and we can see kind of the CALPUFF formulation of it. The important picture here is down on -- down on the right corner. This is a picture of what AGDISP produces at the kind of handoff point in the model formulation.

In this picture, the aircraft is flying into the -- into the picture here. AGDISP is characteristically a two-dimensional model. It tells you where the droplets are, the size, the position of them, the distribution of them, just I think distance away from the field, and height above ground. It doesn't know about the ends of the spray line, it isn't registered in three-dimensional space in the world, it's a two-dimensional model of particles and deposition away from the end of the field. So this is a two-dimensional plot of what AGDISP knows about. It's a very complex distribution of material. You can see the wings have more to feed, you could see drag where there are lower elevation droplets that are being transported less distant from the field. The distance from the end of the field is about 100 to 200 meters downwind. So that's about the point of which this handout is happening where the AGDISP calculation is ending and CALPUFF is picking up.

Each point on this map represents a distribution cloud of droplets of a specific size. So that's how AGDISP tracks their droplets and their calculations. And each one would be a different separate position and also have a specific SIGMA distribution around that point. So all these various dots on the page overlap to produce the entire kind of complex two-dimensional cloud, cross-section of the spray line of a plane coming, dropping down agricultural spray, getting mixed in the wake of the aircraft and evaporating.

As part of the formulation of this, AGDISP did add a panel to the output options within AGDISP that allows you to specify beginning and end position, so that could be supplied to CALPUFF along with the length of the spray line, which otherwise it does not know about, direction of the spray line, base elevation, things you need in order to register this in space for use with a

CALPUFF model.

Okay. So that's the AGDISP. On the CALPUFF -- and to back up a little bit, as most of you are familiar, the model is called CALPUFF. Distributions of concentrations, whether particulate, or droplet, or gaseous are represented as puffs, classically. A gaseous distribution about a center point, but there is also a secondary formulation within the model called a slug. We don't call it CALSLUG, but it's another way to distribute the material within the environment. It's been there throughout the history of the model. So this is not a new formulation but something that's been available to model all along.

A slug is an integrated distribution of mass. It has a -- for a point source, you would have a pollutant that is released, one end of the slug stays attached at the source, and the second end of it is released and grows with time as the SIGMA grows. So you have a new end and an old end. When it's released, it will be transported out to the environment as an integrated slug. So you will have two ends of different SIGMAs, but they will both grow with time and be transported. And it goes through all the standard properties of --

CALPUFF does, including transport deposition, downwash, all those related properties.

The spray source makes use of this formulation, but it does it in a unique way by rather than releasing over time, it releases a slug in one-time step. So it's released instantaneously. Both ends are at the same length, so it's kind of the square to the rectangle. It's a specialized kind of slug. From then on, it could be treated in the same way the model always has. So there's really nothing new in dispersion science here. It's kind of a bookkeeping process we have been going through. And for me to name everything, we have come to name these rods. These are actually the same formulation that was used in introducing the roadway model. So the rod source-type formulation is this distribution that is elongated and the same is instantaneously released. And it can be transported based on its center point in any direction as it moves downwind.

So to bring the two together, what we do is we take our AGDISP distribution as put out from AGDISP. It gets oriented in space properly, and then for every particle position AGDISP represents, we can put in a rod that represents the length that the plane traveled. Remember that the AGDISP plane is kind of a cross-section. And for every one of these, we can put in a rod. There may be several hundred to 1,000 different positions which results in a fairly substantial number of rods, but it's an instantaneous source. There is one set of these put out and then transported further downwind. And if you have spray lines that the plane will come and pass several times over a field, you can accumulate several lines of these. So you will have these rods being disbursed downwind. Each rod has a unique particle size and droplet size associated with it, and it's associated with a rod as opposed to with a species now, and it will be deposited on a rate based on the droplet size.

So to put a little pretty animation with this, this is a demonstration where there are 10 spray lines going down the fields. I believe there are 10. So there is the first line that dropped down and transported, the second line, third, fourth. So you are moving back across the field, the position level, the aircraft is going to the left while things are being disbursed to the right and accumulates 10 separate dispersions, and then the whole mass can be tracked downwind. Whoops.

One step too far.

So it's a nonsteady state application. It's a very specialized and, you know, unique distribution of material, but it fits well within the formulation of a Gaussian puff model and capability coupled with an agricultural spray model such as AGDISP.

We say we are continuing to work with CALPUFF. Some things we are looking at -- we are looking at other unique events of this type to solve specific problems. This consideration -- we did not do evaporation at this point. The handoff was done after evaporation ended in AGDISP, but the model was set up so that all the parameters necessary to do evaporation are actually in the model so that such a process could be initiated. And potentially also track phase change from a liquid droplet to a gaseous phase. It would be a rather simple addition to do that.

We've also been integrating CALPUFF with the PERFUM model, which is a fumigation model, so it's another agricultural application. We have been considering some other NO_2 possibilities of OLM, potentially. Some of the other NO_2 formation options we have been talking about today, and potentially on the roadway sources, is to bring in more refined roadway emissions into the roadway source that's been developed in Version 7. So that is the end of what I have.

MR. BRIDGERS: Thank you, Chris and Exponent, for your comments. Next up, we have Mary Kaplan, and she is presenting on behalf of -- she is presenting on behalf of AECOM, and a discussion about problems with permitting and primary and secondary $PM_{2.5}$ emissions.

MS. KAPLAN: Thank you, George. You know, I really enjoyed seeing the presentations today about the examples for the Tier 1 analyses, and I'm looking forward to receiving the Guidance for the $PM_{2.5}$ permitting, but, you know, there is -- the examples are very straightforward for, say, a new facility with a set emission rate or a PTE emission rate, but when you have an existing facility, things get a little complicated. So I have questions, sort of advanced comments for the Guidance that's coming out, and it may not be addressed in the draft Guidance, but I hope it will come out in the final Guidance next year. But in the interim, I think things are kind of a little muddy. So I wanted to ask my questions, in a way.

So I will go quickly over the Guidance issues for some of our typical PSD projects for an existing facility, you know, what we have to deal with. You know, concerns for Class 1 areas, we have seen some good examples today. Some issues with Tier 1 and Tier 2 complications, and a few recommendations I have.

You know, we have the Appendix W Guidance and the Guidance for the MERPs that was released in April 2019 that was very helpful with some good examples. But as Bob and others have talked about, things get -- things change downwind distance from -- you know, that are -- the maximum is not in the same location for the primary $PM_{2.5}$ as the secondary, often enough, especially if you are modeling things like roadway emissions, or cooling towers, things that are low-level sources versus your high-level sources that are typically NO_x and SO_2 combustion driven. And so that makes things a little complicated. You know, I look forward to using that distance-dependent tool that Mark showed us the demo for earlier today.

But, you know, so here's one of my favorite clients. We try to do projects for them pretty often, and we keep running into these issues in the last couple of years. You know, the facility's had a PSD review for some of the precursor pollutants for NO_x but not for $PM_{2.5}$. So what do we do with that? Things are a little different. We do have a Class 1 area that's just beyond 50 km, so that's always a little challenging. And there is a lot of complex emissions changes. You know, they do some retirements of some of their sources, they are gonna build a new source, they are going to debottleneck some other things. But in the last few years they have also done some minor permitting projects. You know, they want to take advantage of market conditions. So they make some little changes here and there as minor PSD -- or, you know, minor permitting. And all of that ends up sitting in the contemporaneous period when we go back to do another PSD project. So -- and there's different contemporaneous periods, depending on when they last went through PSD for a particular pollutant. That -- you know, I have questions about that. So -- but the April 2019 guidance doesn't address a lot of this. You know, it only talks about a source having these emissions, and that's it.

So for our project, we are doing the past actual to future potential emissions due to the higher throughput of these new combustion sources or changes in the existing sources. They have got some cooling towers that may see some increased use. You know, they may bring in some additional materials, and there is some paved-road traffic for some increase in exports. But the permitted emission rates for the existing sources are not changing. So we are not gonna really see an increase over their permit emission rate that has already been probably modeled in the past.

And then they have some fugitive sources that are near the fence line. These don't create secondary $PM_{2.5}$ emissions. You know -- and those modeled hot spots are quite different from our combustion sources.

So the April 2018 Guidance, you know, they have no mention of contemporaneous sources or what to do with contemporaneous emissions. And, of course, we are still waiting for the permit Guidance, and hopefully we will definitely see that before the holidays.

So this lack of guidance leaves me with a lot of questions. You know, do we model the project-affected-only emissions, or the project-affected plus contemporaneous sources for calculating our MERPs? You know, it makes a big difference. And if those contemporaneous emissions are already accounted for in the background monitor concentration when we get to NAAQS modeling, how do we deal with that? Do we go back to only modeling the project sources to figure out which receptors we might be above the significant impact level at for NAAQS modeling, or do we still have to double-count with those contemporaneous emissions and model everything to get the number of receptors that are exceeding the SIL?

So modeling these different approaches gets very different outcomes. Our SIL will just get -- our SIA will just get larger and larger, depending on how conservative we end up being. And if you are in an area where there are some other sources, you know, that makes for very complicated cumulative NAAQS modeling.

You know, we have a particular project where there is another source across the street. They don't have SIMS. They are a chemical facility, so it's more of a batch process. How do you try to make actual emissions out of their annual emissions to get something more reasonable when you have receptors that are very close to their sources? You know, it makes for a big challenge. So all these questions play into how successful of a modeling analysis that we can have.

For Class 1 areas, it's -- as I said, I have a Class 1 area that is about 50 to 55 km away. So looking at AERMOD at 50 km, and initially we were calculating our MERP value at about 0.37 micrograms per meter cubed, which is already above the SIL for a Class 1 area. So that had me concerned, but then I found out about the distance-dependent concentrations, and I look forward to using the app tool that we were shown a little while ago to try to make some refinements to that. And then going beyond the 50 km, I -- we already saw that the tool will help address that as well, so I'm glad to see that.

In terms of the other AQRVs and addressing some of that, Bret mentioned yesterday that they still like CALPUFF for the AQRVs, so I found that interesting. And, you know, it's which approaches can we use CALPUFF versus the CAMx, and what we do with that. So those are questions.

And for us, it's doing any kind of model evaluation, in addition to some of my other questions that I thought of, you know, how do you do that for over water? If you have a source that's on the coast and you're modeling, say, a Class 1 area that's also on the water, doing a model evaluation for something like that, I guess I have questions about. So -- because there really isn't a station to use to verify. So interesting questions too.

Tier 1 versus Tier 2. Everyone has said that hopefully you won't have to do a Tier 2 very often, and generally a Tier 1 is a lot easier and more straightforward. The Tier 2 is pretty time consuming, and you are not guaranteed to get better results. So that's -- hopefully all of us can go down the Tier 1 road and not the Tier 2 road.

So but -- just my recommendations, it's -- you know, hopefully the upcoming Guidance will provide answers to some of our questions regarding what emissions we have to model and things we have to do. For these more complex sources where things are staying existing emissions and sources and, you know, making the data for peak primary and secondary impacts available, well, I was gonna suggest the GitHub option, but the tool looks pretty cool, so looking forward to that.

And, you know, maybe updating the modeling Guidance to include a Tier 2 example if one exists. There are all those great Tier 1 examples, and there is the tools on the GitHub server, but -- and hopefully the Guidance will be complete soon. That's all I have got.

MR. BRIDGERS: Thank you, Mary, and thank you, AECOM, for those comments. The last of our requested public presentations, we have Christopher Warren, also with AECOM, to give his presentation on innovative techniques for AERMOD.

MR. WARREN: Thank you, and good afternoon. I would like to take this opportunity to highlight some innovative techniques for dispersion modeling. In particular, I would like to focus -- I can't touch that. In particular, I would like to focus on the temporal scale of Bowen ratios, urban characteristics of highly industrialized areas using thermal satellite imagery, and recommendations to further enhance AERMOD's debugging capabilities.

In situations with tall stacks in simple terrain, peak ambient concentrations are often observed when rising convective mixing height reaches a stable plume aloft and mixes it to the ground. Therefore, a critical performance criterion for any steady-state air dispersion model is to be able to accurately estimate the rate of the growth of the convective mixed layer during daytime hours. In its under form, AERMET has a refined temporal resolution of monthly for surface moisture.

The final stage of AERMET incorporated three surface parameters: roughness, albedo, and Bowen ratio, which is the ratio between the sensible and heat fluxes. Research-grade studies utilizing on-site rapid response instruments measuring sensible and latent heat fluxes indicate this ratio fluctuates on a daily and even hourly basis.

Here's an example of one research-grade study. The blue bars represent daytime average Bowen ratios. The orange circles are total daily rainfall. And the red dashed horizontal line is the monthly average Bowen ratio. Note the day-to-day fluctuations of the blue bars or daily average Bowen ratios. It is evident that the daily fluctuations can change significantly between dry and wet days. The same holds true in this particular month where daily Bowen ratios drop by more than twice the monthly average on wet days versus dry days.

Recent findings using research-grade databases indicate AERMET's skill in estimating the magnitude of the convective mixed layer can improve along with the timing of the inversion breakup by a daily selection for moisture characterization.

The current version of AERMET's user's manual actually has a section that describes a procedure to develop sub-monthly time periods by comparing 5-day to 30-year average rainfall. We encourage EPA to consider adding the capability of AERMET to accept and process daily Bowen ratios.

Now, switching to a technique that can identify urban characteristics in highly industrialized areas. As we know, anthropogenic heat releases can cause urban heat island effects. This effect, in turn, prevents the boundary layer from becoming stable at night. We have found that emission sources in highly industrialized areas with significant heat releases may be better characterized with urban dispersion rather than rural. These facilities may include metal processing, such as aluminum smelters or steel mills; oil and gas refineries; taconite processing facilities; and pulp and paper mills.

AERMOD has an urban model option that parameterizes the nocturnal boundary layer using a population input variable. The urban formulation uses a relationship between the urban/rural temperature difference and the equivalent population. Satellites provide us with a large data set of surface temperatures, and this data can help inform the applicant of this urban characterization technique.

Note the warmer, brighter colors denoting higher surface temperatures for a steel and coke mill in Clairton, Pennsylvania, compared to its cooler rural surrounding. These hot temperatures are very similar to those seen in downtown Pittsburgh.

Satellite-derived temperatures can be quite accurate and detect surface temperatures -- surface temperature pertubations as small as 1 to 2 K for 100-meter resolution images.

Note the temperatures obtained by the satellite are nearly identical to the airport's meteorological station in this figure. Only two tenths of a degree Fahrenheit between them.

Highly industrialized areas operating 24/7 in unpopulated areas can create an urban heat island effect. An equivalent population can be estimated through the use of satellite data. Urban characterization of these highly industrialized areas in AERMOD has been shown to improve model performance when compared with monitored concentrations. The latest updates to Appendix W have allowed for this procedure with appropriate documentation. The source characterization technique has been used and approved by EPA without the need for an alternative model approval. We commend EPA's acceptance of this approach and encourage this extension to other source characterization techniques already developed.

Finally, I would like to end with the following innovative techniques. The first has kind of already been discussed in a couple of the presentations. It's a comprehensive debug file that can be used for determining several plume dispersion properties, including whether the plume could reach a peak impact receptor within one hour for each modeled source.

The second technique introduces a new keyword in the control pathway called HABINARY

[sic] that allows for the import of the AERMOD unformatted one-hour binary output from a separate model run. These input concentrations are then added hour by hour to the current model run for generation of a statistical averaging of ranked highs for all currently evaluated averaging periods.

An example from the distance-debug package. By using a new keyword in the control pathway of AERMOD, a file is generated that produces plume and meteorological details for each hour modeled. Each point source is listed along with the peak receptor and associated plume dispersion properties. One such feature is identification of a plume type. In this case, the plume was penetrated for both sources on this day and hour. I think it's important to know what the model is doing and what is going on and not just assume that it's a black box. And that's why I think having debug files is important, not going away from them.

As I mentioned, HABINARY has the capability of taking two separate AERMOD runs and merging them together to generate a final statistical -- combined statistical output.

However, any data imported must adhere to six important conditions: use of exactly the same receptor file, meteorology covering the same time period, identical downwash for all sources between the two runs, the same modeling period, one-hour binary files, and values only for the all source group. Currently, the program does not check for source group by name.

HABINARY could be used by the user to add the results from a previous AERMOD run to an active AERMOD run. This approach would be ideal for sensitivity testing involving multiple sources in which the parameter of only a handful of the multiple sources were varied.

In conclusion, I hope to see functionality added to AERMET in the future -- future at least to be able to process daily varying Bowen ratios, continued support of source characterization techniques, and incorporation of additional tools within AERMOD, such as distance-debug and HABINARY.

Thank you for this opportunity.

MR. BRIDGERS: Thank you very much, Chris, for the presentation and AECOM for the comments.

So this brings us to the part of the presentation where we will accept additional oral comments from those that didn't request. I should have shown this slide right after we transitioned, but it was most pertinent here. For those that may want to offer oral comments, I just want to remind you that this is a transcribed public hearing. For those that want to not provide oral comments and would like to provide written comments, there is a reminder here that the docket -- EPA-HQ-OAR-2019-0454 is the docket for these proceedings, and we will welcome comments in that docket through the end of the day on November 4, 2019.

So this is your opportunity. If there were anyone that wanted to present oral comments, I invite you to the microphone. If you do speak, you do need to identify yourself and your company representation.

MR. PORTER: All right. Thanks for this opportunity. I'm Matt Porter, North Carolina DEQ. I would like to comment on emission rates for screening analyses. And this is under the PSD program. And based on the following assumptions, assuming a project is over the significant emission rates, and it is a big -- gonna be going through PSD analysis and review, and also assuming that the objective -- any SILs or AQRV screening analysis is to protect the NAAQS and increment and AQRVs.

So, yeah, I would like to comment on the -- yeah, the emission rates for single-source impact analysis, as discussed in Appendix W. And you can also refer to that as the SILs or AQRV screening analysis. So, essentially, the screening analysis approach, a de minimis approach, has been discussed -- as George has alluded to, it's been used for 30, 40 years, since the inception of Clean Air Act programs.

And over this past year, I've tried to find any Guidance documents at the federal or the state levels that discuss how to come up with emission rates to -- with supporting technical arguments on how to calculate net emission increases for any SILs or AQRV screening analysis. I found no specific examples or technical arguments discussing pros and cons of doing it one way or the other. So I'm not aware of any Guidance documents that go into the depth required to support how to calculate those emission rate increases or decreases. If anybody else has knowledge of those types of documents, I would be interested in hearing what your inputs are.

Some states provide the guidance, but there is no real background and technical arguments to support the options proposed for calculating those emission rate increases and decreases. The net emission increases is, essentially, what I'm referring to. So in absence of any definitive technically defensible guidance, I decided to go look at what the rules require.

And under the PSD rules for the source impact analysis, subpart 51, 166, paragraph K, in brief, allowable emission increases and associated increases in reductions for any PSD project would or should not result in exceedances of the NAAQS or the increment or, in the case of Class 1 areas, AQRVs. And this applies to all pollutants -- all PSD pollutants and averaging periods, and AQRVs visibility deposition, for example.

Now, allowable emissions is defined under the PSD rules as being, in brief, enforceable, either through NSPS, or SIP, or potential to emit. Now, the increase is not well defined, so getting back to this net emission increase issue, how you go about calculating the net emission increase using the allowable emissions minus some baseline. Now, the baseline emission rate would inevitably come from some -- some baseline that the atmosphere would see, conceivably. But I will get into that a little bit more.

Essentially, the objective of any of these calculating the net emission increase for producing an emission rate to feed into a SILs analysis or AQRV analysis is to protect those -- those standards. And the form of those standards, be they deterministic or probabilistic.

The other part of the PSD rules which are fairly prescriptive refer to Appendix W, and in Appendix W, the single-source analysis is considered the first phase of any model demonstration. And I'm paraphrasing here: It's used to identify a potential worst-case emissions and worst-case operating scenarios. And within that context, it would make the most sense to calculate the net emission increase based on an annualized hourly baseline emission rate to capture all hours of the year for all different operating scenarios for any particular source.

So, essentially, the objectives for any

screening SIL AQRV analysis should be, if you are less than those SILs, or, you know, in the case of AQRV analysis, less than 10, the q/d flag 2010 criteria, you're assuming the project and all the sources within that project would not cause an exceedance of the NAAQS with increment or the AQRVs at any Class 1 areas within 300 km of the project.

The other objective would be the -- from a state perspective, is that this net emission increase methodology -- the calculation methodology would be fair and consistent for all source types and applicants, be they continuous, batch, or perhaps there are sources with larger operational variabilities to consider.

And the other final objective would be that calculating this -- the net emission increase for the screening analysis would be simple and defensible for permit authorities to explain and enforce if need be.

MR. BRIDGERS: Thank you, Matt and NCDEQ, for those comments.

Once again, I offer the podium for anyone that would like to offer oral comments to the docket.

(No response.)

MR. BRIDGERS: Once again, I will make a second offer.

(No response.)

MR. BRIDGERS: I will have the record reflect that there were no other offers or oral comments. I will reiterate that we do have a docket that will be open until November 4th for written comments.

As we close our public hearing, first and foremost, as I started the public hearing, I want to thank everyone for their participation over the last two days. I've heard a lot of positive feedback, but I also would like to get your critical feedback in the days to come as well. I hope your journeys home are safe, or wherever your journeys may take you, and will say it's been my distinct honor to have been the public hearing officer for the 12th Conference on Air Quality Modeling, and by here we will close the conference.

(Conference concluded at 4:04 p.m.)

CERTIFICATE OF REPORTER

STATE OF NORTH CAROLINA)
COUNTY OF WAKE)

I, Joann Bunze, RPR, do hereby certify that the foregoing represents a true and accurate transcript of the proceedings held at the United States Environmental Protection Agency in Research Triangle Park, North Carolina, on Thursday, October 3, 2019.

I do further certify that I am not counsel for, related to, nor employed by any of prty to this action.

This the 10th day of December, 2019.

JOANN BUNZE, RPR
Notary Public #200707300112