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NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS (ACRS)

MEETING OF THE SUBCOMMITTEE ON POWER UPRATES

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WEDNESDAY,

OCTOBER 10, 2007

VOLUME II

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The meeting was convened in Room T-2B3 of Two White Flint North, 11545 Rockville Pike, Rockville, Maryland, at 8:30 a.m., Dr. Sanjoy Banerjee, Chairman, presiding.

MEMBERS PRESENT:

SANJOY BANERJEE	Chair
OTTO MAYNARD	Member
WILLIAM J. SHACK	Member
SAID ABDEL-KHALIK	Member
OTTO L. MAYNARD	Member

JOHN D. SIEBER Member

CONSULTANTS TO THE SUBCOMMITTEE:

THOMAS KRESS

GRAHAM B. WALLIS

ALLAN PIERCE

DAVID DIAMOND

NRC STAFF PRESENT:

THOMAS SCARBROUGH

KAMAL MANOLY

SAMIR ZIADA

STEPHEN HAMBRIC

ANDY du BOUCHET

JOHN WU

VIKRAM SHAH

SAMIR ZIADA

BOB PETTIS

ANGELO STUBBS

RICK GUZMAN

JOHN PARILLO

ALSO PRESENT:

JOHN BARTOS, II

JAMES WILLIAMS

KEVIN BROWNING

DAN PROPONI

ENRICO BETTI

ALLEN BRYAN

MICHAEL CROWTHERS

RICK PAGODIN

RICK DOTY

TABLE OF CONTENTS

P-R-O-C-E-E-E-D-I-N-G-S

8:31 a.m.

CHAIRMAN BANERJEE: I'm bringing the meeting back into session, and I'm going to keep my remarks to the minimum, which is to say nothing, other than to say that today in the morning and part of the afternoon we'll be dealing with steam dryer issues and vessel internals.

And to kick this off, we'll have John Bartos from PPL make the first presentation.

And I guess, John, you have an open session, and then we can close the session any time you want. You just ask for it.

MR. BARTOS: It's marked in our presentation, open and closed.

CHAIRMAN BANERJEE: Okay. So from the viewpoint of transcripts, this is going to go into open session right now, and then when we close it, it will go into the closed transcripts.

Everybody has the slides and everything.

Allan, you have the slides?

MEMBER SIEBER: Slide 63?

CHAIRMAN BANERJEE: Right.

If he hasn't, Theron, can you make sure

he gets a set of slides?

I see General Electric is there as well.

MR. BARTOS: Good morning. My name is John Bartos. Again, I'm the CPPU lead engineer.

This morning -- let's go to the next slide -- we're going to talk about vessel internals and steam dryers. A major portion of the talk's going to be on the steam dryer. At the end of the presentation, I'm going to give you a quick overview of the vessel internals evaluation.

But basically, on the dryer, what I would like to cover is a -- the Susquehanna steam dryer, basically describe it, you know, talk a little about its history, because its history is really relevant to the analysis that we have done.

I'm going to talk about the analysis that we performed on our current -- the dryer that's actually installed in our two units and how we went about trying to calculate and project what the stresses would be at CPPU conditions. And I'll talk about our decision to replace the steam dryer and to put new ones in.

And I'm going to talk about the analysis that we have done to date on the new dryer and the projected stresses at CPPU conditions. We've made a decision to instrument one of the new dryers. I'll talk about that.

There was a question yesterday that came up as to why we're instrumenting this dryer, which is only going to be there for half of the step-up to the EPU, and the other dryer, which is going to go to the full EPU, isn't going to be instrumented, and that was a decision that we wrestled with also, and I'll talk about that later -- cover that.

And again, as I said, I'll briefly give you an overview of the reactor vessels internal evaluation. So let's go to the first slide.

This is a picture of the current Susquehanna steam dryer. That's what GE calls their third generation steam dryer. The first generation, the hoods were square. The second generation, they were slanted. And the third generation, which we have at Susquehanna, is a curved hood design.

The current steam dryer was fabricated as a non-safety-related component. It wasn't fabricated to any of the ASME codes. Construction was basically to shop standards that were present at that time.

When we first started up Susquehanna Unit 1, at our first refueling outage we went in and did a vessel internals inspection, and there was a significant fatigue crack that was observed, and it was along the weld on the seam of the second dryer bank. It was a fairly significant fatigue crack in the weld.

GE evaluated the crack, did some initial analysis and determined that they could generate a fix which they thought would correct the problem. The fix involved welding a strip along this edge of the hood to stiffen up the outer section of the hood here.

The fix was implemented on the dryer, but there were still some questions as to what actually caused the fatigue failure. So we decided to instrument the dryer back in 1985. Essentially, the suite of instruments that was installed at that time was -- there were a number of strain gauges mounted around the patch.

There was also a set of strain gauges on the other side of the dryer that wasn't patched that was symmetrically correspondent to that, to the crack. We installed a pressure instrument on the cover plate in this area.

And there were four accelerometers installed around the ring. One of the things we were worried about was the dryer rocking, so we installed some accelerometers.

We went up in -- there was a power ascension plan after the outage and the fix. There was a lot of data taken. Essentially, we took data at various power levels as we ascended. We also took data during normal plant events like running HPCI and RCIC, closing an MSIV. So there was a lot of data that was taken with those instruments.

The purpose of the suite was -- of the instrumentation suite was to prove that the fix worked, and it did do that. It showed that the stresses around the patched end of the hood were significantly reduced.

After that, GE -- the following outage, GE applied the fix to both -- to the other side of the second bank, and also there's -- looking at the other side, they applied them to the second bank ends also.

This fix was also applied to the rest of the fleet that had the curved hood dryers so the subsequent plants also received this fix.

Because of the cracks that we have seen during the first outage, we routinely inspect our dryers. Since that point, we've inspected them. We have noticed --

CHAIRMAN BANERJEE: How do you inspect them?

MR. BARTOS: It's a visual inspection. When the BRB/WRB I.P. came out with their inspection guidelines, we were very close to their criteria and we only had to make minor adjustments.

CHAIRMAN BANERJEE: Do you put some sort of endoscope in, or --

MR. BARTOS: It's a visual inspection.

CHAIRMAN BANERJEE: -- lens on the end, or what do you do?

MR. BARTOS: Bruce, would you like to address that, please?

MR. SWOYER: Bruce Swoyer, PPL Susquehanna. We use cameras. They've dropped cameras down. This is in the equipment pool, and they drop cameras down and take a look at all the various areas of the dryer. So it's done by cameras.

CHAIRMAN BANERJEE: Is everything accessible by camera?

MR. SWOYER: Yes.

CHAIRMAN BANERJEE: So you can see all the important areas?

MR. SWOYER: Yes, on the outer side. We don't go inside.

CHAIRMAN BANERJEE: So what happens if there was a crack on the inside?

MR. SWOYER: Well, if there's cracks on the inside, they end up having to propagate all the way through. It's so tight in there, it's very difficult to get anything through the center of those banks anyway. There's no -- hardly any way in which you can put a camera in there.

We have looked at --

CHAIRMAN BANERJEE: What are the spaces -- what is the spacing there?

MR. SWOYER: Well, we have looked at -- if you look at the banks as they go on -- we have looked down the center of those banks with cameras, but as far as going up underneath and looking from the inside to see what was going on in the inside, it's virtually impossible to do that.

CHAIRMAN BANERJEE: Have there been any cracks found on the inside?

MR. SWOYER: No, there has not been.

CHAIRMAN BANERJEE: Thank you.

MR. SHACK: Is this an enhanced VT-1 now? Is that --

MR. SWOYER: It's called VT-1.

MEMBER SHACK: Oh, it is --

MR. SWOYER: It's not an enhanced VT-1. The VIP says that it's a best effort VT-1.

MEMBER SHACK: But do you have criteria for resolution of a, you know, mil 1 --

MR. SWOYER: Yes, we do. We do it for-- matter of fact, if we can get an EVT-1, we will get EVT-1. We have done inspections where we found cracking. Any time they see any kind of indication, they come in and try and get the best shots they can.

CHAIRMAN BANERJEE: I forgot in my introductory remarks to introduce Dr. Allan Pierce, who is here from Boston University will be serving as a consultant to us on acoustics and the steam dryer issue, and Dr. Pierce has a question to ask, I think.

After that, feel free to interrupt and go ahead and whatever.

DR. PIERCE: My questions will probably seem very naive, because, up until two weeks ago, I didn't know anything about the nuclear power industry. I do know a fair amount about acoustics.

One of the things that sort of bothers me is that apparently in between these things there is a plate which has vanes inside of it. Is that correct?

MR. BARTOS: Yes. Well, the dryer banks themselves -- there are six banks --

DR. PIERCE: Yes.

MR. BARTOS: -- and they have chevrons, and that's what actually accomplishes the drying. The steam comes up the hood, goes through the banks which have the vanes, comes out the other side. There's a perforated plate on the other side of the vane bank, and the steam comes up vertically, then comes down and goes over the -- out to the vessels.

DR. PIERCE: I guess -- my initial guess is that the vanes are things that bad things would happen to. Do you ever inspect them, or is there any way that you can inspect them downstream?

MR. BARTOS: No, we don't inspect them. I can ask GE. GE has, I guess, inspected several dryers that have been removed.

Has GE ever seen any problems with vanes?

MR. PROPONI: This is Dan Proponi of GE

Well, one thing is that these vane assemblies are between two perforated sheets, so we've got a sheet upstream and a sheet downstream, the purpose being to spread out the flow evenly through the vane assemblies themselves.

So we don't have an opportunity to go in and inspect on a dryer like Susquehanna's. The earlier ones, very early dryers, we did not have those perforated plates, and we can see the vanes. We haven't seen any issues with the vanes themselves.

MR. BARTOS: It's also our understanding that the velocity through the vanes is fairly low.

MR. PROPONI: Right, it is very low.

DR. PIERCE: The history, which I tended to study, said there were bad things happening in Quad Cities. Was there anything bad that happened to the vanes in Quad Cities?

MR. PROPONI: No, there's nothing that happened with vanes themselves.

DR. PIERCE: Okay.

MEMBER SIEBER: Just to sort of fill out the record, could you tell us where the steam lines are with respect to these drawings.

MR. BARTOS: Yes, that's on one of the next two slides I have.

MEMBER SIEBER: Oh, okay.

MR. BARTOS: Yes, I'll do that.

There's a little more -- I wanted to talk about the history. We've seen some IGSCC cracking. We -- when we -- when we find IGSCC cracks, we look at them, evaluate them, determine whether they're structural or not. At this point, we haven't seen any structural IGSCC cracking.

But we do catalog that and we look at it during every outage to see if there's any growth. In 2005 and six, both the Unit 1 and Unit 2 dryers, we did observe a fatigue crack. It was a crack in a weld. There's a plate which connects the first and second bank, and there was a crack along the weld that's behind this lifting rod.

We found it on one unit in 2005 and we

found the same crack on the other unit. Those cracks were repaired, and we looked -- we now look at those areas pretty closely every outage. Let's see.

MEMBER ABDEL-KHALIK: How much does this whole thing weigh?

MR. PROPONI: This is Dan Proponi from GE.

Offhand, I think we're in the 110,000-pound range, or --

MR. BROWNING: This is Kevin Browning, PPL.

The dryer design report documents that they weigh 80,000 pounds, the current dryers.

MEMBER MAYNARD: The new ones will weigh more, is that --

MR. BARTOS: Yes, they will.

MR. BROWNING: That's correct.

DR. PIERCE: Am I correct in -- I read that the diameter of the skirt down there is about 20 feet. Is that right?

MR. BARTOS: Yes.

DR. PIERCE: And it's all steel, right?

MR. BARTOS: Yes.

Okay. This answers the question.

MEMBER SIEBER: Well, it really doesn't, but go ahead.

MR. BARTOS: Well, it -- the -- this is -- represents a schematic of the steam dryer. These -- the red lines are the vane banks. And the vessel nozzles for the steam lines are positioned so that one bank faces two steam lines and the other bank faces the other two steam lines.

They're not 90 degrees apart. They're centered around the 90 and 270 degree azimuths of the vessel.

MR. WALLIS: Actually, it's pretty tight in there. There's a -- there's a very sharp bend, isn't there? There's not much room for the steam line, is there?

MR. BARTOS: No, there are a number of bends in the --

MR. WALLIS: Right, so this is -- this sort of exaggerates how spread out --

MR. BARTOS: Oh, yes.

MR. WALLIS: -- it is.

MR. BARTOS: It does.

MR. WALLIS: The lines are actually very

close to the vessel.

MR. BARTOS: You're correct.

The other thing this was meant to do is to show you the arrangement of the safety relief valves and the -- and roughly how the steam lines are arranged and leave the containment.

We have 16 safety relief valves, as we mentioned yesterday. The heavy black dots represent the safety relief valves. We have three safety relief valves on the Charlie and Bravo lines, and there's actually active steam flow passing those safety relief valves.

We have an additional 10 valves, five on the Alpha and five on the Delta lines, but they're located on dead legs, where there's actually no active steam flow. Steam leaves the nozzle, comes down, and goes up the steam line. So these are what we've called -- termed dead legs, but they -- they only see steam flow when you lift a valve.

MR. WALLIS: So it's the ones which on the outside there would have the Strouhal number of point two or something.

MR. BARTOS: Yes.

MR. WALLIS: All right.

MEMBER MAYNARD: Question on those dead legs. How do you, after an outage, make sure you have all the air out of those? The problem's in some areas when you have a dead leg that gets air in it. You know, air can lead to corrosion and stuff. As long as it's all pristine, you're okay.

MR. BARTOS: Operationally, I'm not -- Jim?

MR. WALLIS: As long as it's just air and not hydrogen and oxygen.

MR. WILLIAMS: This is Jim Williams, PPL Susquehanna.

Before we start the reactor up, we open up the main steam lines and they're close to the condenser vacuum so there's no air flowing.

MR. BARTOS: Thanks.

MEMBER SIEBER: Is there anything unique about the steam lines? For example, there was some suspicion at Quad Cities that the lines there were smaller than others and the velocities, therefore, were higher.

MR. BARTOS: Yes. Actually, that's the next slide. Let's go to the next slide.

MEMBER SIEBER: The nozzles were closer

so the steam had to take a more direct path.

MR. BARTOS: This gives you a comparison of steam velocities for a number of plants that recently preceded us in implementing an EPU. Susquehanna -- original electric civil power velocities were 128 feet per second. At full CPPU, they'll be 153 feet per second.

This is pretty much typical of what Brunswick -- and pretty close to Hatch. Vermont Yankee and Quad Cities were higher. What is significant here that the OLTP steam velocities for Quad Cities is higher than what we're going to see at full CPPU.

MR. WALLIS: So it's pretty much the same as Quad Cities, is it?

MR. BARTOS: No, Quad Cities --

MR. WALLIS: Dresden?

MR. BARTOS: Dresden and Quad Cities have the same steam velocities.

MR. WALLIS: Same thing, yes.

MR. BARTOS: And we're at 153. Quad Cities, when they -- you know, at OLTP, were at 168, so we'll never really approach or get -- match the Quad Cities steam velocities.

MEMBER SIEBER: Approach is a matter of your vision.

MR. BARTOS: That's true.

MR. WALLIS: There's nothing magical about velocity, then, if you put it in some dimension which is important, it might mean something.

MR. BARTOS: Yes. This is just -- just to give you a comparison of where we stand.

MEMBER SIEBER: We're talking about vibration here, which means that, you know, higher velocities and lower velocities, you may not get any vibration. It will have its natural frequency at a given point, and I guess when you go to models and try to scale up, it's not clear to me how you scale up the natural frequency of material.

MR. BARTOS: Okay.

MEMBER SIEBER: But the higher the velocity of it, the more strain you have.

MR. BARTOS: Right. Okay. Let's go to the next slide.

When we started to evaluate doing an extended uprate, we were aware of the Quad Cities incident and we were following the activities that

Quad Cities was undertaking to try to figure out what their failure was.

And you know, the fact that they fabricated -- installed a new steam dryer -- and one of the diagnostic tools that was used at Quad Cities was instrumenting the main steam lines to essentially use those to detect pressure pulses in the steam line, and that information was input into an acoustic circuit model which was developed by Containment Dynamics Incorporated.

And that generated an acoustic load definition that was applied to a dryer model, a finite model. So one of the first things we --

MEMBER SIEBER: Isn't that a sort of a long linkage between strain gauges on the steam line and the dryer which is in a different vessel?

MR. BARTOS: Yes.

MEMBER SIEBER: To me, it's a sort of a stretch.

DR. PIERCE: If I could ask a question about --

MEMBER SIEBER: If you don't know what to do, I guess that would be the thing to do.

DR. PIERCE: Strain -- now, to me,

strain is a tensor. Which strain are you measuring with these strain gauges?

MR. BARTOS: It's the hoop strain.

DR. PIERCE: Okay.

MR. BARTOS: It's the hoop strain in the steam line, and what we do is we actually UTed the pipes at those -- where the strain gauges are located. That strain data then is -- was forwarded to another consultant that does an analysis on the strains and calculates what -- what the pressure pulses would have to be to create that strain.

DR. PIERCE: Okay, so --

MEMBER SIEBER: When you -- when you instrument the dryer itself, how do you get the signals out?

MR. BARTOS: There's actually a penetration on the vessel head for instrumentation.

MEMBER SIEBER: Okay.

MR. BARTOS: -- that you can run through. It's -- it's been done. We did it in '85, and it's been done on other plants. Quad Cities, obviously.

DR. PIERCE: Now, your strain gauges measure hoop stress in the pipe.

MR. BARTOS: Right.

DR. PIERCE: And from that, you infer the pressure within the pipe; is that correct?

MR. BARTOS: Yes. Actually, there's two locations on each steam line, and they -- they look at -- I'm not an expert on what the acoustic circuit model does, but it looks at the time delay between the two, and there's an algorithm which tries to project the steam loading onto the dryer.

DR. PIERCE: Does the -- does the algorithm take into account the thickness of the pipe?

MR. BARTOS: The algorithm doesn't. The calculate of the pressure pulses does, yes. I mentioned we UT the thickness, and when the consultant looks at the strain data, he does an analysis.

Rico, do you want to help out?

MR. BETTI: Yes. My name is Enrico Betti. I work for General Electric.

And what -- what's been -- what’s done in the industry to date is for monitoring acoustic signals in the -- in the steam system is -- is to use strain gauges, and -- and we use a very sensitive strain gauge.

And we're -- we've looked at the strain gauges at very low levels of micro-strain, and recognize that we can correlate the hoop strain to pressure pulses if we use enough strain gauges to average the signals. And then we can recreate the waves, the wave signature, in each of the steam -- of course, the gauges have to be located in the areas of the steam line that's free from any discontinuity, so it's a -- it's a -- you're using cylindrical pipe equations.

You want them to be away from welds, elbows, et cetera. And then as John pointed out, we UT the steam line so we have a good idea that there's a good, consistent thickness in those regions that we're putting the strain gauges on.

DR. PIERCE: So I'm guessing that you're assuming that the -- as far as working backwards, the strain -- the pressure that the pipe is deforming uniformly, independent of things, so --

MR. BETTI: No, we can't assume that because of the low levels of strain that we're measuring -- that first mode of deformation of the pipe is really ovalization mode, and so that's why we need multiple strain gauges around the perimeter, so that we can -- we can back out what the breathing mode would be of the pipe.

So what we do with the data is extract with the eccentric mode of deformation.

DR. PIERCE: Okay, so let's say you found a breathing mode. Are you assuming this is independent of this is along the pipe? I mean, that -- as far as working back from that.

I guess -- I haven't looked at the numbers, but I would worry about some sort of waves going down the pipe and that they may have speeds comparable to the speeds of the pressure waves, or they may not.

If they're a lot longer, then what you're doing seems quite right.

MR. BETTI: Right. And I -- there is a limitation in the frequency response range if you use this method. It's -- you know, it's not going to be good much above the 250 Hertz range that we're talking about, --

DR. PIERCE: Yes.

MR. BETTI: -- because then the pipe's going to be restrained, and there's always the issue that you could run into, say, pipe response modes. And that has happened. In general, we instrument the pipes also with accelerometers so that we have an idea of what the pipe is doing, and -- and to look at that when we look at the strain gauge data.

MEMBER SIEBER: Is that the only method you use to make sure that the strains that you're reading reflect what the dryer is doing as opposed to the whole rest of the plant that's vibrating?

MR. BETTI: Not in this case, no.

MR. BARTOS: No. What this method does is tries to detect pressure source, pressure fluctuation sources in the steam line.

MEMBER SIEBER: That's bigger than the hoop.

CHAIRMAN BANERJEE: Let me -- let me ask a direct question here. This method, putting these strain gauges around -- obviously, there are longitudinal modes and azimuthal modes, all sorts of things.

Have you ever validated it by actually putting a pressure transducer in a pipe and putting these things around in a long pipe and just seeing whether you get the right thing?

MR. BETTI: We presented some work here that we did at Vermont Yankee on some testing on that methodology, but not in a long pipe. We were looking at the sensitivity level of the strain gauges just to see that it could identify waves and signals.

CHAIRMAN BANERJEE: I'm more interested in a validation. Like if this predicts this pressure, the strain gauge -- I directly measure that pressure inside the pipe.

MR. BETTI: Yes, we did that on a vessel test at Vermont Yankee where we were trying to correlate the pressure to the strain, and we were able to do that, but it wasn't in a long pipe. You would also be subject to some of these other waves simultaneously.

The qualification on this --

CHAIRMAN BANERJEE: Was it a black box or something? What did you -- where did you do this validation? What sort of geometry?

MR. BETTI: We used an 18-inch, Schedule 80 piece of pipe that was like steam line with hemispherical heads, and then put pressure oscillations into -- we put pressure oscillations with both the pressure transmitter and a strain gauge to make sure that we could detect this level of micro-strain.

CHAIRMAN BANERJEE: Well, I guess the issue that was raised is whether you've got things happening in this pipe which would obscure the likelihood of your getting an accurate pressure. I haven't heard an unambiguous answer saying yes, we know it is, you know, at the moment.

I've heard that yes, you've done a little test here, you've done a little test there. Did you, for example, just do a 3-D elastic strain analysis on a piece of pipe to see whether, in fact, there are axial modes as well as azimuthal modes and, you know, depending on the pressure pulse, what happens actually, or is it just a 2-D simulation that you're doing?

MR. BETTI: We have done some three dimensional evaluations on the pipe. The ones that I'm familiar with were done near discontinuities, elbows, to make sure that we are out of ovalization modes.

We have done some frequency response evaluations in the pipe to see, you know, how we got a pickup frequency -- how we -- as the pipe responds it’s going to cause a lag or -- and in the frequency ranges and pipe diameters that we're doing, like the cycles were around 200 Hertz, maximum, and that the pipe response frequency modes were higher, we felt that the strain gauges would give us much bias down into that range.

Our qualification in the methodology is -- is based primarily on the instrument -- the dryer analysis that we'd done, recreating the wave fields in the pipe, and then projecting those wave fields into the vessel, and being able to project those wave fields out the vessel.

CHAIRMAN BANERJEE: Explain that. You're losing me.

MR. BETTI: Well, from the testing that we did at Quad Cities, we were able to use strain gauges at multiple locations, and there, Quad Cities did two efforts. They went in and put four strain gauges, and they reinstrumented and put eight strain gauges, just to find out what delta would be in terms of what the change in the load would be.

So from the strain gauge data, what we're really trying to do is reproduce the acoustic wave field in a pipe, and then we use that information to see how well that correlated with temporal pressure-transmitted data that was on the dryer. And that's not such a long shot, that if you have --

CHAIRMAN BANERJEE: How far was the dryer from the strain gauges?

MR. BETTI: Not very. It was -- first set of strain gauges were out 10 feet. The second strain gauges were maybe 40 feet away from the dryer pressure point.

CHAIRMAN BANERJEE: And you were taking the signals, cross-correlating them and looking for a phase lag?

MR. BETTI: Right.

CHAIRMAN BANERJEE: Did you do a coherence function to see whether they --

MR. BETTI: We always look at the coherence functions and the coherence functions are--

CHAIRMAN BANERJEE: Is it close to one?

MR. BETTI: Very close to one at acoustic frequencies, not in between acoustic frequencies. So when we get strain gauge data and we plot it, we average it and come up with what we think is the two pressure pulses. We always look at the coherence of those two signals for that -- for that pulse.

And then, of course, we look at the -- cross-relate the signals.

CHAIRMAN BANERJEE: Did you see different phase lags for different frequencies or not?

DR. PIERCE: Can I ask another question; excuse me for interrupting your thought. In my view of this thing -- that you have a way of -- do you have -- somewhere you have a source, some cavity right beside the pipe or something, and it's generating waves that propagate back towards the steam dome.

But you also have another wave that's reflected from the opening, and so your strain gauge response should be basically due to the combination of those two waves, that incident wave and reflected wave, and I can understand why you need two to sort of figure out how much is going to the left and how much is going to the right.

But somehow what you said doesn't gel with that image of the two waves, because the distance between the strain gauges has to be related to the wavelength of the sound that's propagating in each direction. Is that taken into account?

MR. BETTI: Yes, and -- John, we -- these -- PPL is using continued dynamics modeling for this, and we're now talking about -- is our work, GE's work, on strain gauges and our modeling.

But certainly, the distance is very important.

MR. BARTOS: Yes, they are.

MR. BETTI: It's very important, because you can't get singularities and half wavelengths, et cetera, and -- and -- in that methodology, there are certain waves that it can be difficult to gather.

But in this case, because we're actually measuring eight -- eight locations on a piping system, and we have a couple models, we actually have more information we're dealing with than just two points in a wave, because we also know a lot about the acoustic properties of the dome.

DR. PIERCE: Well, and what he says up there -- I gather that there's only two on the -- what -- what's being proposed for the -- sort of the monitoring of what's going to happen when you do this. Is that correct, or is it -- oh, you're --

MR. BARTOS: No. There's -- there -- there'll be two strain gauge locations on each steam line, four strain gauges in each location, so there'll be eight strain gauges for a lot of them.

DR. PIERCE: Oh, I see, okay.

MR. BETTI: But PPL is also instrumenting a dryer.

MR. BARTOS: Yes, and I'm going to talk about that a little later.

CHAIRMAN BANERJEE: So this CDI model you refer to -- it's a model which is for the gas, the steam. It's not coupled to the walls, is it? Or is it? Is it a -- you can write the model for the wave equations in the pipe, right? Is it coupled to the wall? Or how is the wall being driven for these strain gauge responses?

MR. BETTI: Just with the Delta P's that are -- export from that model -- which is a separate -- separate analysis.

CHAIRMAN BANERJEE: Oh, so it's not a coupled model. It's simply -- you're giving it a bang and seeing what happens.

MR. WALLIS: The wave speed in the pipe

wall is so fast compared with the steam that just --

It's in a different space altogether, isn't it?

CHAIRMAN BANERJEE: So you -- it's a decoupled model.

MR. BARTOS: Decoupled.

MR. WALLIS: You do have some noise transmitted up from the pumps, I understand, which is mechanical type --

MR. BARTOS: Yes.

MR. WALLIS: All right.

CHAIRMAN BANERJEE: And the acoustics are the 3-D wave equation that you're solving, or what are you doing? It's a linear problem, right, or --

DR. PIERCE: What I've seen in the literature suggests that when the pipe --

CHAIRMAN BANERJEE: Oh.

DR. PIERCE: Most people say that's pretty good.

CHAIRMAN BANERJEE: It's enough?

DR. PIERCE: That's just good enough because the -- when you have a pipe and you have acoustic waves going -- you talk about modes, and each mode has a cutoff frequency, and the first mode is the planr wave mode and -- I haven't done a calculation, but I'm pretty sure that you can say you're way, way below the cutoff frequency for the second mode in this situation.

Your wavelengths are the order of eight feet or so, and the pipe's diameter -- what is it, about five inches or so?

MR. BETTI: About two feet.

DR. PIERCE: Oh, two feet, okay.

CHAIRMAN BANERJEE: What about when it comes into the dome?

MR. BETTI: Three-D. Three-D model. Three-D model for the dome.

MR. WALLIS: Are you going to show us any results of this test?

MR. BARTOS: Yes.

MR. WALLIS: We've been talking an awful lot, but I haven't seen any data or any curves or anything yet.

MR. BARTOS: Well, you know, I have some actual strain gauge data I'll show you shortly.

The purpose of these strain gauges was, one, it gives you -- like a stethoscope, it’s a diagnostic technique, that if we did have an acoustic resonance in a steam line, it would show up. It would be fairly obvious. You saw what happened on Quad Cities in their strain gauge data. When you have an acoustic resonance it does show up pretty distinctly on the strain gauges. So we're going to use them as a diagnostic tool for that.

The other thing was, obviously, as an input into the acoustic circuit model to try to get a pressure mapping on a dryer.

So those were the two functions behind why we installed the strained gauges.

MEMBER SIEBER: I take it you get the pressure map analysis as opposed to any kind of a measure?

MR. BARTOS: That's right. The pressure map would then would be inputting upon a model to get out resulting stresses.

Some of the other analysis that we did. The first point was we're trying to figure out whether we're susceptible to an acoustic resonance similar to what happened at Quad Cities where you get a boundary later instability over some kind of a deep layer and the boundary layer couldn't get mapped because of the acoustic resonance of the deep well. And in an acoustic resonance you get a whistle.

CHAIR BANERJEE: What do you mean by a boundary layer instability?

MR. BARTOS: Like vortex shedding.

CHAIR BANERJEE: Oh, okay.

MR. BARTOS: What we did was we did Strouhal calculations, which they look at the velocities and where you get things like vortex shedding and it compares it with the calculated acoustic length of the cavity.

CHAIR BANERJEE: This is flow over cavity, that's what you're getting?

MR. BARTOS: Flow over cavity, right.

CHAIR BANERJEE: Okay.

MR. BARTOS: So these calculations will tell you whether you may be or may not be likely to see an acoustic resonance.

We did some additional scale model testing. We did a one-sixth steam line scale model test. There we just marked up the steam lines and the deep wells. Essentially they were the SRV stand pipes, there's the HPCI and the RCIC steam lines coming off the main steam lines. And there's some drain lines were also marked up. And CDI did this scale model testing. The results of that indicated that we shouldn't see an acoustic resonance.

GE also did a one seventeenth scale model test that was a little more elaborate. They actually mocked up the steam lines. The top part of the vessel. And actually mocked up a small steam dryer.

CHAIR BANERJEE: When you say "scale," what were the nondimensional groups that were being held constant? Does this have to do with the cavity vortex shedding groups or what? Or was this just a geometric scale hoping for the best?

MR. PROPONI: This Dan Proponi, GE.

The scale model testing that we did, we were doing a geometric scaling, so the one seventeenth scale that you're seeing there is the geometry.

And as far as the parameters, since we were looking at an acoustic model we were holding the mock number constant and using that as the basis for scaling frequency. And then we did have issues because we were using low atmospheric pressure for the test rate. So we did run into difficulties as far as couldn't maintain the same Reynolds number in the scaling. So we had to force that.

It worked well as far as scaling the acoustic frequencies and being able to do these kinds of predictions, though.

CHAIR BANERJEE: But you said the governing phenomena is vortex shedding from a cavity, right? At least that's what he said.

MR. PROPONI: Well, it's the true layer instability across the opening of the cavity. And we did reasonably well as far as being able to replicate the kinds of resonances that we were seeing in Quad Cities.

DR. PIERCE: You just try to duplicate where the lens are or you're trying to duplicate the amplitudes of the pressure waves that propagate out down the steam line.

MR. PROPONI: And our intent was to both originally with our scale model testing. And where we were running into problems was duplicating the amplitude, but we were replicating the appearances of the resonances. So for something like---

DR. PIERCE: The resonances should be to

a rough ballpark, fairly easily to predict. If you know the speed the sound, then you know the length of your side branches. You could calculate a wave length, and it's a a quarter of a wave length gives you the resonance frequencies.

MR. PROPONI: Right.

MR. BARTOS: Yes. Scale model really wasn't used for any numeric analysis. It was just more qualitative and understanding what was going on.

The other thing that we did do which we thought would give a fairly good indication of whether we had an acoustic resonance in our steam lines. We have four main steam isolation valves, well actually there's eight, two on each line which we can close one valve. Actually, it was a surveillance that we did for many years. A recorder, we would could close one steam line. They would actually close all of them, but one at a time.

What we calculated was that we could back down below our ROLTP power to a fixed power level, close one valve which would force more steam through the other three lines and could simulate the steam flows that we would see at the CPPU conditions. So we devised a test to do that.

The test that we devised wouldn't produce full CPPU steam flows, but it would produce, basically, 107 percent over our current licensed thermal power steam flows. Essentially, the first plateau that we're going to go to on Unit 1.

We would have liked to have gone to the full CPPU steam flows, but we're very cautious. There are flow switches on each of the steam lines which try to detect high steam flows for brake detection. And they will isolate the lines. And they're electro-mechanical devises, and it's a very noisy signal. And so we wanted to be very cautious. We didn't want to pick up an isolation signal while we had a main steam valve close.

So we decided to just check it up to the first that we were going to on Unit 1. And we did do this test. And we recorded strain gauge readings on the steam lines. We actually devised coming out of the outage, out of the outage where we installed the steam lines, we'd go up at various power levels, record strain gauge data, stop, perform this closure.

We actually did closures at two levels.

We did at a power level that would simulate the current licensed thermal power steam flows by closing one valve and getting the current steam flows in the other three. So we closed each steam valve individually. So we had three strain gauge readings on each steam line at the higher steam flows.

We kind of did that as sort to take a benchmark look at this technique. Then we went up to a higher steam flow. It was around 85 percent power. Closed the steam lines and got steam flows roughly equivalent to a 107 percent steam flow in the steam lines.

The results of this work is that we didn't detect any steam line resonances, so we don't anticipate that when we go to CPPU flow conditions, especially up to 107 percent, what we're really talking of we're not going to see an acoustic resonance.

The other thing this testing told us is that the dynamic pressure should increase as the square of the steam flow increase.

And another thing that we noticed in all three of these is that the steam line dead legs do have a resonance frequency of 15 Hertz.

DR. PIERCE: Can I ask about this dynamic pressures that creates the square of the steam flow increase, does that mean that pressure is associated with turbines so in the flow basically goes with U squared?

MR. BARTOS: Yes. That's it exactly.

DR. PIERCE: Yes. Entirely plausible.

MR. WALLIS: The resonance of the side pipes that go to the relief valves.

MR. BARTOS: Yes?

MR. WALLIS: You don't mention that here, do you?

MR. BARTOS: No. That's because they're very high. They were out of the --

MR. WALLIS: How high are they?

MR. BARTOS: Do you remember what those were?

MEMBER SIEBER: Those are in the hundreds, right?

MR. BARTOS: Or --

MR. WALLIS: They're pretty short, though, aren't they?

MR. BARTOS: Yes, I think it well over--

I think it was over 200 Hertz, I believe.

MR. WALLIS: Right. But what's this 110 Hertz that showed up so much then?

MR. KRESS: What? The 110 Hertz.

MR. WALLIS: They have 100 Hertz somewhere. Oh, that's the recirc pump?

MR. BARTOS: Yes.

MR. WALLIS: That's what it is.

CHAIR BANERJEE: I see that there is quite a lot of proprietary data that will come later. So if we can go through this fairly quickly--

MR. WALLIS: Sure.

MR. BARTOS: That's one of the next slides.

CHAIR BANERJEE: -- we can come back to this.

MR. BARTOS: Yes.

MEMBER SIEBER: Well, when you say this is cavity driven, the cavity you're talking about is the reactor head, right?

MR. BARTOS: Well, we were looking at cavities attached to the steam line.

MEMBER SIEBER: Well, they're all small.

MR. BARTOS: Yes. But that was the real driver at Quad Cities, so that's why we covered that.

MEMBER SIEBER: They're a different diameter steam line.

MR. BARTOS: Yes. Okay.

This next slide, it's the data that we obtained from the main steam line strain gauges that we installed. And these are waterfall plots. The axis here that we have, this is power level, so these are the power levels that we took the strain gauge readings. This axis is microstrains.

I'll point out that the scale on these two are different. This one is .04. This one is .25 full scale. There's a reason for that. And what we did was we did a spectrum analysis of the readings. So this is frequency.

This plot is for line Charlie, which didn't have a dead leg. This plot for line delta, which does have a dead leg.

MR. WALLIS: What is power percent? What does that mean?

MR. BARTOS: That's percent of current license thermal power.

MR. WALLIS: Oh, okay. So it has nothing to do with acoustic power?

MR. BARTOS: No.

MR. WALLIS: It's something else.

MR. BARTOS: This was the reactor power level and the corresponding steam flows that we actually took the data.

MR. WALLIS: You seem to have a very distinct resonance in the right hand one.

MR. BARTOS: Yes.

DR. PIERCE: Excuse me. The critical scale there, are the numbers, the way it's labeled, is that correct? I would think it's got to be a spectrum density, and I got a look at it, but I can't read that far away. But it seems like you just said micro --

MR. BARTOS: Yes, it's not a PSD.

DR. PIERCE: Huh?

MR. BARTOS: It's not power spectral density. This is just a straight --

MR. BETTI: Straight square root of a -- it's basically it's converted power spectrally.

DR. PIERCE: Oh, that's it. Okay. So you have units of --

MR. BARTOS: Hyper strength

DR. PIERCE: -- square root of frequency.

MR. BETTI: Yes. But the frequency, it's divided out first. So it's just the Hertz. Just an amplitude.

MR. BARTOS: Yes.

MR. BETTI: Or an outer bound, some people call it.

CHAIR BANERJEE: So it's it not A square DF in a band? That's what it is?

MR. BETTI: It isn't, no.

CHAIR BANERJEE: It is not. So it's a prospectral density?

MR. WALLIS: It's just amplitude.

MR. BARTOS: It's just A.

CHAIR BANERJEE: Oh. I've never seen anything --

MR. BARTOS: We have some more curves that are PSDs.

DR. PIERCE: I guess I have problems with understanding that, but I don't want to hold you up. But it it's come up. It doesn't drive the way I see plots. I want to say what band are you talking about and so forth. And if you want to get numbers out of your plots, then you should know better what the vertical scale is.

MR. BARTOS: Well, the purpose of this isn't really to try to get qualitative numbers out or quantitative numbers out. It's just a quantitative look at what's happening in the steam line, okay?

When you do a spectrum analysis, basically what we see is pressure pulses basically 50 Hertz and lower. We saw no real high frequency pressure pulses in the steam lines.

If you had an acoustic resonance in the steam line, typically you would show up somewhere above a 100 and below 200 in that range. That's what they saw at Quad Cities.

We see basically three primary low frequency peaks with a 15 Hertz, 24 and 32?

MR. BETTI: Yes.

MR. BARTOS: About 32. With 15 Hertz being the max peak.

What we see on the delta steam line, though, is that the 15 Hertz peak is much greater. This is top of scale is .04, that would be here. And if you cut across there, this looks pretty much like that.

So what's happening apparently is that the dead leg is picking up the 15 Hertz and I think is an energy storage device. And that's what we're seeing here.

The other thing that this shows is that as you go up in power and you go up in steam flows, the amplitudes of the peaks pretty much drove in a proportion to the flow squared. So that's really the qualitative information that we've gotten out of this particular set of graphs.

Basically the diametric frequency that we're seeing is 15 Hertz and it appears that the dead leg is acting as an energy storage device and amplifying that on two of the steam lines. And that things follow the flow-squared relationship.

DR. PIERCE: Okay.

MR. BARTOS: The other thing I want to talk about is we sat down with General Electric and tried to decide. We had this data. We had data from 1985. We actually went back and GE looked, and they actually had the tapes from the '85 data, the instrument tapes. And they were able to reconstruct that data.

The report from 1985 was a very good report. It analyzed the strain gauge data fairly rigorously. It breakdown the strains into various frequency components and plotted how they grouped with steam flow and power increases. So there was some good data. But the focus of that report really wasn't what we were interested in. So, but since we had the actual tapes and were able to reconstruct the data, we could go back and look at that data and try to get additional information from that.

So, since we actually had data on our dryer, we felt that there was a real benefit in trying to leverage that and use that data. We knew that there was this technique out there, this acoustic circuit methodology. And we were interested in finding out how well it worked. Okay.

They had done some benchmarking with Quad Cities. There's actually a benchmark report that was submitted to the Commission where the acoustic circuit methodology was benchmarked against the Quad Cities instrumented dryer. And for acoustic frequencies, which are high frequency signals, it did a fairly good job of picking those up and quantifying them.

What that report also said was is that the low frequency stuff didn't do as well. Okay.

So from the chart I just showed you, we expect everything that we're going to see is low frequency. It's probably turbulent driven. And it probably originates in the steam dump and these turbulences get sucked down the steam lines and the strain gauges are picking it up.

CHAIR BANERJEE: Well, what do you mean by "turbulence being sucked down a steam line?"

MR. BARTOS: Essentially vortex waves originating in the steam line disturbances --

CHAIR BANERJEE: You mean large eddys?

MR. BARTOS: Yes, large eddys.

MR. WALLIS: Well, they're coherent in some ways, not just random turbulences. It's some sort of a frequency --

MR. BARTOS: Yes.

MR. WALLIS: -- which is set by a Strouhal number or something.

MR. BARTOS: Yes. Or it's set by the geometry of the steam valve and the distance between the dryer and the wall. There are many -- you know, it's geometry driven by the structures -- the steam dome and the structures inside.

MR. WALLIS: Great.

MR. BARTOS: What we see at 15 Hertz is kind of a -- low frequency that we see. General Electric has seen that on other plants, too. Isn't that correct, Dan?

MR. PROPONI: Yes. We've instrumented several dryers over the course of these operating experiences. And we have seen that low frequency, something around 15 Hertz, 17 Hertz depending on the plant geometry. We've seen the same characteristics on all the plants that we've instrumented.

CHAIR BANERJEE: What is that due to? I mean if you look at the dryer, can you sort of give me the physics of this?

MR. PROPONI: If you look at the flow from the steam dome over the outer hood and the fact that we've got a curved vessel and a straight hood face, the flow tends to come down the center of the hood face. And we've got the steam lines out to the sides. So it comes down the center and goes out to the sides, and we get these very strong vortices at the entrance to the steam line. And that may be what's driving this low frequency load.

CHAIR BANERJEE: That's easy to calculate with the CFD code if you really have that. That may be fluent, but your own I'm sure is much better.

DR. PIERCE: Is this 15 Hertz related to the length of the steam line?

MR. BARTOS: It's related to two things. There's a source in the steam -- which generates 15 Hertz pressure pulse which then gets transported down the steam line. And what Dan was saying, that they've seen that at other plants.

What's fairly unique to our plant is that we have this dead leg which has an acoustic resonance -- frequency of 16 Hertz.

DR. PIERCE: So 5800 wouldn't correspond to some integral power of the wave length down the steam line --

MR. BETTI: This is Enrico Betti.

And it does -- a lot of these spikes that you see in the steam system, turbulent driven or scroll driven, they do relate to the acoustic modes of the steam system.

I mean, this particular one, GE has done modal analyses, acoustic modal analyses. And we can pick out the 15 and the 24 Hertz. Those are important modes.

I mean for this particular plant, you know GE looks at it and knows that that characteristic peaks that we see in the A and D line are related to, say, the length of that dead leg that you see.

DR. PIERCE: Yes.

MR. BETTI: And the turbulent sources downstream in the nozzles that are good source locations to propagate or instigate that acoustic response.

DR. PIERCE: I think the sharpness of that peak that you see, if you had an infinitely long steam line, you wouldn't see that sharpness. You may, say, well it originates somewhere. But there must somehow be a feedback from the energy --

MR. BARTOS: Yes. Yes. Sure. You're right.

MEMBER SIEBER: The solution to that is to either de-tune the system so the resonances don't occur or make it so strong that it doesn't make any difference.

MR. BARTOS: Correct.

MEMBER SIEBER: And I presume you did the latter.

MR. BETTI: Yes. And we'll talk about that.

MEMBER SIEBER: Yes. I read it.

CHAIR BANERJEE: John, you have to finish this in two minutes, and then we are going to move on.

MR. BARTOS: Yes. I think I can do that.

CHAIR BANERJEE: With one more slide.

MR. BARTOS: Yes, one more slide. That's all I need.

So we wanted to benchmark this technique. Okay. Based on this benchmarking, we thought we could develop a stressing adjustment factor from the benchmarking. So we would take the acoustic circuit methodology, develop the load definition for the dryer, apply it to the finite element analysis. Look at the resulting stresses. Compare it with stresses that we saw. And develop an adjustment factor.

The other thing in talking with Continuum Dynamics, they thought and they eventually did develop from the 107 percent CLTP load definition -- they could develop a load definition from the MSLE closure data essentially that would replicate the load definition at 107 percent CLTP closed. And that we would then calculate stresses with the existing tools, apply the stress adjustment factor. Then because we didn't see any acoustic resonances and there's evidence that the dynamic pressures increase in proportion to the square of the flow, we could then just scale up the stresses to the full CPPU power level.

MR. WALLIS: But there's another step in CLTP is the same as the one at 113 OLTP?

MR. BARTOS: Yes, sir.

MR. WALLIS: Okay. Because I got a little bit confused about what you're doing.

MR. BARTOS: I'm sorry about that. Putting these slides together. That's a lesson learned that we would take away from this.

Okay. Let's go to the next slide, the last slide before we go to closed session.

Just again, the benchmarking analysis. We obtained the in plant strain gauge at the LOTP steam flows. Applied the acoustic circuit model to generate a load definition. That load definition was input into the GE finite dynamic model of the current Susquehanna steam dryer. And we compared the strains from the finite element model to the strains observed in 1985, and the next part is closed.

CHAIR BANERJEE: Okay. Now let's stop for a moment. My plan is to actually go into closed sessions before taking a coffee break, if it's okay with you people.

MR. BARTOS: That's fine.

CHAIR BANERJEE: Because there's a continuative here and I don't want to interrupt it.

So we go into closed session for, let's say, one hour. You've got 25 slides. You should be able to get through them in closed session in one hour. And at 10:30 we'll take a coffee break and come back and do the power ascension.

So GE and PPL, please clear the room of people you feel are --

MEMBER ABDEL-KHALIK: Mr. Chairman, can I just ask a question?

CHAIR BANERJEE: Yes.

MEMBER ABDEL-KHALIK: A quick general question. Is there some reason for the orientation that you currently have with regard to the relative orientation of the veins with respect to the location of the steam lines other than the fact that engineers like symmetry?

MR. PROPONI: This is Dan Proponi.

You're asking the fact that we have parallel dryer banks --

MEMBER ABDEL-KHALIK: Right. I mean the relative orientation of the banks rotating the steam lines.

MR. PROPONI: The orientation of the dryer banks with respect to the steam lines is for the steam flow. When you essentially have an outer plenum that will collect the flow from the dome area and bring it out to the steam lines. If we had the dryer rotated, say 90 degrees, we would lose that space. We would have a much higher pressure drop for the flow coming down to the steam lines.

So in that sense that's one of the reasons. We're using parallel banks so that we can maximize the linear length of bank that we have for the drying efficiency.

MEMBER ABDEL-KHALIK: Okay. Thank you.

CHAIR BANERJEE: So we will go into

closed session and the closed transcripts.

Okay, we are still in open session.

MR. WALLIS: We have this, it looks to me as if the dryer is designed so that the steam is all coming on one side of the vertical things. And then it turns a corner and it comes around.

So your vorticity has all been created in that way, there's the same sense of vorticity being created from all of those things coming off, being shed off the top of these dryers, that is if you've got to one of them. Really from one side. So this vorticity is coming around. And then, as you say, you just pull it out and stretch it down the steam line. So you ought to be able to model that.

CHAIR BANERJEE: Yes, you should certainly be able to model that.

MR. WALLIS: It seems as if your design is deliberately creating vorticity all in that one sense, which then can sort of stretch itself.

CHAIR BANERJEE: Unfortunately, we can't consult with you guys. But we'll show you how to do it informally.

MR. BETTI: You can model it. The question is does the technology exist to couple that with the acoustic circuit model.

MR. WALLIS: Do you do that?

MR. PROPONI: We have tried that. We have tried that. It's a difficult problem because of the numerics involved and the computational power that's required.

MR. WALLIS: Well, it's not really a problem. It's a very organized thing. It's a very strong concentrated vorticity.

MR. PROPONI: We do have-- you know, it is basically hydrodynamic in nature. And if you look at that, the amplitude of that 15 Hertz peak in time, it will vary from almost nothing to the full strain over time, its ebbs and flows. The amplitude ebbs and flows and it's difficult to replicate that.

CHAIR BANERJEE: We're going to have to do an LES. It's not going to yield to a RAMS approach.

MR. PROPONI: No, no. And we have tried out the LES coupled acoustic solution.

MR. BARTOS: But we're still working on that solution.

MR. PROPONI: Right.

CHAIR BANERJEE: So let's go into closed

session.

(Whereupon, at 9:36 a.m. the hearing moved to closed session.)

CHAIRMAN BANERJEE: And we can call in whoever left and go into power ascension and testing, which will be PPL. We'll turn this over to PPL. We're in open session now, open transcripts.

MR. CROWTHERS: Okay. Are you ready to start?

Okay. My name is Mike Crowthers. I'm going to lead the discussion on power ascension testing. I want to acknowledge on my far left Jim Klucar. Jim was involved with the original startup of Susquehanna. He has been involved with the stretch uprate, and obviously he is also now involved with this startup. And then, Jim Williams, whom you met yesterday, the unit supervisor.

Power ascension testing -- I'm going to tell you some things that you've already heard from other utilities. There's not a lot different here, except for the dryer. And I'm going to spend a little bit more time on the dryer, and kind of walk you through some of what you already talked about, so maybe you can see the bigger picture and how the dryer power ascension program is going to actually happen at Susquehanna.

Before I get to that, we'll -- in

general, the power ascension test plan was, again, we used the SRP guidance on EPU power ascension testing. We looked at the GE LTR, and what that drives you to do is go look at your original plant startup, your stretch uprates, your plant history, OE with the industry, and obviously your analysis.

So taking all of that information and doing an evaluation in terms of what -- what tests do we need to do to make sure this machine can do what we believe it can do, which is really what your power ascension testing is trying to do.

Some of the key conclusions were -- and, again, this is similar from what you've seen from others, the generator load reject test, nor the MSIV-4 closure, large transient tests that were done at original plant startup, are not required for the uprate. There's really nothing that has a significant effect on those events.

There are numerous startup tests that are required that we will be implementing. They are not all that exotic. They are things that are checking out modifications, making sure settings are where they should be, and the plant reacts to some minor perturbations appropriately.

I'll talk about the dryer testing in more detail, and then we -- it's clear we need to do some condensate pump trip testing, again, similar to what you've seen from others.

On the load reject and the MSIV closure testing, again, similar -- we have some experience with both of these events. We've had these events occur at our plant. There is industry OE on the load reject on some plants that have gone to the EPU conditions, Hatch and Brunswick, similar units, the Susquehanna.

Our analyses of the events are more conservative from what the actual data tells us, which is what you would expect, or the other way around. And you have maybe some concern there.

And, in general, these -- we can conclude that these tests really don't provide you anything of real value, and they're not worth the cycle that you put on the vessel and the internals and your systems.

Next slide.

This is just a sample of some of the start testings we will be doing, and it kind of lays out across the top what power levels will be doing them. Again, not all that different from others.

Chemistry -- you're looking for connectivity, sulfates, etcetera, making sure that -- that the RWC systems are doing what they're supposed to be doing as we go up in power.

Radiation throughout the plant, making sure we -- we can maintain ALARA, and, you know, REQ limits are what we believe they're going to be for the equipment. The pressure regulator, feedwater recirc flow control, that's just making sure various portions during the startup -- that the systems are reacting to some other perturbations, as they should be, to preclude this bigger event, so that we tweak them properly.

Containment cooling -- making sure we stay within our tech spec limits. Piping vibration, which we've talked, you know, to some extent about. And, obviously, the thermal limits -- making sure that as we go up in power that we are maintaining those thermal limits where we believe they should be.

MEMBER SIEBER: That also includes a lot of physics testing that may be going on.

MR. CROWTHERS: Yes, yes. The three

main elements of the power ascension testing are, we believe, a slow, deliberate -- we will be taking a lot of data, doing a lot of analysis, as we go up, and you'll see that on the next slide.

And then, before I get away from it, the long-term dryer inspections that we have committed to do -- and it is addressed in license conditions that have been briefly mentioned earlier -- to do full dryer inspections for the VIP guidelines and owners group recommendations for two successive outages after we've implemented a full CPPU on the dryers.

CHAIRMAN BANERJEE: As was pointed out, though, full dryer means only those pieces that you can see.

MR. CROWTHERS: That's correct.

Next.

MEMBER SIEBER: And only a certain percentage of -- of the dryer internal is over a 10-year period, right?

MR. CROWTHERS: Yes, we'll be following the guidance of the IP and the SIL -- GE.

This is -- I'm going to try to pull together some of the earlier discussion on the power ascension testing and how we're going to implement it. This graph, if you will, is basically addressed through license conditions that we propose that --

MR. WALLIS: Could you give some indication of the time scale?

MR. CROWTHERS: No. I mean --

MR. WALLIS: Well, it's not going to happen in a minute, is it?

MR. CROWTHERS: No. Well, for example, this is not to scale at all.

MR. WALLIS: Is that several days, or what is it?

MR. CROWTHERS: Well, how --

MEMBER SIEBER: It's about a week, isn't it?

MR. CROWTHERS: That's what I --

MR. WILLIAMS: It's closer to 40 days.

MEMBER SIEBER: Forty days.

MR. CROWTHERS: That really depends on these plateaus that I'll talk about, which we're basically -- we're going to be doing a lot of testing, a lot of analysis work. There's going to be interaction with the staff, so, you know, that timeline could change. It could go -- it could be longer, could be shorter.

CHAIRMAN BANERJEE: It is the usual thing we've seen with other --

MR. CROWTHERS: Yes. The only difference is all the data we're taking on the dryer on this first Unit 1 start up. This is all dryer data we're taking, not only once we get to the higher power levels, but as we go up. The other thing to point out here are these MSIV-4 closure tests that we've talked about earlier.

We're going to do two of those at two different power levels, simulating 107 percent seam flow conditions and the full CPPU flow conditions. So we will have data that will simulate what we've used currently to develop our loads.

MR. WALLIS: So you get one side of the -- of the dryer will get full --

MR. CROWTHERS: That's correct. We're going to close one MSIV at a time and the other --

CHAIRMAN BANERJEE: When you are up to 7 percent of your ---

MR. CROWTHERS: Current.

CHAIRMAN BANERJEE: -- current excess, yes, will you close an MSIV and see what happens at that point? It's only --

MR. CROWTHERS: No. We don't do it down at the lower power levels. The reason is you're going to get the higher -- excessively higher steam flows. You're going to end up closing your other MSIVs on high flow.

Okay. So key testing there, and data that we're going to collect early on. Once we get up to the current license thermal power level, which is about 88 percent of the full CPPU, we will be taking a bunch of dryer data and moisture carryover data, main steam line data, analyzing that data.

And prior to going up in power, i.e. above our current thermal -- licensed thermal power level, we will be reviewing that data with our onsite Safety Review Committee and making a formal decision, okay, everything is where we think it should be, it's okay to go up in power.

MEMBER ABDEL-KHALIK: What's the high flow setpoint for the steam line?

MR. WILLIAMS: James Williams, PPL. When we rescale our instrumentation for power uprate, it will be 140 percent of main steam line flow.

MEMBER ABDEL-KHALIK: Well, let's -- if we reach this intermediate point of 107 percent, and let's call that 100 percent, what would be the setpoint for the steam flow?

MR. WILLIAMS: At your 107 percent --

MEMBER ABDEL-KHALIK: Right.

MR. WILLIAMS: -- that will be a power level of 94-1/2 percent when you rev it up.

MEMBER ABDEL-KHALIK: Right.

MR. WILLIAMS: And the main steam line high flow setpoint is 140 percent. So 94-1/2 percent normal steam line flow, 140 percent is your isolation setpoint.

MEMBER ABDEL-KHALIK: So what did he say, if you were to get those 107 percent and close one MSIV, you would get a trip on high steam flow.

MR. WILLIAMS: As it is today, or in the past when we used to do the fast closures with MSIVs on a quarterly basis, we can only do those at 84 percent power or below without tripping the unit. So --

MEMBER ABDEL-KHALIK: What if you do a low closure?

MR. WILLIAMS: Slow closure is much

easier on the plant, but you still can't do it at 100 percent. You cannot run a plant at 100 percent power with three steam lines.

MEMBER ABDEL-KHALIK: Run it at a lower --

CHAIRMAN BANERJEE: What about 94 percent power?

MR. WILLIAMS: When I was at Brunswick back in the '70s, we ran for a month with one MSIV failed, closed, and our max power was 84 percent, in order to allow for transient response.

CHAIRMAN BANERJEE: That's the reason, I guess, otherwise you have a very good test at 113, you see?

MR. CROWTHERS: Okay. So once we make the decision that all of the data shows that everything is okay at current license thermal power, then we'll go up beyond current license thermal power. We will be taking data per license conditions once per hour as we go up in power. We go up about 1 percent per hour, so this little ramp here is, you know, 3-1/2 hours nominally.

Once we get up to 3-1/2 percent above current license thermal power, we're going to do basically what we did at current license thermal power all over again -- take a bunch of data, do a bunch of analyses, and then have it reviewed by our Onsite Review Committee. And then, at this point we will also be submitting data to the NRC for their review prior to going up to that next level.

Essentially that process gets repeated up to the 107 percent. We'll end up on Unit 1 at 107 percent for that cycle, as we previously discussed. If I were to put -- plot Unit 2 up here, those last two steps would look the same thing. So we go up -- take that process, take it all the way up to the full CPPU.

Okay. Next slide.

As John was describing earlier, once we collect all of this data from Unit 1 -- again, per license condition and per our plan -- we'll be benchmarking all of the analyses, the acceptance criteria, i.e. the limit curve, taking a look at that scaling factor once again, and seeing what that data tells us relative to those parameters, assumptions, fudge factors, whatever you want to call those.

And then, we will be adjusting, as

necessary, the stress analyses. And then, there is also provisions in the license conditions to provide all of that information to the staff prior to going up in power on Unit 2.

So we'll have an opportunity to take all of that data, validate, verify what we've done to date. As John said, if there's something that shows up that needs to result in change to that Unit 2 dryer, then we have the opportunity to do that.

Next one.

Beyond those specifics, you know, we typically monitor moisture carryover. We will, as John mentioned, use those strain gauge data, accelerometer data that's on the dryers, for as long as it will give us reliable data, so that the more data we have the better, obviously.

And then, beyond that, as I mentioned, we'll be doing steam dryer inspections in the subsequent outages, to the extent that we can, per the industry guidance.

We'll also be, during each of those plateaus, be doing inspections and walkdowns of the various systems, to make sure that -- which is kind of typical for a startup anyway, to make sure that there's nothing going on in the plant proper.

MEMBER ABDEL-KHALIK: If you can have a hold that -- the current license thermal power for a few days, whatever loading you're going to get from the data that you would collect from the steam dryer should be consistent with the current loading data, since --

MR. CROWTHERS: Yes, I believe that would be true. That's what the expectation would be.

MEMBER ABDEL-KHALIK: Would there be some kind of consistency check between the two data sets?

MR. CROWTHERS: That's part of what -- the evaluations we would do at that power level, would -- again, we've got that data, so we'll be able to benchmark it to what we think -- where we think it should be, so that, you know, if it looks consistent, as we believe it will be, or bounded, then, you know, that's a basis for a decision to go up in power.

If it's not, there's something strange there. Then, obviously, we need to do some more work before we go up in power. And that's where our

Safety Review Committee comes in -- to help us make that kind of a decision.

MEMBER ABDEL-KHALIK: So before you go from 100 percent CLTP to 103.5 percent CLTP, there is a decision point.

MR. CROWTHERS: Oh, yes. In our test procedures definitely, yes. Okay.

MEMBER MAYNARD: Do you have the criteria set for acceptance, or is this just going to be take the data, show it to the Safety Review Committee, and everybody set around and decide? Do you have some criteria at which you --

MR. CROWTHERS: Well, we do have the Level 1/Level 2 criteria. That's not really applicable at this point, so I don't think we have anything specifically set up at this point. Does anybody have any comment on that? John?

MR. BARTOS: This is John Bartos. We're still working out the details of the startup test program. There will be a procedure which will detail exactly what we're going to do, and that's under -- under construction right now.

MR. CROWTHERS: Yes. It's actually out for review, for a multi-discipline review at this point. And I think one of the focuses, once folks get beyond this meeting, will be a -- to work out some of the details on that procedure.

MEMBER MAYNARD: Well, I would recommend some criteria. It's easy for a group to get around and convince themselves, if anything, after looking at data without some criteria, and I think you need some criteria that provides the force and function for what levels of reviews are required.

MR. PAGODIN: This is Rick Pagodin. I agree with what they're talking about. The Level 1 and Level 2 criteria will still exist. If we get to 100 percent current power, and we find that we're exceeding the 13,600 psi, obviously that's a hold point. What they're talking about is how much margin we want to ensure we have before we say we're ready to go up.

So that's really the level below the Level 1 and Level 2 criteria that we need to finalize and put in our procedures.

MEMBER ABDEL-KHALIK: But how about the consistency check? I mean, you can take the data and analyze the current design and show that you still have margin up to 13,600. But wouldn't you also need to do a consistency check between whatever data you will collect at that point and the data that you've had all along?

MR. PAGODIN: Yes. Well, I think that's -- I think we're saying the same thing, maybe with different terms. So it's what that data should look like when we get to the -- back to the 100 percent power with the new dryer installed compared to all of our previous analysis. Okay? And saying that that's what it should be in order for it to be where we predict it to be up -- at the next step. But we haven't picked that intermediate level yet.

CHAIRMAN BANERJEE: At least the fudge factor should be the same, for example.

MEMBER SHACK: Well, I mean, they will have direct measurements of the pressure, and that will tell them whether they're there or not.

CHAIRMAN BANERJEE: That's right.

MR. CROWTHERS: Okay. We'll shift gears away from the dryer for a bit. One of the other --

(Laughter.)

One of the other tests we will be performing is a condensate pump trip test. The intent of this test, as you can see the criteria there, the Level 1 and Level 2 criteria, is to make sure the trip of a condensate pump doesn't result in something much worse. You know, the system is designed so that that doesn't happen. We've proposed license conditions to address this testing.

Also, we're going to -- our current plan is to do this -- this test at the 107 percent level in both units, and then be able to take that data, compare it to our analytical basis, and then be able to project up the results of the -- at full CPPU. Again, that's a subjective license condition with -- with the staff on how we work out those details of that testing and our evaluation of the results.

Next?

So, in summary, we've used the industry standard guidance, the SRP, the LTR. We have looked at our test data, our stretch uprate data, our original startup test data, and developed the major conclusions that we've talked about. We believe our testing is complete, provides for sort of appropriate test plateaus at their right spots that give us the time to collect the data, analyze the data, involve the NRC, specifically on the dryer and on the condensate pump trip testing where appropriate.

It involves management reviews to our onsite Safety Review Committee, and it will involve some of our contractors. Obviously, GE will be involved with the dryer stuff also, and we've got, you know, acceptance criteria defined for the key -- the key test parameters.

CHAIRMAN BANERJEE: Thank you. Do we have any --

MEMBER MAYNARD: You said that as far as -- you didn't need to test the bypass valves because you weren't taking credit for any more flow through the bypass valves. And I take it from that that what you're doing, just accepting that you -- rather than be able to handle a -- I don't know, 40 percent, you can only handle now 37 or 35 percent load reject through the bypass valves?

MR. WILLIAMS: Bypass valves were originally 25 percent, and now they're down in the 22 percent range.

MEMBER MAYNARD: Twenty-two percent, okay.

MR. CROWTHERS: Okay. Thank you.

CHAIRMAN BANERJEE: Thank you very much.

I'd like to continue, if possible, if the staff is ready, to talk about the mechanical and civil engineering open session before lunch. And that means that if the staff is ready, I'd like to take half an hour for the mechanical and civil engineering before lunch, then break for lunch, and take the closed session after lunch. Is that okay?

(No response.)

Thank you.

We are now at Tab E, moving on. I have an ulterior motive here. I have to leave at 2:30 to catch a plane to California, so I'm trying to get at least the staff review of the EPU test programs done before I leave. So just moving things forward a little bit.

So, Kamal, you are going to lead?

MR. MANOLY: Yes. The review team for the Susquehanna power uprate -- actually, the three individuals that are on the team -- Dr. Andy Du Bouchet and Dr. John Wu and Tom Scarbrough are all now in the NRO, but they're still helping us.

CHAIRMAN BANERJEE: Are you still in NRR?

MR. MANOLY: In NRR, yes.

CHAIRMAN BANERJEE: The last remnant.

MR. MANOLY: Yes.

(Laughter.)

I'm going to be there, but they are continuing involvement with Susquehanna and Hope Creek and transfer, too.

We had the support from Argonne, Dr. Vik Shah, and Dr. Steven Hambric from Penn State, and Dr. Samir Ziada from Mass University. And he offered us tremendous support and invaluable assistance in the review.

We will start with the scope of review, and Dr. Du Bouchet will start with that part.

DR. DU BOUCHET: I guess I'll use my slides here.

CHAIRMAN BANERJEE: You need a mic.

DR. DU BOUCHET: Do I need to sit, or I'm wired?

CHAIRMAN BANERJEE: We have to wire you, or you have to sit.

DR. DU BOUCHET: The scope of review for the mechanical/civil area included methodology, loads of constant pressure power uprate, stresses and cumulative fatigue usage factors, acceptance criteria, code additions and addenda, functionality impact on safety-related pumps and valves, and piping overpressurization, acoustic- and flow-induced vibration loading and monitoring.

The evaluation areas are shown on the next slide, or in your handout. Follow the safety evaluation subsections -- pipe rupture locations and dynamic effects, pressure-retaining components and supports, subtier items under that bullet, NSSS piping components and supports, balance of plant piping components and supports, reactor vessel and supports, control rod drive mechanism, recirculation pumps and supports, safety-related valves and pumps, seismic and dynamic qualification of equipment, and potential adverse flow effects.

We can discuss reactor coolant pressure boundary and balance of plant piping. The approach taken was to retrieve the calculations of record of the same methodology and acceptance criteria employed in the original calculations we used. ASME Section 3, '71 edition, through winter of '72 addendum was the basis for the reactor coolant pressure boundary acceptance criteria.

Some of the balance of plant piping was

also evaluated to the ASME code -- the remaining portion to the ANSI B31.1, 1973 edition.

CHAIRMAN BANERJEE: Were there any modules that wouldn't lift to the supports?

DR. DU BOUCHET: Within main steam and feedwater outside of containment, yes. I can touch on that briefly.

Getting -- continuing with that question, there is a flow increase of about 15 percent for main steam and feedwater, and there is a turbine stop valve closure transient load that required design modifications to snubbers in main steam and feedwater to maintain piping within design stress allowances.

I think three or four supports were strengthened, and perhaps a half dozen were added. And that was primarily the changes, the design changes, for most of the civil structural areas.

MEMBER SHACK: Is that pretty typical for most of these people with a 20 percent uprate?

DR. DU BOUCHET: I can't answer that, to be honest. Perhaps there is someone who can respond to that.

MR. MANOLY: Do you want to --

MEMBER SHACK: I just don't recall hearing about that at the earlier uprates.

DR. WU: Yes, that's mostly because of the flow rate increase of 15 percent. So we have turbines -- the valve, that it's governing loads. So from there it's -- normally we have one or two supports, yes, that need to be --

CHAIRMAN BANERJEE: It goes as a square of the velocity, right?

DR. DU BOUCHET: Yes, that's correct.

MR. MANOLY: But I don't recall how many supports were modified that were compared to -- if you need that, Commission, we can easily get it.

MEMBER SIEBER: That is typical.

CHAIRMAN BANERJEE: I read the staff SE on this, and it was fairly complete, and, you know, we are happy with it.

MEMBER SHACK: Thank you.

DR. DU BOUCHET: To put a bottom line on these reviews, if the reactor coolant pressure boundary piping, the existing calculations of record were adequate for power uprate. For balance of plant, most of the calculations of record were adequate, except as previously discussed, for the mods required in main steam and feedwater.

Going back to the previous slide on evaluation areas, let's touch briefly on some of the reviews that were conducted. For pipe rupture locations and dynamic effects, no new high energy line break locations were identified. Pipe restraint and impingement calculations remained adequate for power uprate. LOCA and SRV loads remain unchanged from power uprate.

We talked about NSSS and balance of plant piping, coming down to the reactor vessel and supports. There is a GE topical report that was used to provide the methodology for that review. That confirmed that the existing stresses and cumulative usage factors for the reactor vessel and supports remained adequate for power uprate.

CHAIRMAN BANERJEE: Are we missing this slide, by any chance?

MR. MANOLY: These are backup slides.

CHAIRMAN BANERJEE: Oh, I got it. Fine. Thank you.

DR. DU BOUCHET: For the next two items, the control rod drive mechanism and the recirculation pumps and supports -- the licensee's evaluation was documented as proprietary. We reviewed that, and we accepted it.

For the RPV internals and core supports, the only item in the RPV that is certified to ASME requirements is the control rod drive mechanism. The remaining components don't need to subscribe to the code, but the original calculations of record did use the ASME code as guidance, and the followup calculations to check for power uprate follow the same methodology. Everything in the RPV was found to be adequate for power uprate.

I'm going to pass on safety-related valves and pumps to a colleague in a moment.

The last item that I reviewed as part of this SER was seismic and dynamic qualification of equipment. Basically, the components that were primarily affected by power uprate were connected to the main steam line, and we talked about the RPV. And the MSIVs are dealt with in another section of the SER.

The plant had performed a seismic margins assessment back around '91 or so. It's a fairly rugged seismic criteria. I think it was three-tenths G -- that came up with a short list of safe shutdown items, part of the total Q list that they had reviewed for seismic requirements when the plant was being constructed. And whatever anomalies and deficiencies were identified during that review have long since been corrected.

So we concluded that seismic and dynamic qualification of equipment remains unaffected by power uprate.

And that's the extent of my comments. Thank you.

CHAIRMAN BANERJEE: Thank you.

Any questions?

(No response.)

Okay.

MR. MANOLY: Next?

CHAIRMAN BANERJEE: So next we are going to deal with the valves and pumps.

MR. SCARBROUGH: Yes. I'm Tom Scarbrough. As Kamal said, I'm in NRO now, but we helped out on this review.

Regarding the pumps and valves, basically we did the same review we typically do for EPUs. We looked at valves within the scope of the ASME Code. We were focused on the EPU effects for functional performance, and in that regard we looked at Generic Letter 89-10 on motor-operated valves, 95-07 on pressure locking, and 96-05 on power uprate type valves.

And the amount of changes were relatively small, as typical for these types of EPU, a small increase in some of the post-accident room temperatures. The flow rates themselves, where the 15 percent increase is, those are typically gate and flow valves which aren't much affected by that type of flow increase. Where there were butterfly valves, which are affected by that flow, they were in the other systems, cooling water, ESW, essential service water, where it's like a 1 percent increase in flow rate. So the butterfly valves aren't affected either.

So we looked over that. We had them provide examples of where they went back and looked back at their Generic Letter 89-10, the calculations, to make sure that those valves were adequate.

Our review criteria were the General Design Criteria, you know, GDC-1 of the general criteria, and also the specific criteria for emergency core cooling and containment heat removal, things of that nature. And basically we found that based on the review we did, and looking at the examples of the valves that they had valuated in the pumps, there was very little effect on the pumps either, that they adequately addressed the --

CHAIRMAN BANERJEE: Were there any effects at all, or was it all -- almost all the same?

MR. SCARBROUGH: Well, there were some small changes. There were some small drywell pressure changes that could have a small effect on the pressures, but you're talking about 44.6 psi to 48.6, just a couple of pounds per square inch. And the temperatures were 320 degrees F to 337 degrees F, you know, about 17 degrees Fahrenheit. That's not much for these.

And, plus, it happens very quickly. Temperature goes up, comes down, and for motor-operated valves it takes a while for that mass of metal to heat up. So they would be up and back before it really affected the internals of the motors. And so typically there isn't much that --

CHAIRMAN BANERJEE: I've noticed that

the drywell temperature in this case went somewhat higher than before. I mean, does that have any --

MR. SCARBROUGH: If it stayed up there, but typically it comes back down. There are calculations that they -- you have to look at for reduced motor output for those higher temperatures. But if it's a transient type of temperature, then it doesn't take long, if there's not a long enough time for that temperature, that motor to heat up, and affect the internal workings of the motor.

So it depends on the times, and typically the higher temperature increases were very short-lived, and they would be back down, according to the calculations, within about five seconds back down to the lower levels. And so there wouldn't be enough time here.

CHAIRMAN BANERJEE: That scale was like 10 or 20 seconds.

MR. SCARBROUGH: Yes, yes. So they shouldn't be affected. So, typically, this was similar to other EPU evaluations we did, and without much effect on them. Okay?

Next is the potential adverse flow effects area, the more interesting area. The items we looked at were the steam dryer function, just to make sure we ground ourselves in what that dryer is supposed to do. The replacement dryers, the review of the dryer with our technical expert assistance that Kamal mentioned from Argonne and the universities, plant monitoring, power ascension, and the license conditions that you all mentioned, and we'll walk you through those, because those are certainly part of this review.

CHAIRMAN BANERJEE: Is there anything that you need to put into a closed session, or --

MR. SCARBROUGH: We will. We will. The slides that you're going to see right now are all open, and so we'll stay away from specific -- specifics. But then we'll go to closed and --

CHAIRMAN BANERJEE: After lunch.

MR. SCARBROUGH: Yes, and then we can talk in detail about calculations and such if you'd like.

But overall, as to dryer function, it's to remove the moisture before the steam is directed to the turbine. There's really no safety function for it, but it must retain its structural integrity to avoid loose parts that might damage other parts.

This morning you heard about the dryer experience at Susquehanna. There was a fatigue failure back in '85, and they've used that information after they instrument it, as part of their evaluation. They had some fatigue cracking that occurred in 2005/2006, and you heard about the repairs on that. And the data that they gathered from Susquehanna for the 1985 repair -- from an instrumentation, they're going to use that as part of that stress underprediction factor, SUPF, that you all heard about and we can talk about more in the closed session.

So as an introduction for the closed session, which we won't talk about here, but just to let you know what we'll go over in the closed session, we'll talk about the original analysis, the replacement dryers, the scale modeling testing, the dryer loading, and stress analysis. So that's what we -- we'll be talking about that in a little while.

The power ascension program -- you just heard about that. Basically, there's acceptance criteria from Level 1, which is a 13,600 psi, and the Level 2 is 11,000 psi. Unit 1 is going to be increased in power over two cycles. With this two-step approach, it will go up to 113 percent OLTP, the 107 percent CLTP. And in step 2, after they benchmark, gathering the data they have from that point, then they go to the remaining 120 percent of OLTP, and then they'll use that all for the Unit 2 power ascension. So that's really a two-step process.

Now, for system monitoring, this just talks about the outside of the reactor vessel. We also look at that as part of our review. They have a vibration acceptance criteria that's part of the power ascension program. They'll be using the ASME O/M Standards and Guides, Part 3, which is the industry standard for vibration monitoring for pre-op and startup testing, so they'll be using that standard.

They will be installing accelerometers in various places, including SRVs, because that was the problem, as you know, at Quad Cities at one point. They will also be using portable vibration instrumentation where they can't really get in there to do -- you know, having things installed or have that installed on some condensate, high pressure cool injection, feedwater drains in different places. They'll have that installed as well.

And they will be monitoring as they go up. Once they get above like 75 percent power, they will be monitoring -- gathering this data. And what they've gathered -- looked at so far doesn't indicate they are going to have a problem, so we'll be working with them as they go up to agree with that.

They will also be doing individual walkdowns. As you'll see in the license conditions, there's hold points as they go up to different levels. And they will be doing walkdowns of the main steam system, feedwater, condensate, high pressure coolant injection, and that -- those results will be coming back to the staff.

They also will be doing some modifications to reduce the piping vibration. They will be installing some supports on the feedwater drain lines to help reduce --

CHAIRMAN BANERJEE: Where are these vibrations most likely?

MR. SCARBROUGH: Where they calculated there might be some is on the supports to the feedwater drain lines, and so there will be some supports in there that they will be installing.

Now, the license conditions -- we use the same concept we did for Vermont Yankee. We wanted the power ascension to be slow and deliberate, with hold points and data evaluations as they went up. They have to have formal plans for the steam dryer and plant instrumentation and all of the other activities, the walkdowns and such, evaluation of data.

They need to specify the startup procedure contents, and we'll be seeing that before they go up. And there will be provisions for licensee and NRC staff interaction to address the plant data, the evaluations, the walkdown inspection and procedure. So there's -- it's a slow process for them to work their way up to EPU.

Now, in terms of the license conditions themselves, Unit 1 and Unit 2 are different because, as you know, Unit 1 has the dryer instrumentation initially. So I'll mention the differences once we get through Unit 1.

But for Unit 1, these are in detail in the -- in the draft safety evaluation, but they're -- to summarize them as briefly as possible, the requirements for operation above CLTP, the 3,489 megawatts thermal, they monitor the main steam line strain gauges during power ascension, they hold at each 3-1/2 percent step above 3,489 for 96 hours, and that allows time for evaluation of the data, the steam line data, the steam dryer data, and conduct the walkdowns.

And then, they provide that evaluation to the NRC Project Manager for the staff to look at. And then, if they have any acceptance criteria or limit curve exceeded, then they have to return back down to a lower power level and justify.

They also will be monitoring the reactor pressure vessel water level instrumentation, and main steam line accelerometers for resonance frequencies, because as -- as you've talked about today, with regard to lower frequencies, that's an area where these could come in handy in terms of looking for some of these lower frequencies.

We'll also have -- there will be resolution of any discrepancies of the steam dryer analysis within 90 days of reaching the --

MR. WALLIS: Are these two things connected, this water level instrumentation and MSL accelerometers?

MR. SCARBROUGH: No, they're not -- they're not.

MR. WALLIS: They're two different --

MR. SCARBROUGH: Yes, they're two different --

MR. WALLIS: Why did you put them together like --

MR. SCARBROUGH: Oh. Well, because in terms of the license conditions, this is the paragraph that they're in together. They're --

MR. WALLIS: They're two different things all together.

MR. SCARBROUGH: Yes, yes, yes. They are going to be monitoring the -- not just the water level, but the resonance frequencies coming out of that -- out of the instrumentation. So what they can glean from that, we're trying to find ways for them to identify areas that maybe the steam line strain gauges may have missed. And so those are areas where it's a completely diverse location of --

CHAIRMAN BANERJEE: What happens if they don't, they just have to hold that power level? Let's say they can't resolve a discrepancy in the analysis within 90 days.

MR. SCARBROUGH: 96 hours.

CHAIRMAN BANERJEE: No, I'm saying --

MR. SCARBROUGH: Oh.

CHAIRMAN BANERJEE: -- in the steam dryer analysis.

MR. SCARBROUGH: Oh, I see, the last one. Right. If they don't resolve any discrepancies, they will have to come back to a lower power level. I mean, they can't -- if they still have discrepancies there, they will have to back down to where they were. They did not have those issues --

MR. WALLIS: But there will be discrepancies. There always are.

MR. SCARBROUGH: Oh, right. But, yes, we're talking about the -- where they might go over the limit curves. Of course, there are going to be differences.

MR. WALLIS: What sort of limit is tolerable on a discrepancy?

MR. SCARBROUGH: Right. It's going to be -- it's going to be where they go above those limit curves. If they have places where they would see their limit curves, they're going to have to resolve those down, and that's -- that's the criteria that were used.

MEMBER MAYNARD: Why is this tied to 90 days of issuance of the EPU? Within 90 days of issue -- within 90 days after the issuance or --

MR. SCARBROUGH: Right. Right. After the issuance.

MEMBER MAYNARD: Why is it tied to that rather than a certain number of days prior to startup or --

MR. SCARBROUGH: Right, right.

MEMBER MAYNARD: -- exceeding the power level?

MR. SCARBROUGH: We had a lot of discussion about that back when we were doing Vermont Yankee and such of what should be the starting date for that, and what we wanted to make sure was there was a clear point at which we would be getting this taken care of. I mean, we wouldn't -- so we wouldn't be -- if it was startup, what do you define as startup?

We had discussions of, you know, is it -- you know, is it this point? Or is it exceeding

CLTP? Or is it -- you know, could there be an issue where it might drag on for a longer period of time? And we decided that that was a -- everybody knew that date -- when that date would be, and that way we'd have a specific day where we would expect them to have it resolved. So that's why we wanted a calendar date to work with.

CHAIRMAN BANERJEE: So this is unambiguous, but on the other hand, if they encounter some difficulties which are unexpected and going up, then what happens?

MR. SCARBROUGH: They will have to resolve those discrepancies. That's just part of this process, to make sure that we don't drag this out, that they take care of any issues that resolve quickly, so we don't have the plant up there at sort of a -- a level that --

CHAIRMAN BANERJEE: Was this what we did with Vermont Yankee?

MR. SCARBROUGH: Yes.

CHAIRMAN BANERJEE: I don't recall.

MR. SCARBROUGH: Yes, it is.

CHAIRMAN BANERJEE: Okay.

MEMBER ABDEL-KHALIK: What that implies

is that they would have to go back to CLTP.

MR. SCARBROUGH: Or at least back down to a level where that discrepancy was no longer relevant, like if they exceeded the limit curve, go back down to where they're now below the --

CHAIRMAN BANERJEE: They're going up in 3-1/2 percent roughly steps, right?

MR. SCARBROUGH: Right.

MEMBER MAYNARD: It would probably take some licensing action. If they don't resolve the discrepancy, I would think there would have to be some type of a formal submittal, exemption, something --

MR. SCARBROUGH: Yes. There would definitely be discussions with Office of General Counsel and that sort of thing, decide where we go from there. But what we have -- we have had very good interaction with Exelon, with Quad Cities, during this process where they went up, and also with Vermont Yankee.

So we have -- we feel we have a good track record on working with them, because they look at the data and we look at the data, and usually we agree if there's something that doesn't look right, and there's action that needs to be taken.

DR. PIERCE: Can I ask you a question? Did you have some sort of expectation that they could resolve these discrepancies? Is it theoretically possible they could do it, or --

MR. SCARBROUGH: Yes, because a lot of times with -- like what you heard with Dave, there is Revision 4 of the ACM out there. I mean, there is better -- there is techniques that they could use to try to reduce that discrepancy, remove it from being relevant. So there are techniques that they could use to try to resolve those.

DR. PIERCE: Do you think there's a reasonable expectation that if they did the right things that in 90 days they could resolve their discrepancies?

MR. SCARBROUGH: Yes. Yes. We think they could do that.

MR. WALLIS: Is this 90 days a deadline for them or for them plus you? Because they're going to submit something.

MR. SCARBROUGH: Right, right.

MR. WALLIS: You have to review it. Is that within this 90 days, or do you have an infinite amount of time to review it, or --

MR. SCARBROUGH: Yes. Well, we are usually under a lot of pressure to get our review done very quickly when they're under pressure.

MR. WALLIS: To get your stuff back to them.

MR. SCARBROUGH: Yes. Right, right. So we would -- we've spent weekends working with Vermont Yankee on -- when they went up to deal with issues. So we have the same -- the same --

MR. WALLIS: So the thing isn't really resolved until you say it is resolved. I mean, you're the umpire in this game, aren't you?

MR. SCARBROUGH: My management is the umpire, yes, sir.

MR. WALLIS: So it isn't really resolved until you guys have done your bit as well.

MR. SCARBROUGH: Right, yes.

MR. WALLIS: So you should be included in the 90 days.

MR. SCARBROUGH: I guess we are. I guess we are. By default, we're included in the 90 days.

The next sort of -- license condition

number 2 was what PPL will implement. And first is they have to -- to finish the as-built dryer, because it's being built, and we talked about -- heard about the hammer tests they have to do. They have to finish up the acceptance criteria and prepare those final limit curves 45 days before exceeding CLTP. So they have to give that to us before then.

They also have to benchmark the stress analysis, and you all heard a little bit about that -- is 90 days before they go beyond that first step, before they exceed that 107 CLTP, they have to finish that benchmarking. So that's why you have to take all of that data they've gathered from the dryer over that first time period and benchmarked that stress analysis.

So that's where they were talking about they were deciding if the analysis is showing that it's reasonably conservative, then they might stop there, or they might use an updated model if they find they have to do some more detailed analysis. So they have to do that.

If they challenge the --

MR. WALLIS: What is it, 11,000 psi, or

-- Level 1 is a lower pressure, lower stress?

MR. SCARBROUGH: Yes. Level 2 is 11,000, and that's --

MR. WALLIS: The numbers predicted were 12,000.

MR. SCARBROUGH: Oh, that's -- yes, that was -- and --

MR. WALLIS: Well, they're expecting to go above Level 1.

MR. SCARBROUGH: Well, they -- according to their analysis, I mean, they were showing that they might go above it. Right, right. So -- but if any of their -- their measuring data goes above, you know, in terms of their analysis, their limit curves -- their limit curves are set up that they -- once they hit those limit curves, they have to stop, and then they have -- anywhere along that line, they start off with -- they start off with current plant data. And as the plant goes higher in power, if they hit a resonance and it comes up and it hits that limit curve, they have to stop. And 11,000 is a -- sort of a warning to them, and then the Level 1 is a complete stop.

MR. MANOLY: That's 80 percent.

MR. SCARBROUGH: Right, 80.

MEMBER MAYNARD: I think they also said that they expected to have more margin than what the calculations were showing.

MR. SCARBROUGH: Right. And that -- and then there's some items there that we could maybe talk about during the closed session.

MEMBER ABDEL-KHALIK: But that second constraint is not really a constraint, because they're not expected to go above 107 percent during the next cycle, for Unit 1 at least.

MR. SCARBROUGH: Oh, well, for Unit 1, but, yes, this is license conditions for all the way up to 120 or 114 CLTP. So this is -- will still be in place for that next step, too, so they'll have to maintain that. So this will hold for them, so we'll be getting this information before they go up that next step.

And then, after they reach 107 CLTP, we have to provide those updated stress reports and limit curves, so they will be sending that in to us. And then, if they -- if they do hit a Level 1 limit, then they will have to reperform the structural analysis, you know, as they go above. So this is -- this is written for all of the way up to 120.

And then, on the next slide, this -- this is item number 2 continued, they have to revise the long-term monitoring to reflect the GE Service Information Letter 644 for steam dryer inspections, submit the dryer reports at 107 and 114 percent CLTP, and they have to submit the flow-induced vibration portions of the startup procedure before exceeding CLTP.

And that gives us a chance to see it ourselves as they walk up. We have our game plan right in front of us, so -- what they're doing, so we can talk to them on the phone and be sure we're understanding what they're doing.

The third item is kind of a laundry list, and I just really summarized it here. It's a long list in the license conditions, but it's what the startup procedure has to include, and it has to have the dryer acceptance criteria, the main steam line limit curves, the hold points, all of the activities, the parameters, the walkdowns, and also verify that those actions were complete. And that list is spelled out in the license conditions.

And then, the next slide is sort of the ending point. It's sort of like where you sort of reach the end of this. The fourth license condition is that you cannot make any changes to certain attributes of the power ascension plan, and one of those is that 3-1/2 percent step. They can't change that step without NRC staff approval.

The Level 1 criteria can't be changed, and the stress methodology cannot be changed. All of those -- they have to come back to us for rereview.

So, then, once they get to the first fuel -- two refueling outages for -- after two full cycles, they perform the visual inspections of the dryer using the BWR VIP-139 and GE guidelines.

MR. WALLIS: Looking, of course, at the things they can see.

MR. SCARBROUGH: Right, right, right. And then they have to provide those reports to us within 60 days of startup, and then also they have to have the overall results to us also. Within that 60 days of the power ascension completion, they have to give us that as well.

And then, the license condition sort of

expires -- items 5 and 6 expire after they finish those two operating cycles, and they haven't seen any unacceptable flaws inside the dryer.

MR. WALLIS: Do they know what an unacceptable flaw is?

MR. SCARBROUGH: Well, every time they see any flaw it gets reported back, and they have to evaluate it -- what it is in terms of, does it reflect an unacceptable condition regarding their assumptions and their analysis? If it's in a location or it's a -- it indicates that their analysis --

MR. WALLIS: Well, I would suspect any kind of a crack would be unacceptable.

MR. SCARBROUGH: Well, a lot of times you'll see little -- tiny little things in these dryers. I think it's sort of typical of dryers.

MR. WALLIS: Of ones that are --

MR. SCARBROUGH: Well, sometimes it's better, you see them better, you have better techniques to look for them. But a lot of times we sort of keep an eye on steam dryer inspections, and it's very common to find little tiny things in there. You just --

CHAIRMAN BANERJEE: But we did do it at Vermont Yankee, didn't we, or --

MR. SCARBROUGH: Yes, right. We found little things. It just -- it's just I guess the nature of it that you --

MR. MANOLY: Yes. For existing dryers, because you already have maybe some indications of cracks, IGSCC could be, and --

MEMBER SHACK: Yes. But, I mean, in this case we're designing against initiation.

MR. MANOLY: Right.

MEMBER SHACK: And we're designing against IGSCC, so I --

CHAIRMAN BANERJEE: Any cracking.

MR. SCARBROUGH: If they see anything, it would get a lot of attention. I can guarantee that.

MR. WALLIS: You would see it best before you have installed it. I mean, when you've got it on the floor up there, you can fall all over it and you'll see something. When it's inside, it's much more difficult to see something.

MR. SCARBROUGH: It is.

MR. WALLIS: So if you see something

when it's inside, something has happened.

MR. SCARBROUGH: Right, yes. We will definitely be looking at every --

MEMBER ABDEL-KHALIK: Now, the current plans call for essentially the instrumentation to be destroyed after the first refueling outage. So are you happy with the extrapolation from 107 percent to 114 percent of current license thermal power without an instrumented dryer?

MR. SCARBROUGH: There was a lot of discussion among the staff about that, and with the licensee about which -- which dryer to install an instrumentation. What we expect is that, as they go up in power, and as they go up to 107 CLTP, they will be benchmarking their analysis. And if they don't see any resonances at that point, then their extrapolation should be the velocity squared, and we should see that.

If we see any resonance start to occur, we may be more concerned. Now, what we have done is, as indicated in the slides, you know, some of the scale model testing that the licensee talked about, and we'll talk about more later, they do not indicate resonances up to the full EPU condition.

And that's part of our basis for acceptance is that they did not see it from the scale model.

CHAIRMAN BANERJEE: They are saying that -- I don't know if we can talk about it in open session, but the low frequency oscillations that have been seen are due to a difference source than -- at least there's a different source term for that.

MR. SCARBROUGH: Right.

CHAIRMAN BANERJEE: So, and that may not be properly scaled in the scale models.

MR. SCARBROUGH: That's possible.

CHAIRMAN BANERJEE: We can talk about this in --

MR. SCARBROUGH: Yes, right. That probably would be better to --

CHAIRMAN BANERJEE: I don't know how much is probably --

MR. SCARBROUGH: Yes, that would probably be better, to wait on that, because we do have a slide for the closed session on the scale models.

Unit 2 license conditions, they are very similar, as you can see, but they do not have the dryer instrumented, so they will be using the --

CHAIRMAN BANERJEE: Let me ask you: why didn't you ask for Unit 2 to be instrumented?

MR. SCARBROUGH: They asked the staff if we would have a preference and --

CHAIRMAN BANERJEE: Or have them both.

(Laughter.)

How much are we talking about? Is it a lot of money?

MR. SCARBROUGH: It's a lot of work. It's a lot of work.

CHAIRMAN BANERJEE: You did one or the other.

MR. SCARBROUGH: Yes, that's -- yes. And what we felt was the information we had -- it would be sufficient, combined with the CL model testing, to show what's going on with the dryer. So that was a decision we had to make -- was it sufficient that -- what information they were going to give us.

Okay. And then, the last one, just conclusion is that we found that the components will continue to meet the general design criteria. There's reasonable assurance the new dryers are within the structural limits and for the extrapolated EPU conditions. And the EPU amendment is acceptable with respect to component evaluation. And we have license conditions. We provide for monitoring, evaluating data, and taking prompt action, if necessary, from the EPU operation.

So that concludes our open session discussion.

CHAIRMAN BANERJEE: Thank you, and I think we can continue this in the closed session.

We're going to take a 45-minute break, and we'll be back at five past 1:00. All right?

(Whereupon, at 12:23 p.m., the proceedings in the foregoing matter recessed for lunch and resumed in Closed Session.)

CHAIRMAN BANERJEE: So this is open session. We're back to the open transcripts.

And whoever wants to at this point, we're back in. We're missing Graham Wallis, but --

MS. ABDULLAHI: I'll go get him.

CHAIRMAN BANERJEE: Is he back? I think he is meeting with one of the Commissioners.

(Pause in proceedings.)

CHAIRMAN BANERJEE: Okay. So we're going back into open session, and the purpose of this discussion now is to elicit opinions from the subcommittee members about these presentations and the cases we've heard, and to provide some guidance to PPL and the staff about what we think we might want to hear at the full Committee meeting.

Of course, you can make your own judgments about this. So maybe we'll start with Jack. Give us your views on this, Jack.

MEMBER SIEBER: When I reviewed the documentation prior to the Subcommittee meeting, there were a few things that stuck out for me. One was the flow assisted corrosion issue, and what stuck out in the documentation was the fact that I would read, well, the flow doesn't increase this much and we haven't had all of these kinds of problems, and it comes to pass that 16 of the 18 years went by without using ChecWorks, and that Susquehanna is basically just starting out on the systematic use of trending and tracking for their flow assisted corrosion program.

On the other hand, they haven't had an accident of which I attribute to luck. They've also garnered enough information from the examinations that they've made to replace piping, and it would seem to me to be pretty expensive. So I can't condemn their whole program.

I considered what they had done up till a couple of years ago a weakness. On the other hand, with regard to whether the EPU should be allowed or not, I think that there is enough there in the fact process and program to justify granting EPU.

The other issues that I got from my reading was basically what we've been talking about for a day and a half, which is the strength of the steam dryer, its response to EPU conditions and how they arrived at the point where the licensee considers it acceptable.

I still think there's a lot of open ends, which one of them is how do you extrapolate distresses based on frequency. One of the consoling features of this is they did what a practical engineer would do, and that is if you don't know the answer, make it twice as strong or three times as strong or ten times as strong, and I see that that's what they have proposed to do.

The thicknesses of material have been substantially increased. I don't think there's enough data to be able to analytically prove that the design of the dryer is where it ought to be. It would take more testing than has been done so far. The models need additionally refined, and I think that better analytical people than me would be better to render a decision.

On the other hand, I am not totally uncomfortable because of what I consider to be ample margin in the actual construction of the replacement dryer.

So those are the two issues that stick out.

CHAIRMAN BANERJEE: Are there any items, Jack, that you, in particular would like them to address at the full committee meeting?

MEMBER SIEBER: Those two items.

CHAIRMAN BANERJEE: Okay.

MEMBER SIEBER: The other issue which has come up in other EPU reviews is the start-up and test program. There have been more EPU start-up and test fire ascension programs that look like PPLs than there have been with others.

In the old days we objected to not performing large transient tests, but when you really think about it, the need for large transient tests has been greatly reduced because of the refinement in the calculational methods for hangers and supports and, in particular seismic supports.

Large transient tests at one time were used to train operators. We now have simulators that do the same job, and to find out what in the plant is going to break, and I think we're all better engineers now and assure ourselves based on calculations and standards that it is unlikely that we're going to break hangers and supports, and so one has to ask themselves what is the need for putting a big transient on the plant and shaking up everything when you aren't going to accomplish the two main goals, which is to prove the plant will stay together and to train operators, neither one of which is necessary in this age.

So that's the other issue that has been out there, but I don't hold it as an issue on my own. I think the start-up program is well thought out. There's plenty of time in there to do everything that has to be done. They don't plan to do tests that I believe aren't necessary, and on the other hand, they do plan to do tests that I do believe are necessary. So that's pretty much the same.

CHAIRMAN BANERJEE: Thanks.

David, could I ask you?

MR. DIAMOND: Yeah. I guess generally I understand what the licensee has done or I should say the vendor has done to show that its methods are applicable to the EPU conditions that are expected at the plant. I would say that the major weakness that I see in their methods -- and I'm focusing on the neutronics methods is the fact that the validation of the methods is used to lead to values of uncertainties which go into determining whether you meet particular limits on safety parameters like linear generation rate, NCPR, and Nappleunder (phonetic), and those uncertainties that go into determining where you are are based on a limited database for ATRIUM-10 fuel.

This I feel could be corrected by getting more data, for example, more gamma scans that are applicable. You use gamma scans. You also use -- well, you use the plant data ot help you with your validation, but it's really the gamma scans which are important for, among other things, determining the uncertainties in pin power and bundle power.

And if there were more data, I think one would have more confidence that those uncertainties really apply to a particular fuel that's to be used for EPU conditions.

CHAIRMAN BANERJEE: Thanks, David.

What about is there any uncertainty effects on other transients, like void uncertainties? Do you see that as being an issue?

MR. DIAMOND: I think that the uncertainties that are most directly -- well, of course, all of these uncertainties factor into the transient analysis as well. So the short answer is yes. Uncertainties will impact the transient analysis, and --

CHAIRMAN BANERJEE: But I think what you're saying is to the main Committee we would want the licensee and the staff to address how they are dealing with uncertainties in the neutronics, such as using --

MR. DIAMOND: Right.

CHAIRMAN BANERJEE: -- gamma scan data, whatever it is.

MR. DIAMOND: Yeah.

CHAIRMAN BANERJEE: To quantify it.

MR. DIAMOND: Exactly, because it's those uncertainties which form the basis for understanding what's going to be the uncertainty in your heat generation rate, your limiting linear heat generation, and in the results that you get out in transient analysis.

CHAIRMAN BANERJEE: Okay. Thanks.

Let's move on to Graham.

DR. WALLIS: I assume you're summing up now?

CHAIRMAN BANERJEE: I'm not summing up. I'm asking --

DR. WALLIS: I assume we're summing up.

CHAIRMAN BANERJEE: -- for opinions.

MEMBER SHACK: We're obtaining an interim summation because Sanjoy is about to leave.

DR. WALLIS: So we're going to have some more presentations?

MEMBER SHACK: We are going to have some more presentations.

CHAIRMAN BANERJEE: But we're doing it --

DR. WALLIS: Well, this application meets the usual criteria for NRC, and we've heard from the staff on that. We didn't see any obvious holes where they missed something or evaluated something incorrectly.

Generally, it compares with other CPU applications that we've reviewed, and most of those have been successful, I understand.

Now, I do think that the uncertainties and the safety criteria following up on David's statements, could be done better, but just the fact that your neutronic calculations lead to power distribution calculation, which fits the TIP data, there's some measure of uncertainty, but it doesn't really tell you how uncertain the safety measures are. It has made to focus on those things.

I think what we need to do is do a better job of showing what the uncertainties are. Those metrics which are, after all, the regulatory things that matter. Once it gets over to the Findley-Dix and the AREVA method -- I think we're going to have another meeting on AREVA methods next month where we're going to dig into this --

CHAIRMAN BANERJEE: But this will be after the full Committee meeting.

CHAIRMAN BANERJEE: He says yes and you say no.

MS. ABDULLAHI: Well, it is AREVA methodology for the instability detect and suppress in RAMONA.

DR. WALLIS: Doesn't it go back into void fraction or not? It doesn't.

MS. ABDULLAHI: I don't think so.

DR. WALLIS: Well, I think --

MS. ABDULLAHI: I can get a confirmation from AREVA, but my understanding is not.

DR. WALLIS: It's a comparison with AREVA fuel, the ATRIUM-10 fuel. Those are the data that matter. From that you can extract uncertainties. I'd like to see them propagated through some calculation to just see what effect they have on the answer. That would be the way I'd like to see it done.

I look to Novak Zuber, and he is astounded that his bubbly flow model is applied to annuler mist flow with spacers and all of that.

MR. PIERCE: Did you say Novak Zuber?

DR. WALLIS: Novak Zuber.

MR. PIERCE: Say hello to him if you see him.

CHAIRMAN BANERJEE: He had dinner with them last night.

DR. WALLIS: If it works well enough and if the uncertainties can be propagated through the system and shown not to make unreasonable effects on the answer, then I guess that's okay. If it works with the data, that's the real test.

I think the steam dryer approach is okay. It's cautious, sort of learn by experience extrapolated, but change your ideas if necessary and extrapolate. I think that's the right approach, instrumenting as well as you can.

I'm nervous about this fudge factor, 2.71, because if some mechanism has been left out, no fudging the mechanism that you've analyzed isn't really the way to account for it. So there may be surprises. I just hope there aren't.

There's some other driving source for the vortices or something which is under underestimated or not estimated at all, and it may turn around and bite you.

On the ECCS confirmatory analysis, I think it was a good idea. I think the staff made a good effort. It's a little hard to know what to conclude because they did something a little different from what the vendor did. They made different assumptions. They got numbers which seemed high if it's a best estimate model, and yet low if you put in radiation. So I don't quite know what to conclude there and maybe the staff can make a better case somehow for why what they've done gives us confidence. Because the risk is it might even muddy the waters rather than clearing things up.

That's about it. Generally there's nothing that stands out to me that says you've got to really investigate this thing.

CHAIRMAN BANERJEE: Bill.

MEMBER SHACK: Well, I think clearly one item of interest is going to be the steam dryer, and I think, you know, they have the tremendous advantage, of course. They can benchmark against these string gauge measurements from the earlier one, and I'm actually quite comfortable with what they've done, and it seems to me that they have enough data and they're cautious enough with the instrumentation they have on the steam lines that if things that don't scale the way you expect them to, like residences, they'll be able to identify those.

But I think that's going to be an important item here. On the analyses, you know, it may be of interest to us how they did the different LOCA analyses, but the conclusion from both LOCA analyses is there's lots of margin, and I'd be willing to declare victory.

This question of uncertainty and whether we have an adequate database to define the critical parameters seems to me somewhat more focused of where we should be, you know, and it might be the more contentious issue as to whether this application is or is not acceptable.

CHAIRMAN BANERJEE: Or with what uncertainty.

MEMBER SHACK: Or with what uncertainty, well, as it stands, yeah.

CHAIRMAN BANERJEE: Sure. Okay. Thanks. Said.

MEMBER ABDEL-KHALIK: Let me add comments to whatever has bene said already. The vessel over-pressure transient, the change in tech spec from allowing four inoperable SRVs to a maximum of two inoperable SRVs, I assume if the analysis had shown that who inoperable SRVs were unacceptable, they would have gone down to one inoperable SRV to meet the ASME acceptance criteria.

And this needs to be justified, you know, especially since ascertaining operability of the SRVs during operation is not possible and, therefore, establishing that this condition is actually met would be important.

The second thing is using GE's NEDO-32047 to justify not needing to do a design specific ATWS instability is, in my opinion, unjustified.

The third issue that came up is bypass

voiding. The impact of bypass voiding on the set points for the detect and suppress Option 3 stability needs to be clarified.

I agree with my colleagues about the concern about the uncertainties. I was particularly struck by the 3.87 percent uncertainty number that was given and whether that really was applicable for the case at hand where you're extrapolating beyond the parameter ranges of at least some of the correlations.

Also, the fact that some of these correlations -- the database supporting those correlations do not include some conditions, for example, when you have severe axial power gradient, and the example I gave was when, you know, the control blade tip is right at the top of the part length rods. You know, this is a real condition, and you don't have data to support such severe axial power gradients.

I guess the staff has committed to do a calculation to examine the effect of the number of bundles included in the LOCA analysis as representative of the hot channel versus the average channel, and by doing that, we see the sensitivity of the results to that assumption.

In their case, they were using four bundles to represent the hot channel, and given the fairly uniform power distribution and the large number of bundles near the peak power, the result of the analysis may be affected by the size of this hot channel.

They also have committed to try to reconcile the Appendix K results presented by the Applicant against their best estimate analysis.

And finally, I think it would be a good idea as suggested towards the end of the presentations developing acceptance criteria for the data to be collected at the 100 percent CLTP testing.

Thank you.

CHAIRMAN BANERJEE: Thank you.

Allan, your views on particular issues.

MR. PIERCE: As a consultant, I'm not a member of the ACRS.

CHAIRMAN BANERJEE: Consultants become members of the subcommittee.

MR. PIERCE: Anyway, on the whole I was impressed with the overall plan that PPL had. Their redesign of the stream dryer seemed to me as a guy who worries about strength of materials, to me that's very conservative, and if you double the thickness of something, that's pretty drastic, and if you worked with half of it, it seems it's going to work.

I think you're stuck with this way of estimating the stresses in the steam dryer, and the 2.17. My guess is that that is probably a very conservative thing to do, but I feel very uncomfortable with it. I hate to penalize PPL and not put the hazard uprate just because I feel uncertain about them and uncomfortable with that.

It's unlikely that anything drastic will happen, in my opinion, but I'd like to see more science in this, and also I liked that the NRC that had a plan to sort of force them to present the science and develop new science and to take measurements as they go along, and this, I think, would probably avoid difficulties downstream if they really did that.

MEMBER SHACK: Otto.

MEMBER MAYNARD: I had a few things. As far as the operator, I was really impressed with the

OPS involvement in this whole process. A number of changes were made to actually make things better for the operators and for the operations. The areas that decreased some were really quite minor percentage-wise compared to where they were.

I also felt good that it was able to actually be able to observe some operators in the plan as well as simulator scenarios and see how things go.

It's also obvious from their fuel performance, lack of fuel failures that they are very conservative in their operation as it is related to the yield, and also in the extremely low to almost no incidence of rod mispositioning errors, which is the entire fleet always is struggling with a little bit there.

So those are all very positive things. The dryer, if we were trying to justify continued user of the existing dryer I'd b a lot more concerned about the analysis and a number of things. Where we're going to a completely new dryer, it's going to be instrumented and its going to be tested as various stages. I think the analysis is nice to kind of get us in the ballpark. I'm just not sure how much we really need to try to force anybody to refine the analysis to be everything that we need.

I put a lot more reliance on the fact putting a dryer in that's instrumented, we're going to have some data to compare it to and some analysis to compare that with, and a cautious move up rather than some other ways.

I think the only thing I might add in that, and it was mentioned in one of the presentations in a little bit. You know, one of the most important things here is the instructional integrity of the dryer. It's not whether it cracks or not. It's whether it generates any loose parts or causes any other damage and might need a stronger statement as far as the defense in depth there. We keep talking about to try and prevent any crack, and that's nice a noble, but that's no necessarily what necessarily the real design requirement from a safety aspect.

The ECCS with the margins, I'm not concerned about that. Using really not only Appendix K versus best estimate, but different codes and stuff that's involved typically if you have a lot of margins, you're modeling and you don't have to be quite as refined if you're close to margin if you start refining the modeling, and that typically will bring things closer together, but with this much margin I'm not sure that it's necessary to go back and try to get any more detail.

On the SRB operability, I think we've got to be a little careful there. There's a lot of history. These are code safety not only in nuclear power. We have to be careful, I think, that we're not asking them to do something where we're basically changing the requirements in the regulations and everything because really the EPU part of this and the way they're handling that really isn't any different than the way all the plants handle SRBs and operability right now.

So we may have a generic issue, but I think we need to be able to separate if it's a generic issue that we have versus is this really an EPU item related to the Susquehanna power uprate.

That brings me kind of to my last point. We had a lot of good discussion yesterday and today, and I think one of our challenges we do need to sort out what's really applicable to EPU and what is something that may be more of a generic item or an issue that needs to be handled separate from that because we do have to get back to the regulatory requirements for EPU and make sure that we're dealing with that.

So that's all I have.

CHAIRMAN BANERJEE: I'm going to hand this over now to bill. Tom, you will be the last man to speak, and then Bill will do whatever is needed, give me enough guidance for the full Committee.

MEMBER SHACK: Will do.

DR. KRESS: I will write you a report. Sanjoy, I'll write you a report. That way you'll have it in writing.

CHAIRMAN BANERJEE: All right. That will be great.

DR. KRESS: You won't have to rely on Bill necessarily. But in general I agree with a couple of the members who feel that the application satisfies the general requirements for upgrade, Chapter 15, the general design criteria. So I didn't see any real holes in there that would be something to complain about or something that would hold up the application.

I feel like Jack, very comfortable with what they're doing with the steam dryer. I think that's the appropriate approach. I don't view it as a safety issue anyway. I think it's an operational issue of sorts, and so I'm not concerned much with it. I think the approach you're doing is okay and it should work.

I still, in spite of what Otto said, want to see the staff to reconcile the differences in the best estimate calculations. It just makes me feel better about it. I don't see this as an impact on the EPU. You know, maybe for future reasons we want to know why they're different.

There was one place in the SER where they were talking about reactivity insertion accidents, which weren't very severe, but the staff quoted acceptance criteria in calories per gram, and they had two different values at two different places. I think they need to check and find out what the actual value is.

With respect to the PRA, I didn't have any problem with the human error probabilities and the time changes and their effects on CDF and LERF. I think they did what everybody else is doing and relied on models that have been reviewed and stuff, but I did have a little bit of problem with the staff's use of Reg. Guide 1.174.

In the first place, the PRA determination of things like CDF and LERF needs to have all of the modes of operation and all the initiators and from that standpoint I was disappointed to see the seismic eclip-type thing rather than actually quantifying. I'm glad the staff made some estimates of what the contribution was, but the contribution indicated to me that seismic was the dominant contributor and raised the CDF up to something like ten to the minus five. I think that raised a flag for me, and I would maybe like to see a better determination of that.

I'll say more about the Reg. Guide 1.174 in my report.

MEMBER SIEBER: It's only dominant because they didn't include shutdown risk.

DR. KRESS: That's the other. All modes and all initiators, indeed.

MEMBER SIEBER: Yeah.

DR. KRESS: I had a problem. You know, one of the things that we talked about was because of the number of modifications that the -- I'm still in the PRA space -- that maybe the failure probabilities of the unavailabilities may be a little wrong for some of the components because you don't have a database on them, and so they talked about a break-in period in which the risk might be a little higher, and they made some estimates of what that might be, some sensitivity studies.

I thought it was a good idea. The problems I have with it is I don't know how long the break-in period is. I don't know how to deal with short-term risk because I don't think we have an acceptable acceptance values on what short-term risk is acceptable.

So I don't know how to deal with that. So I think, you know, it's not important because the CDF was so low anyway that I don't think it mattered, but in principle it bothered me. I just didn't know what a break-in period was and how long it is and what effect it's going to have over the long run.

One other thing. Maybe it's just my ignorance, but they talked about one issue of the fuel, which is a bowing problem in the channels, and they talked about susceptible channels. I don't know how you know which ones are susceptible or not. Maybe that's just my lack of knowing the problem, but anyway, those are the kind of vague comments I have about it.

I think it was a good application. The staff did a good review, I think, and I'm pretty pleased with that.

MEMBER SHACK: Follow-on comments from anybody?

(No response.)

MEMBER SHACK: If not, I think we can resume our presentations.

We have a staff presentation on the EPU test program.

MS. ABDULLAHI: I think we get a break.

MEMBER SHACK: Do you want a break?

MS. ABDULLAHI: Did it say so?

MEMBER SHACK: It doesn't say a break at least on my schedule.

MEMBER SIEBER: We already worked through the first break.

MS. ABDULLAHI: Oh, we did?

MEMBER SIEBER: So I'm all for a break.

MEMBER SHACK: Okay. If you want a break, a 15-minute break. Come back at five of.

(Whereupon, the foregoing matter went off the record at 2:40 p.m. and went back on the record at 2:54 p.m.)

MEMBER SHACK: We can come back into session.

Our next topic is EPU power ascension and testing and the NRC review, and Mr. Pettis will take us through this.

MR. PETTIS: Okay. Good afternoon. I'm Bob Pettis from the Quality and Vendor Branch, part of the Division of Engineering in NRR, and I have a brief presentation on PP&L's power ascension test program.

Standard Review Plan 14.2.1, general guidelines for EPUs provides the guidance for testing programs based on primarily Reg. Guide 168 and plant specific initial test program. This SRP was developed several years back as a result of some initial comments from the Committee that had to do with coming up with a staff review document that would be analogous to something that we had already on the books for license renewal.

We had a license renewal set of guidelines that the staff would follow for future applications, but we didn't have anything in place for EPUs at the time. So this version came out in 2002, December of 2002. We had many ECRS discussions and meetings throughout the years. It was followed up by presentations that involved the GE topical report, the CPPU, constant pressure power uprate, topical review. So all of this is basically incorporated into the standard review plan, 14.2.1, which became final back August of last year.

So now we have the final version, and it has been tweaked many times based on input and comments from the Committee as well.

The EPU test program should include sufficient testing to demonstrate that structures and components will perform satisfactorily at the requested power level.

Our branch reviews the programmatic aspects of the licensee's power ascension program, including the large transient testing justifications, if necessary.

Other technical branches within NRR that you've had the benefit of their presentations already go into other aspects of the power ascension test program as well, like condensate and feedwater testing, the steam dryer mechanical-civil engineering aspects of that Plant Systems Branch, Reactor Systems Branch.

So what I'm presenting here is basically the overall programmatic review of the PP&L program. The staff guidance considers the original power ascension test program and the EPU related modifications as was discussed earlier by PP&L. They had a slide that showed start-up testing as a function of different power levels all the way up through achieving EPU power, and basically that in concert with their initial test program gives us, you know, basically the adequate support that we need to say that the program is satisfactory.

With respect to taking exceptions to certain testing, that is well within the purview of SRP 14.2.1, and the next slide or two will just talk briefly about that.

The staff guidance acknowledges that licensees may propose alternative approaches to testing with adequate justification, and supplemental guidance provided in the SRP for staff evaluation of alternative approaches is presented there.

The basic exception that most licensees have taken in the past through about the 13 or 15 or so EPU applications that have come before ACRS has been in the area of the large transient testing, which for the boilers, this was an original requirement that was in the GE topical reports back some time ago, and they had listed the MSIV closure test, and they has listed the generate a load or rejection test as being two tests that were part of the EPU process.

And over time that requirement basically became somewhat diluted and justifications were presented based upon industry experience, specific plant operating experience, code validation benchmarking, to pretty much say that here is a justification for us not to perform these tests.

And I think we've heard some of that justification this morning in the licensee's presentation with respect to additional demand on the plant to do these, and I'm sure there's other reasons for not doing them as well. But we look at it in relation to what we've looked at for previous plants to try to come up with some justification or some support for their justification.

The licensee's test program consists primarily of steady state testing and does not include performance of large transient. Large transient was part of the initial test program which we all know is part of the Reg. Guide 168 requirement for dealing with plants in the EPU area that already have operating licenses. We don't want to confuse the fact that the original testing was done in accordance with Reg. Guide 168, which is not directly applicable to EPUs.

The rest program will monitor important plant parameters during power ascension. There was a slide that was shown that basically was documenting data that was taken through the power ascension process for the steam dryers, but basically this slow and steady power ascension is pretty much what's dictated in the GE topical report for the CPPU process, which we have discussed previously.

Tech spec surveillance and post mod testing will confirm the performance and capability of component. Power ascension testing follows the staff approved GE constant pressure power upright. We approved that topical report back some time ago.

The licensee's justification for not performing large transient testing addressed the factors discussed in the SRP which were consistent with previous staff approved EPUs. In the SRP there's a section, Section 3(c), that basically provides some factors that the staff will use in looking at justifications to the licensee not performing certain tests.

There's no requirement that they have to reperform every test that they did back during the initial power ascension. The burden is on the licensee to provide a power ascension test program that will insure that the SSCs will perform satisfactorily.

But we give about six or seven factors in which, you know, the staff will review, and most of the licensees today, since we're through 15, 16, 18 EPUs, have pretty much followed the guidance that is given in the SRP. The first several EPUs that were done to the draft SRP guidance were not quite as comprehensive as the applications that are coming in today. They specifically cite the review criteria. They cite the SRP 14.2.1. They see what the staff is reviewing, and the application follows a pretty systematic discussion of those points.

Several of those points are here. One is industry operating experience, which includes several unplanned events, MSIV and load rejection, which produce expected results. I think that was discussed earlier this morning.

No new thermal hydraulic phenomena or new system interactions identified. No change in design and pressure margins which follows along with the CPPU approach. Limited scope of EPU mods for balance of plant systems. No unique limitations associated with conformance to analytical models. Plant staff familiarization with facility operation and EOPs, and conformance to previous NRC staff approve GE CPPU report.

In summary, the SRP allows the justification for not performing all of the initial power tests from our other technical groups within NRR. It has been discussed that the large transient testing is not needed for code analysis benchmarking of the transient analysis codes that are used.

Staff has considered the operating

history both in the industry and also specific to Susquehanna. Limited scope of EPU mods, and conformance to the staff approved topic reports.

The conclusion is the licensee's proposed program satisfies the criteria of 10 CFR 50, Appendix
B, Criterion 11, which is test control, and it also complies with the staff's guidance and review criteria that are established in the SRP.

MEMBER SHACK: Any questions for Mr. Pettis?

(No response.)

MEMBER SHACK: Okay. Our next presentation then --

MR. PETTIS: Thank you.

MEMBER SHACK: -- is on plant systems.

MR. STUBBS: Okay. Good afternoon. My name is Angelo Stubbs, and I'll be discussing the review of the balance of plant systems.

Okay. Our review was performed in accordance with the Review Standard RS-001, which is the review standard for extended power uprates and included review of all of the areas in Section 2.1, Matrix 5, with the exception of fire protection in those areas that are specific to PWRs, such as auxiliary feedwater.

The scope of our review for EOP systems included over 20 systems in the six areas that follow. The first one is internal hazards for which reviews are performed for EPU impact on flood protection, equipment and floor drains, circulating water system, missile protection, turbine generators and pipe failures. So those were the internal hazard areas that we reviewed.

The second area, the fission product control, we reviewed the fission product control systems and instructors, equipment and floor drains, the turbine gland (phonetic) ceiling system, and the condenser evacuation system. The component cooling and decay -- we'll go back one -- the component cooling and decay heat removal systems included the spent fuel pool cooling and clean-up system, the service water system, reduction cooling water and the ultimate heat sink.

Okay. Next.

In this area we have the balance of plant, which included the main steam, main condenser, turbine bypass, and condensate and feedwater systems, and the final two areas, the waste management system, which was gaseous liquid and solid radwaste, and then review of emergency diesel fuel oil storage, and light load handling.

In addition to the systems that I just mentioned, we also reviewed test considerations for certain EOP systems. The staff focused the review on auxiliary systems for which an increase in decay heat loads associated with the -- or just heat loads, I guess -- associates with the uprate plant operations might provide additional challenges or increased challenges to the systems.

These systems included spent fuel pool cooling, ultimate heat sink, and condensate and feedwater systems.

Next.

In regards to the spend fuel pool cooling system, based on our review, the staff is satisfied that the uprated plant, that the licensed basis relative to spent fuel pool cooling will continue to be maintained, that is, the spent fuel pool cooling system will continue to maintain spent fuel pool bulk temperature, water temperature below 125 degrees for normal batch off-loads and maintain the time to boil of at least 25 hours.

And this is the licensing basis as described in the FSAR for the spent fuel pool cooling system as such.

Also, the emergency service water system which provides a seismic make-up source for the spent fuel pool cooling system has sufficient capacity to provide the make-up that would be required to compensate for water loss due to boil-off and/or evaporation.

The licensee performs at a specific analysis to insure the pool remained within the cooling capability of the available cooling equipment, and they have administrative controls in place to insure that the pool temperature and time to boil continue to satisfy the licensing basis considerations.

MEMBER SHACK: Is this one of these shared fuel pool arrangements?

MR. STUBBS: The two units do share a fuel pool. They are connected.

DR. WALLIS: What is spent fuel pool coolant?

MR. STUBBS: Yes.

DR. WALLIS: I thought the licensee said that this was okay for certain months when the river water was cold enough.

MR. STUBBS: Okay.

DR. WALLIS: Refueling outages are usually scheduled, but that they'd have to evaluate the limits for a particular outage depending on --

MR. STUBBS: Okay. That's something that we brought up to the licensee, and they did an evaluation, and the staff looked at the evaluation and didn't really feel that evaluation was bounded, and that's why we're relying more on outage specific evaluations analysis to make sure. Because there are certain conditions that have to be satisfied for that evaluation to hold true, including what's the temperature of the service water or the river water.

And they base that on normal spring temperatures, and without appropriate controls and administrative procedures in place, we didn't feel that that by itself was sufficient. So --

DR. WALLIS: You normally couldn't offload the fuel in August?

MR. STUBBS: They would have to evaluate that and demonstrate that they could do that. They can offload it. What this comes down to is there's different parameters you can control the offloading. One is the time between the shutdown and the beginning of the offload., and you can control the offload rates and different things. So they have to control the heat load in the spent fuel pool, and it doesn't preclude them from actually offloading during later in the year, but it means that they have to manage the heat load in a way and they have to demonstrate prior to the offload that the heat load would be managed in a way so that they don't exceed the coolant capability of the spent fuel pool.

DR. WALLIS: This might affect their optimization of their fuel cycle. I mean, they might really want to offload in August and then it turns out that the river just is so dried up in August or --

MEMBER MAYNARD: We may want the licensee to address this because I believe that their procedures require calculation, and I think it's a timing issue. I don't think it prevents them --

MEMBER SIEBER: But it's not going to be

by months the highest decay heat levels when you first shut down after three, four, five days, that heat level that you find.

MR. STUBBS: Right, correct.

DR. WALLIS: So you can't shut down at certain times.

MEMBER MAYNARD: Well, you can shut down.

DR. WALLIS: You just have to offload.

MEMBER MAYNARD: Let's let the licensee guide. We're guessing at some things here.

MR. WILLIAMS: All right. James Williams, PPL.

We can always offload our fuel. We have a 25 hour time to boil limit before we're allowed to take our safety related cooling system out of service, which is RHR. So any time of the year we can't offload fuel.

DR. WALLIS: Yeah. It's just that you can't take you RHR out of service?

MR. WILLIAMS: Correct.

DR. WALLIS: So you can't at any time.

MR. WILLIAMS: Correct.

DR. WALLIS: I wasn't quite clear from

what I read. Okay.

MEMBER MAYNARD: And I thought you had separate --

MR. PAGODIN: Yeah, that was the other correction. This is Rick Pagodin. I think you mentioned that we had a common spent fuel pool. We have two independent spent fuel pools. Between the two of them we have a cask handling pit, and the gates can be removed to that cask handling pit and cross-connected to fuel pools, but there are independent fuel pools for each unit.

MR. STUBBS: Okay. As indicated previously in the licensee's presentation, for the ultimate heat sink there were some modifications made. Two of the modifications were that a number of large spray array nozzles was reduced to increase the spray height and improve efficiency. That is, they capped some of the nozzles in the large spray array in order to increase the pressure, which results in higher spray, an increased efficiency of the large spray ray.

DR. WALLIS: Is this based on experiment? I remember our absent Chairman asked about that because it's very difficult to predict exactly how efficient a spray will be from fundamentals. Is this based on experiment, this optimization?

MR. STUBBS: I will let the licensee speak to that.

MR. PASTOLIS: Richard Pastolis, PP&L.

We base our thermal performance of the UHS based on computer models. Those computer models were benchmarked against test data performed at Susquehanna in the original licensing phase in the plant.

DR. WALLIS: There is test data, which is very difficult to do a priori.

MR. PASTOLIS: Yes, sir.

DR. WALLIS: You can't predict the drop size and all of that stuff very well. Okay. Thank you.

MR. STUBBS: And the other modification I mention here and they mentioned earlier, I believe, they provided redundant isolation capability for the spray arrays by installing a manual isolation valve in the spray array bypass line.

DR. WALLIS: Do you have to go out and

turn it?

MR. STUBBS: Yes. It's manual, yes, but it's a bypass here that doesn't require action right away. There's time before. You can send the water directly to the ultimate heat sink without going through a spray array for some time after that before you want to go to the spray arrays. So it's not --

MR. PAGODIN: This is Rick Pagodin again.

That valve would only have to be operated if the motor operated bypass valve failed to close, and the operator response time is required to happen within three hours after that.

DR. WALLIS: You should be able to make it that far.

MR. PAGODIN: Sure, we can.

MR. STUBBS: Okay. Some of the important review considerations. The first thing, like you were talking about, they use test data and they benchmark against the test data they had when they originally started work at the plant. One of the things that we wanted them to do and they've already done that was just confirm the condition of the nozzles. So they've gone out and they've looked and they found that there is not erosion problems. There's not degradation problems.

So that the nozzle performance will be as expected and as modeled. There is some post modification testing that will be performed and may have already been performed by now to confirm that the flow rates are consistent with the analytical assumptions, and the proposed tech spec requirements assured UHS operability consistent with the analytical assumptions, that a flow path will be available and manual isolation valve operability would be maintained per tech spec.

The condensate and feedwater system requires some modification in order to pass higher flow rates that's going to be required to operate at uprated conditions. Some of the modifications I have listed here on this slide: impellers replaced, and Phase 1 and Phase 2 is for Unit 1 they're going to be -- for the first unit that goes into uprate, it's going to be a two-part uprate as far as a seven percent follow-up by the full power uprate during the next cycle.

But the condensate impellers are being

replaced, and the condensate minimum flow valves will be replaced in Phase 1, and the pump turbine, the feed pump turbine is a Phase 2 replacement, which would be at biologies (phonetic) in the second unit will be done to support operation at full power.

Okay. Next.

Okay. Important considerations here were the acceptability of the condensate feedwater performance will be demonstrated by the power ascension testing program. So as they go through power ascension testing program, they'll demonstrate the acceptability of that of the condensate feedwater system, and then Phase 1 and Phase 2 testing will be performed to confirm that the trip of a condensate pump will not result in a loss of feedwater.

And to assure that, we've introduced a licensing conditions. We place licensing conditions and establish licensing conditions to have the test performed after Phase 1 for the one that goes through the intermediate and at Phase 2, whichever one gets to full power first.

DR. WALLIS: Why does this thing perform

for the EPU? Has this test been performed at all in the condensate feed pump?

MR. STUBBS: Excuse me?

DR. WALLIS: Has this test been already performed at existing power levels to detect that feedwater can still be maintained?

MR. STUBBS: The condensate trip pump? Well, strip test. This is not unusual. We find this in most of the operations in the past, but as your system response to the transient will change at uprated power, and there's going to be a number of changes and set point changes and pressure drops. So we want to insure that the trip of one of the condensate pumps, and the condensate pumps is limited here over feedwater pumps will not result in a pressure drop that results in the feed pumps tripping on low pressure.

DR. WALLIS: Has this test been done before at regular power levels?

MEMBER SIEBER: Part of the start-up testing.

MR. STUBBS: Yeah, it's part of the start-up, yes.

DR. WALLIS: Just checking that with new

check points, it still works?

MR. STUBBS: New set points, new operating -- this is, right, modifications to the condensate pumps, modifications to the feed turbines, different flow rates. The system is -- the operating parameters have changed, and we want to make sure that we're not going to be in a situation where they won't have enough net positive suction pressure that you result in one pump tripping and then the next pump tripping and then next pump tripping and restarting at a total loss of feed situation.

Having said that, we didn't provide a licensing condition in the SER, but we're going to -- we've been discussing this with the licensee. What we've been doing in the past is we've had this licensing condition on the plants, and they've had an opportunity to come back later on after they had test data if there's an intermediate to try to show whether they have margin and not have to do it at full uprate power.

So we've been discussing with them the possibility of including that into the licensing condition instead of having them come back for a separate amendment, but we haven't come to a conclusion on that yet.

MEMBER SIEBER: Well, right now it's still under a test plant.

MR. STUBBS: It's still under a test plant to test at both the intermediate -- the one unit that will operate one cycle at the seven percent uprate will be tested at the seven percent uprate, and then whichever unit gets at full power first, full uprated power, will be tested, will have the trip test there. But we're still looking at the possibility of allowing them to present to NRC information after they have their tests that could be evaluated to determine whether there's sufficient margin so that they could testify of not performing a test at the full power, which is something that everybody really has the opportunity to do now, but it will be coming as a separate submittal, but this is sort of looking ahead.

MEMBER MAYNARD: I'm not sure I understand. They would do the test on Unit 1 at 107 percent or whatever, and then on Unit 2 they would do it at the full uprate power. If it's good on Unit 2, they wouldn't have to do it on Unit 1 at the full --

MEMBER SIEBER: That's correct.

MR. STUBBS: Correct, because the units are similar, sufficiently similar so that that would demonstrate.

MR. GUZMAN: We will let the licensee talk. Essentially that's actually not true.

MR. CROWTHERS: Yeah, what we've proposed is performing the test at 107 percent on Unit 1 and then also performing the test at 107 percent on Unit 2 after all of the modifications have been installed, and then taking those two data points, okay, looking at our analysis and projecting up to the full CPPU and determining whether or not we really need to do that test at the full CPPU conditions based on those two tests.

That's our current proposal.

MEMBER MAYNARD: But you haven't acted upon it.

MR. STUBBS: We are still reviewing that proposal.

Okay. In summary, to summarize our review results, we found that the proposed EPU is acceptable with respect to the balance of plant areas based on the valuations that were performed, the commitments that were made, such as the outage specific spent fuel pool cooling analyses, and the testing that will be completed, such as tests that we were just talking about in terms of the condensate transient, the transient on the condensate and feedwater system.

Based on all of that, we felt that the licensee has demonstrated that the EPU would be acceptable for balance of plant considerations.

MEMBER SHACK: Okay. Thank you very much, Mr. Stubbs.

Are there any questions for Mr. Stubbs?

(No response.)

MR. STUBBS: Thank you.

MEMBER SHACK: Okay. Then I think we move on to our final presentation on source terms.

MR. PARILLO: My name is John Parillo. I'm in the Accident Dose Branch, which is in the Division of Risk Assessment in the Office of Nuclear Reactor Regulation.

And in this talk we're going to address source terms for input into radwaste management systems, and basically the licensee evaluated the source term in the reactor coolant system for EPU conditions and has concluded that the existing design has adequate margin to accommodate the extended power uprate and continues to meet the requirements if 10 CFR Part 20 and Part 50, Appendix I, and GDC-60.

So that the staff agrees that there is adequate margin in the existing system to accommodate the source term for normal operations, and --

DR. KRESS: This is stuff that's in the RCS water, just --

MR. PARILLO: Right. Well, the radwaste systems are designed based on very conservative assumptions of one percent failed fuel and whatnot, you know. So there is a relationship between that and the core power, but there's enough fat in the design, if you'll excuse the expression, to accommodate, you know, the 20 percent.

And normally, you know, you're running these systems way below what they're actually designed to. We have better fuel performance and whatnot, and this is for what they call, you know -- how is it written? It's normal operations with expected transience. They don't use the word "transient" -- anticipated operational occurrences in Criteria 60 basically.

Your systems need to be controlled, release of radioactive materials to the environment under normal operations with anticipated operational occurrences. That's Part 1 of our evaluation.

Any other questions on that?

And the more challenging aspects of what I do as a dose analyst is radiological dose consequence analyses, and this is so-called design basis accidents, and the licensee provides a very systematic approach to their EPU by submitting all of their suite of design basis accidents, reevaluated at the proposed EPU power level, and they did that when they submitted for what we call an alternative source term amendment, and they analyze the loss of coolant accident, the main steam line break accident, the control rod drop accident and the combination fuel handling-equipment handling accident in the spent fuel.

All of these accidents were done at the EPU power level with a two percent margin for measurement uncertainty, which brought it up to

4,032 megawatt thermal, and this whole body of work was submitted, and the license amendment was approved January 31st of this year.

DR. KRESS: The license amendment to use the AST.

MR. PARILLO: Not only to use the AST, but to use the AST at the EPU condition.

DR. KRESS: At the power.

MR. PARILLO: Right. That's the smart way to do things so that when we come to EPU we don't have to really look it. This discussion now is based on the SC that was prepared to support the AST. And there were no changes. They didn't change any of the radiological assumptions when they went to EPU. There was no need to because they did everything using the EPU.

DR. KRESS: Did they have to do anything with the containment leak rate?

MR. PARILLO: No. No, I don't believe that was an issue.

DR. KRESS: They still could meet the --

MR. PARILLO: Yes.

DR. KRESS: -- 10 CFR 100 with the --

MR. PARILLO: It's actually 50.67 now

because when you go to the alternative source term, your dose now is computed in terms of the total effective dose equivalent, and that's covered in 50.67. The old source term is siting criteria.

And there wasn't any particular reason, but sometimes people are interested in control room issues. So I happened to just pick that out of the submittal just to speak about that because this has been a concern in the industry.

And in their analyses they only credited their emergency control room system for the LOCA and for the fuel handling accidents. They took a very conservative 510 CFM for the unfiltered in-leakage, and this value is supported by tracer gas testing, which was done in December, and they took very conservatively, as you can see by the numbers, they took the high end of the measurement and then added some besides that, and basically they took a very conservative approach in their accident analyses and were very comfortable with their AST application.

DR. KRESS: I'm glad to see they did the tracer gas.

MR. PARILLO: Yes.

DR. KRESS: Because I think that gives

you a more believable --

MR. PARILLO: Yes. Well, this, as you know, has been an issue with control rooms with the unfiltered leakage, and this is all done up front prior to the application for AST, which is, again, the smart way to do it. Sometimes they make an assumption. They send the AST and then they have to, you know, test in the middle.

So it was a systematic approach and very comfortable with their work.

DR. WALLIS: Can I ask you a question?

MR. PARILLO: Certainly.

DR. WALLIS: I read that -- I thought I read, anyway -- that in a normal operation the annual dose to a member of the public from all radiation sources at the Towers Club west-southwest sector was 13.4 millirem. That is normal operation.

MR. PARILLO: Oh, I would --

MR. WALLIS: This is supposed to meet the requirements of 25 millirem per year from 40 CFR 190. This is in normal operation.

MR. PARILLO: Okay.

DR. WALLIS: And now could you tell me does that mean that a member of the public is supposed to stand there naked all year round and get this does? How do you calculate a dose like that?

MR. PARILLO: Well, that's a different body of work than what I just spoke about.

DR. WALLIS: -- proposed consequences.

MR. PARILLO: Absolutely, and that's what we do in Appendix I, and that's why the licensee has their off-site dose calculation manual where they actually keep track of real releases.

Now, that does, I'm not sure where --

MR. GUZMAN: This is Rich Guzman.

And that part of staff review was done by our Health Physics person.

MR. PARILLO: Yeah.

MR. GUZMAN: Not Tracy, but to address your question better --

MR. PARILLO: Maybe the representative from the licensee might have a -- but that's the normal operating --

DR. WALLIS: Did I quote properly from your document?

MR. DOTY: This is Rick Doty from PPL, Susquehanna.

You have correctly quoted. That is

true.

DR. WALLIS: This is the normal operation, and this person, what's he doing? He's standing or she is standing on the fence line or something? How do you calculate something like that?

MR. DOTY: The Towers Club is a recreational facility, which is outside the fence.

DR. WALLIS: Oh, I'm sorry. So it's someone who is outside the Towers Club?

MR. DOTY: That's correct.

DR. WALLIS: Looking at the or standing close to the fence or something?

MR. DOTY: It is very near the fence line.

DR. WALLIS: And is that year round in the same place?

MR. DOTY: We assume that the person is there about four hours a week throughout the year.

DR. WALLIS: Four hours a week. I thought it was continuous.

MR. DOTY: No, that is not --

DR. WALLIS: Four hours a week?

MR. DOTY: Yeah. That is not continuous

occupancy at that facility.

DR. WALLIS: Oh, okay.

MR. DOTY: The 13.6 millirem is a calculated value, not a measured value. The actual measured values are negligible.

DR. WALLIS: This is from SHINE, mostly from SHINE.

MR. DOTY: Calculated from SHINE. That's correct.

DR. WALLIS: Well, it interested me because the QHOs seems to come out as four millirem per year, but what is it, the qualitative health objectives or something of the Commission, which seems very low and is lower than this number.

So I'm just sort of curious trying to understand the regulations about how this number is bigger than what would come about it you try to impose QHOs on this plant.

MEMBER SIEBER: QHOs are a goal. The other one is a regulation.

DR. WALLIS: Well, I know, but suppose you imposed them?

MEMBER SIEBER: You can't.

DR. WALLIS: Suppose you said the

regulations was the QHOs. You might have to explain how you got that.

DR. KRESS: I don't know where you get that number for the QHOs but it doesn't seem right.

DR. WALLIS: Yes, that is true. QHOs equivalent to four millirems here.

DR. KRESS: To get a QHO you have to have a death, which is, you know --

DR. WALLIS: You have to have what?

DR. KRESS: You have to have a death.

DR. WALLIS: Oh, this is the radiation.

DR. KRESS: Probabilistic death.

DR. WALLIS: This is the radiation. This is the cancer QHO. This is the delayed cancer QHO.

DR. KRESS: I'm talking about cancer.

DR. WALLIS: It's simply a dose. Right, and you take the dose and you divide by the number which is the probability of getting a cancer curve, and you get this number.

So I was just curious. I'm not saying that this is an impediment to your EPU, but it just looks strange to me to see that you're coming up with a number for normal operation only for four hours a week which would appear to violate something which is being proposed as possibly a regulation for nuclear power plants.

MEMBER SHACK: But I think the QHO dose, you k now, applies to an average person within the ten mile radius, and this is --

DR. WALLIS: So how do you work that out? This is the first four hours a week. Is that an average person or what?

MEMBER SHACK: It's not an average. There's lots of people. This is the person who's standing at that border for four hours a week.

DR. WALLIS: But it's only four hours a week. So maybe someone is there --

MEMBER SHACK: But, you know, if that was the only release in the whole thing, the average person in a ten-mile area is going to receive --

DR. WALLIS: Oh, that's right. I just wonder how that's related.

MEMBER SHACK: Nothing, nothing, nothing.

DR. WALLIS: Well probably not.

DR. KRESS: I think the ten miles is for the prompt fatality.

MEMBER SHACK: Yes, there's some distance. I'm not quite sure what the distance is, yeah.

DR. KRESS: It's further than that.

DR. WALLIS: Okay. It's not a problem for you. It's just that I'm interested in how all of these things fit together. Does somebody spend a lot of time in the Towers Club or is it a very --

(Laughter.)

MEMBER SIEBER: A couple minutes.

MR. DOTY: This is Rick Doty again.

I think probably the four hours per week is an overestimate for what an average person would spend there.

DR. WALLIS: Do they wear some radiation monitoring when they're there?

MR. DOTY: No. That's outside the fence. There would be no monitoring required or warranted.

DR. WALLIS: Is there a custodian who is there 100 hours a week or anything like that?

MR. DOTY: No, there is not.

DR. WALLIS: I don't think this is a big issue, but I did notice it, and wanted to ask a question about it.

MEMBER SIEBER: I have a question just out of curiosity in your last slide, which was Slide 24-4. You say 510 cubic feet per minute is the assumed unfiltered in-leakage, and then you referred to a tracer gas test supporting that assumption. The tracer gas test which is 150 plus or minus 235, which to me plus is 385 and Train B is 129 plus or minus 298 which is plus side 427, which is 160 percent higher than the assumed unfiltered in-leakage.

Is that consistent or --

MR. PARILLO: Well, that's the right --

MEMBER SIEBER: -- or is the slide wrong or am I wrong?

MR. PARILLO: The licensee is giving themselves a little bit of margin because these tracer tests are done I think it's a six year interval. So this was one test, but six years from now you're going to bring these folks in and they're going to test it again, and you want to make sure that that test does not go above what you've assumed in your analysis because if it does then you've got to get into, you know, justification for continued operation and all of that stuff. So they've built in some margin. They've built in margin.

MEMBER SIEBER: December 2000 --

MR. PARILLO: The higher that number is the worse.

MEMBER SIEBER: -- already exceeds the assumption.

MR. PAGODIN: This is Rick Pagodin.

I think you're reading the two trains together, which is --

MEMBER SIEBER: Yeah, I am. I'm adding the two.

MR. PARILLO: Oh, you're adding them together. Oh, I'm sorry. No, these are individual trains. No, it's individual

MEMBER SIEBER: So the 510 belongs to one train

MR. PARILLO: Bounds both Train A and it bounds B, and we're not adding A and B together.

MEMBER SIEBER: Well, you run with A and B together.

MR. PARILLO: I see a lot of heads going like that.

MEMBER SIEBER: Do you or don't you?

MR. PARILLO: It's one or the other, yeah, yeah.

MEMBER SIEBER: Okay.

DR. WALLIS: I'm sorry to go back to my point here. I read the regulations very carefully. I thought it was something in 20, 20 CFR actually. This dose to a member of the public was to be computed assuming that the person was there all the time, not four hours a week.

Now, I'm not sure that I can quote you the regulation, but I read it very carefully because I was very surprised to see what I saw there. This radiation to a member of the public had to be counted as if the person were there all the time.

MR. DOTY: This is Rick Doty again.

We have, if you will, two categories of individuals for whom we calculate doses. One is the type of individual that you've just said or a residence or whatever where you make the assumption that the person is there 100 percent of the time, and there is a second category of facilities for which you know that not to be true, which is a very transient population.

Towers Club is one such facility for us

and there are a couple of others which do not use 100 percent occupancy.

DR. WALLIS: You then have to look at other places where someone is there more of the time? How do you decide when the other regulation applies to someone who is there all the time?

MR. DOTY: Well, it really works in the reverse manner. We have to prove that our justification for the facilities for which we assume less than 100 percent occupancy. So we did studies of the Towers Club and the other facilities in that category to insure ourselves that no one was there more than the assumption that we made. Otherwise it is a 100 percent occupancy assumption.

DR. WALLIS: And the nearest place where there might be 100 percent occupancy is so far away you don't have to worry about it; is that it?

MR. DOTY: I wouldn't say we don't have to worry about it, but we know by land use census every year exactly where those places are, and we calculate to those places.

DR. WALLIS: That would be a resident then.

MR. DOTY: Yes.

DR. WALLIS: The regulations talk about a member of the public, and I'm never clear what that means, a member of the public. If they would say a resident or something, I'd understand what that means, but someone who wants to demonstrate against nuclear power has the right to come and stand outside your plant presumably.

MR. DOTY: That would be correct.

DR. WALLIS: And take the radiation as it comes.

MEMBER SIEBER: You can build your house right up against the chain.

MR. DOTY: And we would have to evaluate those against both 10 CFR 20 limits and 40 CFR 190 limits.

DR. WALLIS: And close down because the person is standing there all the time or drive them away? I mean, I'm puzzled by --

MR. DOTY: Luckily we have not been in that position. I'm sure it would be an interesting one.

DR. WALLIS: I don't think it's an EPU problem, but I just don't understand that regulation as I read it in the 20 CFR.

Thank you.

MEMBER SIEBER: Well, I know of a power plant where one guy wouldn't sell his property and his house was right up against the fence. Exclusionary, and so he was typically the 100 percent fence line person.

DR. WALLIS: Did you have to calculate stuff for radiation and dose for him?

MEMBER SIEBER: Well, not specifically. You calculated the fence post dose.

MEMBER SHACK: Are there any more questions for Mr. Parillo?

(No response.)

MR. PARILLO: Thank you.

MEMBER SHACK: All right. That ends the formal part of the meeting. Thank you very much.

I'd like to thank the licensee for obviously an immense amount of work in putting together oral presentations. They were very good.

The staff also did, I think, an excellent job in reviewing this application and making presentations, and we appreciate that.

Are there any more comments from the members?

MEMBER MAYNARD: One thing we might want to add is the resolution of that testing on the condensate pump trip. However that gets resolved is whether that's part of the full power testing or not. That's the only thing I would add.

DR. WALLIS: Does this go now to the full Committee?

MEMBER SHACK: This goes to the full Committee.

DR. WALLIS: Do we have any advice?

MEMBER SHACK: Well, I think Sanjoy and Zena were working on that at lunchtime, but you know, if anybody has any suggestions for things they think should be there, you know, obviously with two hours we have to be somewhat selective, but you try to think of the various issues that people might raise.

MEMBER ABDEL-KHALIK: I mean, they have some guidance based on the comments that people made.

MEMBER SHACK: Yeah, but we'll let Zena and Sanjoy figure that out.

MEMBER SIEBER: I guess I have one additional comment. As subcommittee meetings go, the preparation of the slides and the presentations by both the licensee and the staff were better than average and very good.

MEMBER SHACK: As soon as I can figure out why the aspect ratio is wrong.

MEMBER SIEBER: That came from some software. Anyway, I find it easy to follow, and I appreciate it.

MEMBER SHACK: Well, especially for considering -- I don't remember one where we had quite as much in and out of the proprietary information.

MEMBER SIEBER: Right.

MEMBER SHACK: That sort of made it more interesting and exciting in shuffling of bodies here.

DR. WALLIS: We have to guard this proprietary --

MEMBER SHACK: Especially, yeah, when we have multiple proprietary interests, three different ones.

DR. WALLIS: Do I put my proprietary stuff here to be mailed or do I have to carry it?

MEMBER SHACK: I'm not letting go of

mine. The non-proprietary I'm not going to worry about. The proprietary I'm hanging onto.

If there are no further comments, we are adjourned.

(Whereupon, at 3:46 p.m., the Subcommittee meeting was concluded.)