Transcripts of Public Meeting
NRC meeting with Southern California Edison
Laguna Hills, California

November 30, 2012

>> CHIP CAMERON: Well good evening everyone. It's nice to see all of you here and thank you for coming out for this meeting. My name is Chip Cameron and I'm going to be your facilitator tonight and in a couple minutes I'll go through some meeting process issues so that you know what to expect from tonight's meeting. This is the Nuclear Regulatory Commission's technical meeting with Southern California Edison, who we all know is the licensee for the San Onofre Generating Station. The subject of the technical meeting is the licensee's response to the NRC's Confirmatory Action Letter on steam generator tubes in unit 2 facility.

We're going to try to limit the use of acronyms tonight to make the understanding of the technical issues easier for everybody but there will be some acronyms and phrases that we'll be using; NRC is one of them. You may hear the facility referred to as SONGS. Something else you might hear is the term Category 1 or Cat-1 and that's very relevant to the format for the meeting tonight. This is an NRC Category 1 meeting that's the parlance that's used as opposed to the last meeting that we did several weeks ago which was a Category 3 meeting.

Now a Category 1 meeting is a meeting between the NRC staff and the licensee staff to discuss potential resolution of safety issues at a particular facility. Tonight's case it's the Confirmatory Action Letter on steam generator tubes at unit 2. For a Cat-1 meeting most of the meeting is devoted to a discussion of the technical issues between the NRC staff and the licensee staff. However all of these Cat-1 meetings are open to public observation and also we'll open the latter part of tonight's meeting after the technical discussion, we'll open that up to all of you to answer questions to hear your perspectives on the issues.

Now just a couple ground rules and I'll go over this again when we get to the discussion part of the meeting but we won't take any questions or comments during the technical discussion between the NRC staff and the Southern California Edison staff. When we do get to public discussion part of the meeting I'm going to come out into the audience and I will make sure that I equitably go to every part of the audience. If you have a question or something to say just raise your hand and I'll come over with the microphone for you. If you want to come out in the aisle, if that's comfortable for you to do that, then please do that. We've created some aisles in the middle of these seating blocks to make that easier. I would just ask you to introduce yourself and ask everybody to give their full attention to whomever has the microphone at the moment and listen to what they're saying. We have a lot of people here tonight and thankfully we have room for everybody who came out but I would ask you to follow a three minute guideline in your comments or questions so that we can make sure we get to everybody tonight.

I know there's a lot of issues of concern around the San Onofre facility just like there is at any other nuclear facility but we really

want to focus on the topic that these gentlemen are going to be discussing tonight which is the Confirmatory Action Letter and steam generator tubes. We do have what we call feedback forms out at the desk in front and these are comment forms for people to give us their evaluation of the meeting if they want to, things we could improve on, things that were done well. But in addition to that evaluation, if you want to use it to pose a question to the NRC staff on things like seismic issues, emergency planning or any of the issues that we won't be discussing tonight, please use those forms to do that. And as always let's give courtesy to everybody who's talking. There's always a difference of opinion on these issues so let's try to respect the person who's giving that opinion. In the courtesy department, it is fine to have signs in the room but we have to ask you to display them in the back of the room so that they don't block anybody's view or interfere with anybody who's watching the meeting.

So I would ask you to observe that. In terms of the agenda for the meeting, we're going to have some opening remarks tonight by Ryan Lantz from the NRC staff and then we're going to go to Mr. Tom Tomisano, who's right here, from Southern California Edison and he's going to do a presentation on Edison's efforts to identify the causes of the steam generator problem, steam generator tube problem and also what they're going to do to try to address those issues. Then we're going to go back, remarks, NRC staff. We'll take a short break of 15 minutes and then we're going to come back and we'll go out to all of you for questions. It's not clear right at the moment how long the technical discussion will be but we'll try to provide extra time at the end of the meeting if we can so that we can make sure we can go out to you. Let me ask the NRC staff to introduce themselves and then we'll have Pete Dietrich and his colleagues introduce themselves and I just want to point out some other NRC staff that are here. Ryan?

>> RYAN LANTZ: Hi, Chip, thank you. This is the first microphone test. I'm Ryan Lantz as Chip said. I'm a branch chief with responsibility of regulation of San Onofre.

>> ART HOWELL: Hi my name is Art Howell. I'm the -- just been directed to be the leader of the newly formed organization that has oversight of San Onofre and I'll be talking about that a little bit more in a few minutes.

>> GREG WERNER: Hi, I'm Greg Werner out of region 4, branch chief. I'm actually now the inspection assessment lead for the inspection activities going forth for SONGS steam generators.

>> DOUG BROADDUS: My name is Doug Broaddus and I'm the branch chief in headquarters with responsibility over the licensing and technical evaluation activities associated with San Onofre.

>> CHIP CAMERON: Great. And Pete?

>> PETE DIETRICH: Yeah, thank you, Chip.

Pete Dietrich, the senior vice president and chief nuclear officer from Southern California Edison and I have two of my colleagues here with me tonight. I'll let Tom introduce himself first.

>> TOM TOMISANO: Thank you, Pete. And I am Tom Tomisano. I'm the vice president of engineering, projects, and sites support for Southern California Edison and I led the technical work that we'll be summarizing tonight in our presentation.

>> DOUG BAUDER: Good evening. Doug Bauder, site vice president and station manager for San Onofre.

>> CHIP CAMERON: Thank you all, I know it's going to be a very interesting and informative discussion. The last thing I'll say and probably the most important, this is a sort of an in-joke for all of us who were at the last meeting is that if you do go out to go to the bathroom tonight, you will be able to get back in the meeting so...

[CLAPPING AND LAUGHTER]

>> CHIP CAMERON: With that, I'm turning it over to Ryan. Go ahead, Ryan.

>> RYAN LANTZ: All right thank you, Chip. Well good evening again. I'll start tonight's meeting by saying in advance I look forward to a very productive discussion this evening with Southern California Edison. Mr. Dietrich, a little bit of history: Ten months ago, pretty much today, Unit 3 was operating with 100% power in its first operating cycle with the new Mitsubishi Heavy Industry steam generators. They've been in operation for just about a year. Your operators responded to some plant alarms that diagnosed as steam generator tube leak and safely shut down the plant.

Unit 2 was already shut down. They were in their first scheduled refueling outage after having replaced their steam generators and been in operation about two years. Since then you've conducted extensive work with lots of help from folks outside your organization to figure out several things: Why the leak occurred in unit three, why eight steam generator tubes in Unit 3 failed to maintain structural integrity requirements, and finally why you believe right now that it's safe to restart Unit 2.

The amount and type of tube wear in all four of the steam generators at San Onofre is a significant concern to the Nuclear Regulatory Commission and too many others. So we're looking forward to hearing about your work to date and specifically why you think Unit 2 is safe to restart. With that Mr. Dietrich I'd like to turn the floor over to you.

>> PETE DIETRICH: Okay, thank you very much. Chip, I think I need either the clicker or one more slide.

>> CHIP CAMERON: Okay, are you ready? Okay, here you are.

>> PETE DIETRICH: Thank you. Thank you. As Ryan mentioned we are here tonight to present our Unit 2 Confirmatory Action Letter response and look forward to the discussion tonight. Let's go on to the next slide please. We take the operation of San Onofre Nuclear Generating Station very seriously and we take our commitment to protect the health and safety of the public as well as our employees with utmost seriousness.

We dedicated ourselves throughout the efforts of the last eight months of analysis to convincing ourselves first that it is safe to operate Unit 2. We're pleased to be here tonight with the NRC and the public to present that eight months of hard work. And just to reiterate, by our submittal of the Confirmatory Action Letter response, Southern California Edison is satisfied that it is safe to operate Unit 2. That has been a very big decision for the company and we treated that decision as such with challenge and diverse thought. Although we relied heavily on the experience and conclusions of our experts, the final decision to submit the Confirmatory Action Letter was clearly that of Southern California Edison and we take full responsibility and accountability for that decision.

We've emphasized throughout that there is no timeline on safety. Tonight we desire to present over eight months of hard work in a few hours in a manner that people can understand. But we also recognize that this will require additional questions and additional work and additional interface actions and discussion and we are fully prepared to engage in the additional actions and discussions that we need to, to educate others specifically in Nuclear Regulatory Commission in your decision about whether it is safe to operate Unit 2.

We do feel that there is substantial conservatism and safety margin in our Confirmatory Action Letter response and we look forward to that discussion tonight and beginning to discuss that with you. Let me now turn the discussion over to Tom Tomisano. Thank you. Tom?

>> TOM TOMISANO: Thank you, Pete. We have the mic on? Very good. Good evening. As earlier said I'm Tom Tomisano the vice president of engineering projects and site support and I will be presenting a summary of our Confirmatory Action Letter response that we submitted in early October. As part of the Confirmatory Action Letter, we committed to understanding the cause of the tube to tube wear which occurred in unit 3 and implementing actions that would mitigate that cause prior to restart of unit 2. We have submitted that material and over the next several hours I will summarize that material for the NRC. We're looking forward to our questions; so we appreciate this opportunity and as Pete has said we're looking forward to making this presentation.

>> SPEAKER: Excuse me, Tom. Involving questions, can we ask you questions as we go along?

>> TOM TOMISANO: I'm fine if you ask questions as we go along, certainly, thank you. And if that helps with understanding I would appreciate that. What I'm going to do tonight is kind of give an overview of the background, just a brief synopsis of the history of the replacement steam generators, picking up on what Mr. Lantz said, just summarize the tube leak that occurred. I am going to talk a bit for the benefit of the public about just an interview of the steam generator construction, I think that's useful, so as I talk in more detail about tube to tube wear and vibration it puts it in context for everybody in the room. Then we'll get into the specific cause of the tube to tube wear and the corrective actions we have developed and implemented and proposed to the NRC.

With that, just a brief history of the replacement steam generators as been noted. They were fabricated by Mitsubishi Heavy Industries. The contract was awarded in September of 2004. The installation actually started for Unit 2 in the fall of 2009 and the Unit 2 then resumed service in early 2010 and unit 3 replacement started in the fall of 2010 and returned to service early in 2011. The design and fabrication was done largely in 2005 through the 2008 timeframe, followed by shipment to the site. The replacements were done in full accordance with NRC requirements for full modification to the plant and replacement steam generators. And in fact as you know, two license amendments were submitted and subsequently approved by the NRC related to the steam generator replacement.

Now the unit 3 tube leak. As you mentioned, on January 31st, 2012, unit 2 was already in a plant refueling outage for about 3 weeks at that point in time. Unit 3 was running at full power. A small primary to secondary leak occurred leaking radioactive water from the primary into the secondary. The installed plant monitors responded properly, very quickly and identified a slight increase in radiation levels on the secondary side. The operators recognized it, diagnosed it and responded very effectively in accordance with our procedures and wrapped the unit down, took it offline and proceeded to shut down and cool down the reactor and the primary cooling system.

The leak occurred after 11 months of full power operation falling installation of the new steam generators, certainly a disappointment to Southern California Edison and to our customers. Inspections that occurred then in February after we established safe conditions in unit 3, identified a unique and heretofore unseen tube to tube wear phenomena in this style of steam generator has not been seen before in the domestic industry in the U.S. nor internationally, this tube to tube wear. I'm going to talk quite a bit about that tonight and I'm going to put that into perspective with respect to our actions on both unit 2 and unit 3 in a minute.

As Pete has emphasized, our commitment to safety and ensuring we understand and mitigate the cause well beyond the commitment under the Corrective Action Letter, our commitment to ourselves and our stakeholders and our public. We step back and we recognize the significance of the unit 3 condition. A primary to secondary leak in brand new steam generators is significant by itself but as we saw the data indicating the unique tube to tube wear it clearly was an indication that something that had not been seen before in operating steam generators had occurred. We also stepped back, Unit 2 was completing its refueling outage by the end of February and Unit 2 had in fact met all the requirements including steam generator integrity requirements based on a full inspection and could have legitimately been started up under the license. We elected not to start up unit 2 until we better understood the issue in unit 3 and the susceptibility of Unit 22. We felt it was a prudent, safe, and conservative decision not to rush to restart unit 2. So we delayed restart of Unit 2 as a prudent, conservative action. Public health and safety is the first and foremost issue.

And in developing our corrective action we have used the best worldwide expertise. Pete alluded to this but I've been in the commercial

industry for over 30 years now and involved in engineering and operations and we have assembled a team of not just Mitsubishi and Southern California Edison, but every other steam generator manufacturer and designer in
the U.S. and internationally with its censored experience. A significant team of experts including academics with some specific knowledge of vibration and thermal hydraulics. Probably the best team I've seen put together and we have spent the last eight months really understanding this and making sure we know what the issue is, know that the corrective actions for unit 2 will be effective. We had over 200 engineering people when we collect the people from all these vendors, all these consultants and our own people and our utility peers and another 600 technicians assisting us during this effort. The bottom line is as we made our CAL submittal here in early October and as we make our presentation tonight, we have ensured that there is significant safety margin in the unit 2 analysis and the Unit 2 corrective actions prior to restart of unit 2 to ensure we will maintain tube integrity.

I want to just outline the methodology. This is one of the items that we discussed as we established the meeting requirements for tonight. So at a high level, I've already mentioned we engaged world class experts. We did not just rely on our own expertise, which is substantial; nor did we rely just on Mitsubishi's expertise.

>> SPEAKER: Excuse me, Tom. May I ask a question? You indicated that this tube to tube wear had not been seen anywhere in the world either in the United States or in other countries yet there is experimental research test data that indicates that the cause of the tube to tube wear could in fact happen. So my question is, do you plan to address that tonight? Were your staff or the vendor staff aware of that back at the time that the team generators were designed?

>> TOM TOMISANO: I'll address it briefly tonight and I think as we complete root cause work we'll get into that in more detail over the subsequent several weeks and months. What I'm referring to is in operating steam generators, this phenomena had not been seen nor occurred. What you're eluding to Mr. Howell is, and to jump ahead in the presentation, fluid elastic instability is the technical term for the cause, which causes a high amplitude or high displacement vibration of the tubes which cause them to contact each other. That dated back to about the 70s not in steam generators but I think in condensers initially --

>> SPEAKER: Actually there was some work done in that early 2002 timeframe --

>> TOM TOMISANO: I'm going to run you forward through the timeline. So the phenomena was recognized in the 70s as a theoretical phenomena demonstrated over the years. There's been research in the last 10 to 15 years that has demonstrated in some test facilities. But again it had not been seen in operating steam generators and up until the point of San Onofre unit 3 the information had shown that if you adequately designed against normal vibration and adequately design against what is called out-of-plane vibration you will have substantial margin to this in-plane vibration of fluid elastic instability. That's were the research had taken us. As far as 2005, 2006 we are in the process of

completing our root cause work so I'll defer more discussion on that to a later point in time.

>> SPEAKER: Okay, thank you.

>> TOM TOMISANO: Back to methodology. World class team of experts but very systematically then we start with what happened in unit 3. Why did the tube leak? Which led us to the tube wear indications and led us to the fact that tubes were contacting each other. So they're vibrating excessively well beyond what they were designed to do. So then what's the cause of excessive vibration? We identified that cause, we validated that cause with some of the research you're talking about, with some of the experts we brought in who actually authored and did some of that research. Then we determined our corrective actions, understanding what causes it and its particularly thermal hydraulics and I'll talk more about that tonight as well as a lack of damping due to the support structure. So we identified a cause, we identified the contributors to the cause, then we developed the corrective actions to prevent that in Unit 2. And we validated the cause and corrective actions again with the experts; we did not just rely on our own judgment on this. And we've ensured substantial safety margin exists in the actions web have proposed in the Confirmatory Action Letter response.

Just to summarize some of the expertise: Mitsubishi Heavy Industries has designed and built steam generators for a number of years. AREVA, a worldwide firm designs and builds steam generators. Westinghouse, worldwide firm designs and builds steam generators. The NW Canada, designs and builds steam generators. Mitsubishi agreed early on to bring 3 of their competitors in to scrub their work, their design work, their analysis work and their conclusions to make sure we didn't have a mindset; we didn't just rely on their expertise or our expertise. This has been unparalleled cooperation. I know you and your work as a regulator would recognize the level of cooperation that these companies have exhibited in understanding and solving this problem. We also mobilized MPR associates. This is a firm who specializes in problem solving of technical issues, nuclear and non nuclear. Work in many different industries and their expertise is problem solving, a systematic approach. They help us avoid a mindset if you will and we've used them both for technical reviews and Pete has used them as an oversight role to ensure that we're doing our job effectively and not getting focused in on an easy answer.

As well, we have EPRI which is the Electric Power Research Institute. This is the research arm of the Electric Utility Industry not just nuclear, strong nuclear expertise. Fifty years, almost 50 years of steam generator experience and they develop and maintain the steam generator program that we are all committed to in this country. And then likewise we have other industry personnel from peer utilities, recognize academics and specialized consultants. This gets to some of the people who wrote the book and did the research over the last 15 years on fluid elastic instability.

So now I want to shift and kind of give an overview of steam generators. I want to make sure as we get into the more technical terms we're all baseline on this. I'm going to attempt to use the pointer. The staff has done a great job. I'll try not to hit anybody

in the head. Its a little green dot, its a little difficult to see but we'll do our best here to be able to point at either screen to show you some of the aspects of the steam generators I'm talking about.

First, the pressurizer water reactor layout: I just want to talk about the steam generator itself, its function. In the center of the containment building, this is the building that looks like a dome, you've got the reactor itself shown there in yellow with the red fluid being pumped through it. That's where the nuclear fuel is. The waters circulate around the fuel and moves the heat from the fission process in the fuel. That is a self-contained primary system referred to as a reactor cooling system or the primary cooling system. That water flows inside the tubes in the steam generator. In a couple minutes I'm going to show you some schematics and then some pictures to put that into perspective but that water flows inside the tubes. And the from that hot water are the reactors transferred across the tubes to the secondary side where we boil water to make steam. So on the secondary side of the steam generator showing in blue is water being pumped in at the bottom, boiled to steam, steam comes out in turns into turbine and then to the generator. If this were a coal plant, if this were a gas fired boiler that part of the process is the same. We heat water, we make steam, we turn a turbine generator.

Now with a steam generator specifically, a couple key functions: First of all, the nuclear safety function. The fuel is inside fuel rods inside the reactor. The fuel rods are designed to keep all the fuel and all the high level radioactive waste products in the rods. That's the first barrier is the fuel rods. We call it the fuel clad. The second barrier, if there were a leak in the clad is the reactor coolant itself that you see in the yellow and the red going around in our little animation there. That includes the steam generator tubes. So the steam generator tubes have a very important safety function. They're a boundary, they're the second barrier if you will, in the fission product release to the environment in the event of an accident. And the third classic barrier is the containment structure itself. In the event the first barrier and the secondary were to fail we have radio activity in the containment building, the structure itself is designed as the third boundary or barrier.

So the tubes have an important safety function; they contain radioactive material. They also have an important function, they transfer heat for normal heat transfer when the plant is operating normally to boil the water to steam to turn the turbine and then also how we remove heat from the reactor after it's shut down through the steam generator tubes, the secondary side. So safety function to contain the radioactive activity and the heat transfer function both for normal purposes, shut down purposes as well.

The primary to secondary leak that occurred in unit 3 and the significance of the tube to tube wear in unit 3 because that's a breach in that second barrier. When a steam generator tube leaks or doesn't maintain integrity, that's a breach in the second barrier. That is important from a safety standpoint. That was the at the heart of our decision not to restart Unit 2 until we understood the phenomena, our commitment to safety and our commitment to our public.
Little more on steam generators, this is a good schematic cut away of an actual steam generator; we've effectively cut it in half. The hot

water out of that reactor flows in at the bottom, it's called the hot leg. And by the way, out in the hallway there is another schematic picture of this as well, as well as some models of tubes and things for you to look at. The hot water flows up. We refer to these as a U tube steam generator. The hot water comes in the bottom; flows up, the tube is literally shaped in a U and you'll see a picture; the water from the reactor then, after the heat is transferred to the secondary, comes out the cold leg and is pumped back into the reactor. So with tube integrity maintained and no leaks, all that water stays contained and just circulates through the reactor and the steam generators.

On the secondary side, not as easy to see, we pump that feed water, we call it feed water, into the secondary side of the steam generator, it comes down on the outside and flows up through the tubes. As it flows up, it starts at the bottom as water, and as it flows up the heat is transferred and the water boils and steam exits the top. Later when we talk about fluid velocities and steam quality and things that's in the middle of the tube bundle particularly in the upper part of the bundle where the water has been boiled to steam and the steam is about to go through the very top. The top I'm not going to spend any time on it. That is steam drying equipment to strip any remaining moisture out of the steam before it goes to the turbine.

I want to show you what steam generator tubes look like. These are large comports. These are over 60 feet tall, probably weigh 600 tons each. You're looking at something about 15 foot in diameter; that's the opening of the top of the steam generator. This is a picture during actual fabrication where Mitsubishi's about to start inserting tubes. These are long, thin, very strong tubes. It’s a material called alloy 690 which is used predominantly in all the replacement steam generators in the industry. It is very corrosion resistant; it's a very good choice for steam generators. You're looking at the top of what's called a tube support plate and you're seeing actually a set of tubes about to be inserted. That's a column of tubes. I'm going to show you a close up picture in a minute. The key thing in a olumn, the tubes adjacent to each other in a column are physically separated only by a design gap. There's no physical separator between the tubes in the column. And this is one of the things that allowed tubes to contact each other.

Little bit of a close up. Again you see some tubes being inserted, you see a column partly built out, you see them inserting the next tube, you see a number of columns already completed here and you see the ends of anti vibration bars. There are physical bars, and I'll show you some more graphics in a minute that illustrate this a little better, that separate columns from each other in adjacent rows. So tubes are organized in rows and vertically in columns. So think of them that way. The anti vibration bars dampen any tube movement and physically separate tubes in adjacent rows and that is their function.

This is just a picture. The tube bundle has been completed. This is just a close up of the very top and I'm going to zoom in and show you a little detail in that red square. So looking at some detail in the square: you're seeing what is the top of the tubes, these are the top of the tubes here; you're seeing the end of the anti vibration bars, and you can see how they go down between each column to separate the rows; you're seeing the very end, and these are V-shaped; and you're

seeing something called a retaining bar, this heavy bar here and a retainer bar underneath. We did find a wear phenomena that was unexpected. It only affected 94 tubes in each of the four steam generators but it is something we found. We discuss in the Confirmatory Action Letter response so I'm going to briefly status that tonight and then get on to the tube to tube wear.

Back to our cutaway of the steam generator, we're going to do a little zooming in here with some our computer-aided design tools. We're going to zoom in on the upper part. Where the wear has occurred that is of most concern is the tube to tube wear. This is the unusual wear not seen before in operating steam generators that in 11 months of operation caused a wall leak in unit 3. We're going to be focusing tonight mainly on this upper part of the tube bundle we'll call the U bend region. This would be say, the hot leg side, this is the cold leg side, the green things are tubes. There are now 8,727 in each of the steam generators, two steam generators in each unit. I'm going to just round that off to about 10,000 per steam generator. But in this tool here, we're able to just show you a segment so we can talk about the structure. You see here these bars coming down, you'll see a close up, these are the anti vibration bars that I've referred to and shown you in a picture. Zoom in a little more.

Now we get a pretty good look at the green tubes; you see the anti vibration bars coming down; you see, you know, where we've exposed this tube column; you see how they run down the entire length of the column; and you can see the heads or the tops of the other anti vibration bars between adjacent columns. I've also annotated the slide to show in-plane and out-of-plane direction. This is important. The real phenomena in unit 3 with this tube to tube wear, this excessive vibration is a problem with in-plane motion. It has not been seen before, and this is what causes movement of the tube which allowed the tube to vibrate and contact the tube above and below it and cause the amount of wear we saw and ultimately the leak.

In the out-of-plane direction tubes would tend to vibrate sideways and they are restrained by the anti vibration bars. I should say in any Team generator we know there's normal vibration. There's water flow and steam flow, there's turbulent flow. These tubes vibrate normally. You account for that in the design, you account for that in the material selection and steam generators have run 20, 30 and 40 years with normal vibration and normal wear.

>> SPEAKER: Excuse me, Tom. Just a minute about the anti vibration bars. Can you talked just a little bit about the design, the design philosophy of the anti vibration bars?

>> TOM TOMISANO: Could you clarify design and design philosophy?

>> SPEAKER: Sure. It's to my understanding that these anti vibration bars were designed so that they would have zero gap and zero contact force in between the rows of tubes so that you would prevent tube to anti vibration bar dings and dents due to wear of the anti vibration bars with the tubes. You represented change from the previous design philosophy that your vendor had used in making steam generators.

>> TOM TOMISANO: I will give you an answer about the design of the anti vibration bars. As far as MHI's previous design philosophy and current design philosophy, that's not something I'm prepared to speak to and we can answer that at a later point in time with MHI. So rather than me speak on their behalf, their root cause work is on going as well. With the anti vibration bars, what Mr. Howell is referring to, these anti vibration bars, it's a fairly similar design used by other steam generator manufacturers. Again most of the vibration that is experienced in a steam generator is normal random vibration and they're designed so when a steam generator is hot and operating the vibration bars have a zero gap; they just contact the tubes without significant force because you want the tube to be able to experience some vibration without excessive force wearing at it. They are designed to limit the out-of-plane displacement of the tubes and again, this is a typical design that several of the vendors use in these larger U tube steam generators and it's evolved over the years.

>> SPEAKER: I just wanted to make clear, they were designed to prevent out-of-plane displacement?

>> TOM TOMISANO: They were designed to prevent out-of-plane displacement, they also provide some damping to in-plane vibration and I'll talk about that in terms of, you know, a fluid film damping and just friction damping when they're in contact with the tube. But again industry experience up until the San Onofre unit 3 issue, was that if you have adequate margin to out-of-plane vibration by your analysis, by your thermal hydraulics and support system you had more than enough margin to in-plane vibration. One of the things that has occurred here is there was less margin recognized in-plane vibration and you'll hear me later say the support system was not effective in unit 3 in restraining the in-plane vibration.

>> SPEAKER: But that in-plane vibration that's presented is based on operating history, right? Not analysis or testing or ...?

>> TOM TOMISANO: Based on operating history, the analysis typically looks at more normal random-plane vibration and out-of-plane vibration. Okay, so that's an overview of the steam generator construction. And that sets the stage really to start talking about the inspection results we found, the cause of the tube to tube wear and the corrective actions. So I'm going to take Unit 2 first and then I'm going to take us into unit 3.

Unit 2 is already in a plant refueling outage. So at the end of the first cycle with new steam generators -- and let me give you some background. When new steam generators are built, designed and fabricated, before they're installed you do 100% inspection of all the tubes after fabrication before installation. So you have what's called a pre-service inspection or a pre-service baseline. So you absolutely know the condition of the tubes. After the first full cycle of operation you repeat a 100% inspection and that's your first comparison of how the steam generators and tubes performed from your pre-service inspection to your first in-service cycle. Then typically your program has you go forward with periodic inspections of samples of tubes if your results have been acceptable. That's how the program works.
So in Unit 2, we had entered Unit 2 on January 9, 2012. So we had done a full scope inspection. We did 100% of all the tubes, all anomaly

10,000 tubes in each steam generator with what's called an eddy current bobbin coil. This is a sophisticated device that is run up the entire length of the tube. To give you some perspective, there's tubes at the top of the bundle, the very outer tubes are 76 feet long inlet to outlet. In all of those 9,727 or roughly 10,000 tubes, we run a probe up that, through on electrical signal, assesses the tube wall. It looks for any indication of dents, dings, wear marks, etc. It's been used for many years. This technology is proven and has been refined through the EPRI, Electric Power Research Institute program. Then we –

>> SPEAKER: Tom, can you talk about the sensitivity of that probe vice, I think you're going to talk about a different type of probe here in a minute.

>> TOM TOMISANO: All right, I don't have the sensitivity specs with me Mr. Lantz.

>> SPEAKER: I mean like how, you know, how small of an indication in order that it could detect reliably?

>> TOM TOMISANO: Rather than pull something off the top of my head, I'll be glad to answer that either after the break or later. I just don't have that number at the top of my head. It is a fairly sensitive examination. What you're referring to is the next bullet, the eddy current rotating coil exam. This is a different type of probe that is slower and is used for a sample of the tubes or for certain areas if we see any indication with the eddy current bobbin coil probe, we go through with a rotating probe which has different sensors on it which is a greater sensitivity and allows us to characterize something we might see on the bobbin coil probe.

Then we did a full U bend exam of tubes adjacent to the retainer bars. When I talk about the results, retainer bars in each steam generator affect 94 tubes out of the 10,000 in each steam generator. They're there largely for fabrication support. They do have a function in certain accident scenarios to restrain the tubes but they largely have no function in normal operation. The retainer bars had a design problem and there were some wear marks on some of the walls not through wall. So we did a full examination of those tubes. We also then from the secondary side, go in with cameras and do a visual inspection. All the eddy current stuff I'm talking about is done from inside the primary side of the tube. The visual inspections are done from outside the secondary to correlate what we may see on the electrical testing signals visually. And then we do special eddy current and ultrasonic exams, and especially driven, once we got the data out of unit 3, we had decided not to restart Unit 2; we went back into unit 2.

>> SPEAKER: Tom, could you just take a moment and describe what that design problem was?

>> TOM TOMISANO: The retainer bars? I'll be glad to. You're getting ahead of me so we'll cover it now. So the retainer bars, if you remember the graphic I showed, there's a long retaining bar and the retaining bar span the entire top of the tube bundle and there's multiple retaining bars. Underneath the retainer bars and welded to them, are a series of smaller retainer bars. Half of the retainer bars are about two feet long with a fairly thin diameter, thinner than MHI

had used in the past. Those retainer bars, in the normal operating condition with 100% power, vibrate; just the half of them that are the longer and narrower retainer bars. That vibration which was unexpected with retainer bars. They vibrated and they wore that vibration, which was unexpected out of the retainer bars, wore against some of the tubes. Now this is not tube vibration, it's not tube to tube wear, it's a retainer bar to tube issue wore at unacceptable depth of operating issue.

Now we identified that fairly easily in Unit 2 and as you're well aware but just to state it, whenever we do a steam generator inspection we know there's normal vibration, we know there's occasionally wear indications. Those are manageable. We manage those, we trend those, we have plugging criteria in our technical specifications. The retainer bar wear is not a normal expected vibration issue. It was clearly a design flaw so we then preventatively plugged all the tubes affected, all 94 tubes in each of the four steam generators affected by the retainer bar. And the design flaw itself, MHI had used this design in the past successfully; but in the size of these tubes of these steam generators, these were the largest U tube steam generators MHI had designed and built, and in upsizing to this level, these bars were long and thin enough that they basically fluttered. That's physically what happened that caused the wear in the tube. That was not recognized by MHI. They didn't do a unique analysis for the retainer bar vibration. That was the error that was made. Does that answer your question?

>> SPEAKER: My understanding there's two sizes of retainer bars. There's a thicker one and a thinner one. So I guess I want to understand now, in the new design, did they make a retainer bar thinner than they had in the past or thicker than they had in the past?

>> TOM TOMISANO: If you think of it, picture that whole bundle. When you're near the top and center of that bundle, your bend radius is much larger, you can have thicker bars. As you get to the edges of the bundle, because of the bend radius you have thinner bars. In fact for half of the retainer bars they use thinner bars than they had previously used and again their mindset was that, you know, previously this has been successful. It was not an operational item in their minds so they didn't do the vibration analysis on the thinner bars. So it’s related to the use of the thinner bars and the length of the thinner bars.

So Unit 2 steam generator inspection results: Again the unit 2 steam generator inspection was largely done when we got into the unit 3 results so we went back in. And I should mention, to give you some perspective, we have done over 170,000 tube inspections between the two units. We're not talking about a weekend's worth of work here. We did months of tube inspections with these sophisticated probes and different probes to make sure that we understood the indications, we characterized them properly and went back in to confirm that we didn't miss anything.

So with that background, so with inspection results: First of all, and I stated this earlier but to make it clear, Unit 2 actually met all the steam generator program requirements. When we shut down for an outage and do a steam generator inspection, whether it's the first cycle or several cycles down the road, we have to do an inspection of some sort,

in this case 100% inspection, and confirm during the last operating period anything we found met the steam generator tube integrity requirements. That's part of the EPRI steam generator program. It is established by our technical specifications. We must meet that to confirm the steam generator is operating as expected. And Unit 2 in fact did.

>> SPEAKER: And Tom, quick question. Your initial exam of the unit 2 steam generator, did 100% exam with the eddy current probe and based on the unit 3 experience I think you went back into Unit 2 after extensive tube to tube inspection on unit 3. So you did more extensive evaluation of about 1,000 tubes I think it was with the rotating pancake which is a more sensitive probe. And that's why I asked the sensitivity question earlier. The statement you just made that Unit 2 met all of the design criteria given the inspection results, is that still true given the rotating coil and the two indications that you're calling tube to tube wear at this time?

>> TOM TOMISANO: The unit 2 -- my statement on Unit 2 meeting all the requirements, this was on the baseline inspection which was both the bobbin and selected rotating probes and empty coil probes, just so you know. We went in with selected areas to look. Unit 2 in fact did meet all the program requirements. The two tubes we're going to talk about in a minute that had early indications of potential indications of tube to tube wear, and I want to label that as potential because they're just at the level of detectability, so we've treated them conservatively. Given that it's not a random phenomena, that's one reason we decided not to proceed forward. It would still literally meet the program requirements but we felt it was not prudent to move forward.

>> SPEAKER: Okay, so you think it still meets program requirements even with indications –

>> TOM TOMISANO: I'd have to go back and read the program but again two indications well below the plug in criteria, you know, we would identify them; we would evaluate them; decide, you know, in terms of meeting the program requirements. It's a backward look to say was integrity maintained during the operating period. It in fact was maintained not shallow during the operating period. So I would tell you yes, it met the integrity requirements at the end of the operating period.

>> SPEAKER: Okay, all right.

>> TOM TOMISANO: Now, per the industry guidelines, a single tube pressure test: One of the retainer bar indications was deep enough and large enough, this is on one tube where the retainer bar wore against the tube, was deep enough and large enough that we couldn't analyze that and decide simply to plug it. We had to actually go test it. This is how we demonstrate we met the steam generator integrity requirements. So when we find indications in a tube, no matter where they came from, we have analysis methods and the way to characterize it and say if it meets certain requirements I may elect to plug it or I may have to plug it but I met the integrity requirements. If the flaw is such that I can't tell that by calculation I have to test it. We

had to test one tube in Unit 2, not related to tube to tube wear, related to retainer bar wear, and it in fact passed the test.

Now let's talk about tube wear in general. We found tube wear, and this is tube to anti vibration bar wear, this is where some normal wear where the anti vibration bar contacts the tube and through normal vibration you get some wear. We found tube to tube support plate wear. I didn't dwell on it but in the straight sections the tubes that are seven tube support plates would provide lateral support. There is some expected wear at those locations. We found retainer bar wear. And I've discussed that fairly extensively in answering your question. And we found two tubes with potential indication of free span tube to tube wear. So let me talk about the first two types.

We found more wear than we expected, more normal wear. Tube to anti vibration wear and tube to tube support plate wear. In brand new steam generators of this design in this material we expected to find relatively little wear. We found significantly more wear than we expected. The wear is understood. It's due to random normal vibration. There is more of it than should be there. That relates to the adequacy of the support structure than the design clearly. That wear is manageable on a going forward basis if that was all the issue. Now other units in the country, we've looked through the eyes of EPRI and our vendors. We're somewhat at the high end of the amount of wear after one cycle of steam generator operation. There's been a couple plants that have similar numbers but we certainly are at the high end of that.

>> SPEAKER: Tom, when you say the wear is "manageable going forward," just to expand on what you mean by that.

>> TOM TOMISANO: Well the wear is understood, it can be predicted, it can be trended.

>> SPEAKER: Okay. Wear rates can be --

>> TOM TOMISANO: Wear rates can be

predicted. We've got years of experience with it.

>> SPEAKER: Okay.

>> TOM TOMISANO: The retainer bar wear is different. That was clearly a design flaw which is unacceptable and had to be mitigated prior to restart, which is why we plugged 94 tubes in each of the steam generators to eliminate those tubes so even if the retainer bar wears on them they are not a source of leakage. Then the free span tube to tube wear, early indications potentially on unit 2 in only two tubes in the two Eco 89, one of the two steam generators. I'm really going to get into that in depth as I talk about unit 3.

So what we did, the tube wear and anti vibration bars and tube support plates, there were two tubes with wear above the 35% limit. As you are aware, in our technical specifications when we have a wear flaw or a wear mark that is greater than 35% through the thickness of the wall of the tube it has to be plugged. So there were two that were required by our program to be plugged. There were two more that below 35% but they

were close enough that as we look at operating another cycle, we preventatively plugged those to be conservative and add safety margin.

The tube to retainer bar wear: I've talked about that quite a bit for those wear above 35% but we preventatively plugged another 100 -- and this is Unit 2 I'm talking about -- 180 tubes just to take them out of service to ensure that, that retainer bar problem did not affect the tubes.

The tube to tube wear in Unit 2 we found two tubes most likely caused by this in-plane vibration which manifested itself severely in unit 3, so we treated it as such. It was measured at 14% with the probes. It is probably a little less than that, that's a conservative sizing of that. It is well below the 35% limit but again not acceptable to keep in service so they have been plugged.

Additionally, and when I talk about the corrective actions later, we identified 321 other tubes between the two unit 2 steam generators to preventatively plug.

>> SPEAKER: Tom, just to clarify for me, you said that -- okay, so the two tubes, 14% at the realm of detectability but unacceptable to keep those tubes, what makes that unacceptable?

>> TOM TOMISANO: If they're tube to tube wear, our experience out of unit 3 and all our work through the last eight months shows the phenomena in unit 3 is unpredictable and it's rapid. So to contrast it for people who are uninformed on the program, a 35% plugging limit, one of the things it's predicated on if there is a wear indication below 35%, as long as you can predict wear rates, you can justify leaving it in service and operating another cycle or until your next inspection. But it's got to be predictable, you got have to be data and it's got to be a phenomena you can understand and predict. Tube to tube wear does not fall under that category.

>>SPEAKER: Okay.

>> TOM TOMISANO: The 321 tubes we conservatively plugged between the two steam generators, we identified if the plant were to operate at 100% power, based on what we learned out of unit 3, these would be susceptible potentially to the same phenomena occurring of this fluid elastic instability and excessive vibration so we plugged them.

>> SPEAKER: Tom, could you compare and contrast what you plugged in unit 2 preventatively versus unit 3? Are they the same tubes, is it a subset of the --

>> TOM TOMISANO: It's a very similar set of tubes. If you'll hold that question Mr. Howell I'm going to get to the tube map in a few minutes and I can come back to that. So, now unit 3: So I've kind of talked about unit 2 and I've introduced unit 3 quite a bit into it but let me recap unit 3. So after the January 31st shut down, we went in and you start with, which tube leaks? So we've got capability, once we shut down and cool down the unit and get into the inspection, to identify the leaking tube. We identify that readily. We then did the complete 100% inspection. The eddy current bobbin coil, the rotating coil examinations, that's done first of all with leaking tube and the

adjacent tubes to confirm the leak and characterize the nature of the leak. Then we did 100% full length of all tubes just as we would have at the end of the cycle. The unit 3 had only run 11 months now, only half of the full cycle.

Think of the U bend portion of the tubes we talked about, we did a full U bend exam around the retainer bars. Based on what we learned out of unit 2 on the retainer bar vibration, we went and looked for the same issue in unit 3 and we did confirm the same design problem with the retainer bar vibration. We then also did visual inspections from the secondary side and we did specialty eddy current and ultrasonic examinations from inside the tubes to further gather data and understand principally the tube to tube wear phenomena, the nature of the wear and the interaction with the tubes and the support structure.

So steam generator inspection results: start contrast here. Unit 3 did not meet the inspection program the performance requires. As again, it's a backwards look on the 11 months of operation. The tube leak itself as well as the number of issues we found with tube to tube wear did not meet the tech spec program requirements. So unit 3 starts out very different than unit 2 by the nature of the tube leak and by the nature of the tube to tube wear.

Secondly, I describe to you the one pressure test we did in Unit 2, one tube related to a retainer bar issue. Test in Unit 2 was done and passed. Unit 3 we had to do 129 tube tests, which is an extremely high number for any unit in an outage. And we had eight tubes that did not pass. So they failed. So that tells us that those eight tubes would have failed structural integrity requirements. There are three plateaus. One is an operational pressure, one is a main streamline break accident pressure and one is an overall structural integrity. Three failed at the main streamline break accident pressure and the remaining five met the upper limit of structural integrity.

>> SPEAKER: Tom, it might be useful at this point, we have one tube in unit 2 in one of the steam generators that had to be pressure tested, 129 total between the two generators in unit 3. Could you just talk briefly about how it is determined to pressure test the tube? Was there a certain methodology?

>> TOM TOMISANO: And I alluded to this earlier but basically when you do an examination of tubes with our electrical equipment, our eddy current equipment and our various probes and you see some sort of wear indication or flaw in a tube, you've got to characterize it because it could be a challenge to steam generator tube integrity. It could be a challenge from a leakage or an integrity issue. So we've got to characterize the flaw and decide, does it have to be plugged? Does it hit the 35% limit or is it close? And whether it's above or below we've got to characterize it and conclude that it meets the integrity requirement. If we cannot conclude that based on the size and shape of the flaw and do that analytically, we have to pressure test it. So in Unit 2 we had only one flaw that we felt we had to pressure test to conclusively demonstrate. In Unit 23 we had 129 tubes. We were not satisfied that analytically we could show the method requirements and in fact eight failed. We actually predicted those eight. Based on our calculations and flaw size we said we would predict this many would fail and those eight were in fact predicted to fail.

So quick summary -- and I'm not going to dwell a lot of Unit 3. We've covered a lot of this. We did see wear of the anti vibration bars. We saw wear tube support plates in unit 2. We saw the same retainer bar wear and we saw significant free span tube to tube wear. I will mention we see difference in Unit 3 and Unit 2. Unit 3 ran 11 months and even in the anti vibration bar and tube support wear where I characterize maybe as normal wear only to a much greater degree than inspected Unit 2, Unit 3 had even more wear in half the operating time. So Unit 3 is behaving differently than Unit 2, that is clear. And the free span tube to tube wear is very dramatic. But even as we look at our other wear indications, we see a difference between unit 3 and Unit 2.

Very quickly because I want to get on really to the cause and the actions to summarize tube wear retainer bars, we did the same thing we did in Unit 2. We understand that. All of the tubes that are affected or potentially affected have been plugged. We did plug three tubes above the 35% limit at the anti vibration bars. Significantly, we plugged 230 tubes above the limit at tube to tube support plate. Those are all related to tube to tube wear. What is happening there is those tubes that are vibrating excessively, we not only see it in the U bend area but they're vibrating against their tube support plates in the straight sections and that's where that unusually high number comes from compared to Unit 2.

And then tube to tube wear, 326 tubes between the two steam generators. So each unit 3 steam generator is not only 10,000 tubes, there's about 160 tubes in each that are effected by this excessive vibration, this excessive movement, the tube to tube wear, the tube to tube support plate wear, 326. And then we plugged another 292 tubes that would be susceptible at 100% power. Mr. Howell I think this gets to the comparison you had asked about.

>> SPEAKER: So you plugged roughly 200 more tubes in unit 3 than in unit 2?

>> TOM TOMISANO: Anticipating you might ask the question we've done the math. In Unit 2 we plugged a total of 570 tubes either due to indications or preventatively as a conservative measure to add safety margin. In unit 3 we've plugged 807 tubes. Now, you know, and I want everyone to know, we are not done with unit 3. We've done enough work on unit 3 to understand the effect on unit 2 and that's where our efforts have been focused. So I'm not going to tell you tonight that I'm done with unit 3 at about 800 tubes.

>> SPEAKER: Tom, one quick question. So 326 tubes plugged due to tube wear and precautionally 292 more in Unit 3. Now those 326 did they exceed the 35% value they're required or that's just –

>> TOM TOMISANO: Some of them did, some of them did not. And I can give you a more detailed breakdown. If you look at the 230 tubes, they're a subset of that 326 those and those did exceed the 35% at the tube support plate levels.

>> SPEAKER: Yeah that was going to be my next question was, how the tube wear at the tube support plates was related to the tube to tube wear? And if they were the same tubes? Different tubes?

>> TOM TOMISANO: Those 230 are a subset of the 326. And those 326 were vibrating excessively and we're seeing the indications of that in the straight portions against the tube supports.

>> SPEAKER: My follow-up question then would be then for the two tubes on Unit 2 that you characterized as having potential tube to tube wear, was there any indication that those tube support plates on those two tubes that wear was a little more than what you saw –

>> TOM TOMISANO: I would have to check the data. We inspected that but out of the 20,000 tubes in unit 2 those are probably the only two that I didn't remember. So let me check that data and get back to you.

>> SPEAKER: We do know that there weren't any tubes on Unit 2 that saw any wear at the tube support plates which required plugging.

>> SPEAKER: Right.

>> SPEAKER: Right, exactly. We do expect to see some amount of what Tom has characterized as random wear driven by turbulence and normal vibration within the steam generators. But we could follow up with you, Mr. Lantz, and get you the specifics on those two tubes.

>> RYAN LANTZ: Thank you.

>> TOM TOMISANO: We have all that data.

>> SPEAKER: And just for Mr. Howell's question, you had asked, "how does the overlay essentially of the unit 2 preventive plugging compare to the unit 3 tubes where we saw tube to tube wear?" It was our intention to plug a very, very similar area on Unit 2 anticipating and with our conclusion that unit 2 could be susceptible to the same phenomena as unit 3 so our intention was to overlay. And when Tom gets to his tube maps here in just a minute you'll see that there is a specific localized region of the steam generators where we have that concern.

>> TOM TOMISANO: And the material we submitted is with the CAL response, we submitted a lot of material that preventative plugging in the rationale fort and the location is fully described. And again we'll be glad to get into that with more depth.

>> SPEAKER: So just so I'm clear, Mr. Dietrich, Mr. Tomisano, you had roughly 620 tubes that were plugged in unit 3 because of tube to tube wear, is that right? Either preventatively or because they were effected in unit 3.

>> TOM TOMISANO: That is correct.

>> SPEAKER: And in unit 2 you preventatively plugged 321 tubes with the difference being approximately 300 tubes?

>> TOM TOMISANO: That is correct.

>> SPEAKER: Okay. And you say in the CAL response it provides the technical basis for that difference?

>> TOM TOMISANO: That's right, that's correct. We identified a criteria, and it's summarized well and in detail in the CAL response. In looking at Unit 2, if the plant were at 100% power the tubes that would be susceptible to fluid elastic instability and this excessive vibration, and we elected to preventatively plug all of those susceptible tubes and we have our criteria laid out and again, deeper than we're prepared to go in tonight but we can easily take the staff through that.

Now with that background on inspection results and kind of the summary of the plugging, I want to talk about tube to tube wear. So it's part of the methodology, if you think back in my earlier comments. So we've identified and we've got tube to tube wear occurring in unit 3, so now what is physically happening? And why is it happening? Steam generators -- cut away just to refresh us -- we're going to refocus mainly on the upper part of the bundle we'll call the U bend. I've annotated this tube to tube wear. I'm thinking that one tube comes up in a U shape and comes out on the other side, hot leg to cold leg. I'm going to show you a picture in a minute that talks about how these tubes are actually moving.

Now this graphic, and I've exaggerated the tube, but this gives you a feel for how long those long tubes are. Notice the highest tube is 76 feet long inlet to outlet. So this is a long, thin, very strong tube but it's flexible. So the blue shape there would show you a tube say at a normal condition with no movement, no deformation. The red shows you the effect of this fluid elastic instability causing an in-plane vibration causing this tube to move excessively, to vibrate excessively. So on this one, you can see what would be on the right side of the screen the tube flexes or moves to the right as part of the vibration and you can picture there are tubes above and below it.

So you can picture this, if it moves far enough it's going to contact the tube above it and on the other side, it's contacting the tube below it. And then when that tube vibrates and flexes back the other way, picture that tube just vibrating back and forth, it's contacting tubes above over here, above on this side and below on both sides. That is physically what's happening with the tube.

So we plotted all of our indications out of the unit 3 steam generators. What we see here, this is a schematic, I should just orient you, you're looking at a schematic of a cross section of steam generators. When you see things like O3H, O3C, O4, these are the tube support plates. So the tubes are straight in this portion, these are the tube support plates that provide horizontal support, then the tube if this were a tube, it bends through the U bend portion. These V-shaped things are the anti vibration bars. So what is happening when these tubes flex back and forth, we are seeing the predominant number of these long wear scars due to tube to tube contact in this region of the U bend and in this region. Going back to the previous slide, if the tube is moving back and forth this way, where would I expect to see the contact and the damage? And in fact this correlates very well with where we are measuring the contact and the damage through all of our

tube inspections. So this is part of the story now confirming, you know, we understand how the tube is moving. It correlates with the actual measured damage that we see on the adjacent tubes in the steam generators. When I talk about 326 tubes between the two steam generators, this is where the predominant damage occurs. The other damage I haven't annotated would be those 230 things where as the tube vibrates, you know, if the top of the tube is moving well the straight portion is vibrating as well and it's impacting the tube support plate. That's where those indications come from.

Now what I want to show you here -- we'll start talking about and overlay. This is interesting. This is a little hard to understand but this is actually a picture, we call it a tube map. This is a representation of the 10,000 tubes in one steam generator. So we're kind of in the primary steam side of the generator looking up at what's called the tube sheet, where all the tubes, either the opening is or the outlet, the inlet or outlet. What this testing has shown, this darkened region is where, let's take this is 3 Eco 88, I believe the number was 161 tubes effected by tube to tube wear, they are all clustered in a very tight cluster. So it's a very tight subset of tubes.

>>SPEAKER: I just want to be clear, Tom. You said this was the whole steam generator. It looks like it represents half of the steam generator, is that –

>> TOM TOMISANO: You're looking at the hot leg side. Remember the tube is a U bend so you're seeing the inlet to all 10,000 tubes. I have a companion picture that would show you the cold leg or outlet side. So this does represent all the tubes in a steam generator. It’s just a certain view.

>> SPEAKER: I see. Okay, thank you.

>> TOM TOMISANO: Yeah. Now unit 3, echo 89 steam generator, very similar in terms of pattern and very similar in terms of location. What's important here is we understand the cluster or pattern of the location. This gives us clues to the conditions that are occurring that effect tubes in that region of steam generator. And we're going to get to the thermal hydraulic conditions in a minute.

Now Unit 2: Two tubes in Unit 2 between the two steam generators. That is a picture of the two tubes with potential tube to tube wear and the number two Eco 89 steam generator. Similar location which led to our conservative decision to treat them as if Unit 2 was showing the early signs of phenomena at 100% power. And that, the clean picture is a Unit 2 Eco 88 steam generator. We have seen no indication after multiple examinations of 2 Eco 88. But again from a conservative standpoint and a safety margin standpoint, we feel it is important to treat Unit 2 as susceptible and propose the corrective actions we're proposing.

Just going to give you a quick summary. We've talked about a lot of this, Unit 3 first: The number of tube to tube wear indications. Now indications are different than the number of tubes. I can have multiple indications in one tube, remember? I can have indications on either side of the U bend. So one tube can have multiple indications. So in

Unit 3 I have a total of 823 indications of tube to tube wear. They effect 326 tubes. The max depth is 100%, this in fact caused the leak. We have a number of tubes that are well over 50% through wall, you know, tube to tube wear through wall depth. The longest length is 41 inches. That is an extremely long wear mark. Usually wear marks through normal random vibration are limited to the width of the anti vibration bar that the tube's in contact with. These are extremely long. We had to do 129 pressure tests. That is an unusually high number for any site. We failed eight pressure tests. That is an unusually high number. And the unit operated only 11 months on brand new steam generators.

Unit 2 is clearly different, clearly different based on results. We had two tubes with potential tube to tube wear indications, two indications, two tubes. The maximum depth is about 14% was about the limited detectability. The max length appears to be six inches based on our ability to characterize it. We had to do no pressure tests due to no tube to tube wear; set aside the retainer bar issue. And we failed no pressure tests and it operated a full cycle of 21 months.

So based on all the work we've done, starting with what was the tube wear? What did it look like? Where did it occur? How does a tube have to move? And with all the expertise we assembled to review this and develop this, we've identified the fluid elastic instability caused excessive tube vibration in an in-plane direction which is the unique phenomena that we've seen now in these steam generators in Unit 3. And that occurs when a tube is subject to fluid velocities above a critical value. In other words the flow of water and steam passed the tube is high enough it's above a critical velocity that will start the tube to vibrate; and secondly, the support structure and the fluid is not damping the tube enough so the tube vibrates unstably and with a high amplitude and allows it to contact. That is the technical cause of the tube to tube wear.

Two key points because these are important to corrective actions: it starts with adverse thermal hydraulic conditions. When you have high fluid velocity that's what transfers energy to the tube. And whether it's random vibration or this unique in-plane vibration, energy is transferred to the tube by the fluid. High localized void fraction What does that mean? When I talk about void fraction or steam quality, I'm talking about how dry the steam is. You know the function of the steam generator is to boil water, turn it to steam, then turn it to turbine. You want steam but all that equipment at the top of the steam generator called moisture separators and steam dryers because we want a certain amount of steam generated but we don't want patches of very dry steam. We want to strip the moisture out of the very top of the steam generator. What's happening here because of the adverse thermal hydraulics with high velocities, we also have localized patches of very dry steam. When you have very dry steam the tubes are not effectively damped by movement through a water fluid and there's not a water film between the tube and anti vibration bar. And that water film actually, the technical term through all the research is squeeze film damping. That water film actually helps to dampen the tube and prevent the vibration. When you have these adverse thermal hydraulics, the tube's excited and the vibration is not dampened.

The other piece of this is the support structure and this gets to a key difference between Unit 2 and Unit 3. Again up until now by the other manufacturers and MHI, MHI has been successful with this type of design in smaller steam generators before, the anti vibration bars have been effective in controlling both out-of-plane and in-plane vibration previously in MHI's experience and other vendor's experience. With this size steam generator, for whatever reason, this anti vibration bar design was not effective coupled with the adverse thermal hydraulics. So when the two combine, we have this localized area where the subset of tubes, 160 tubes out of 10,000 steam generators were exposed to this and vibrated excessively causing the damage.

>> SPEAKER: Tom, you said MHI was successful with the previous generators with the similar anti vibration design, would it be fair to say that potentially those other generators just weren't challenged so much in the design because the thermal hydraulic conditions were not the same?

>> TOM TOMISANO: It's hard to make a conclusive statement. We've done enough work with MHI and the other vendors. And you know, MHI has supplied similar steam generators in Japan, elsewhere internationally and one other set in the U.S. and they have been small. So it would appear to us that our thermal hydraulics, our fluid velocities and void fractions at 100% power, and that's the key, are higher than they have previously experienced before in their design.

>> SPEAKER: Okay.

>> SPEAKER: Yeah I need a second to organize my thoughts. MHI, the vendor, when they designed the anti vibration bars for your steam generators it represented departure from their previous design philosophy. In fact they were trying to maximize dampening and minimize contact force, right? But I guess they didn't recognize or it was not recognized that by doing so that it lowered the natural frequency of the tubes in the in-plane direction, is that fair to say?

>> TOM TOMISANO: I won't say that conclusively without talking to MHI. I understand what you're saying. They have previously used this anti vibration bar specifically at the plant in this country, much smaller plant. They've used it elsewhere. In terms of their design philosophy, the zero gap, the contact force, without consulting with MHI I can't state conclusively that, that was their goal.

>> SPEAKER: Okay. Well I mean clearly it was Edison's goal to dings and dents in those tubes in the context of the anti vibration bars with the tubes.

>> TOM TOMISANO: Our goal, our specification was a steam generator that would operate 40 years, very little tube wear, no tube leaks for a number of years, etc. In terms of how the designer does that to achieve those goals, we provide oversight, we rely on their judgment, their engineering expertise and our oversight.

>> SPEAKER: Tom, Mr. Howell, to address your question, this goes back to some elements of what we were seeking in our replacement steam generators. The reason the industry, as you gentlemen know, the reason the industry has gone through an extensive and expensive and prolonged

process of replacing steam generators was primarily due to phenomena that occurred during the course of the lives of those steam generators that weren't fully expected when the steam generators were installed back in the original construction, 60s, 70s, and into the 80s for us. That was primarily involved cracking of the tubes which was driven by a chemical corrosive attack. One thing that's important, very important to note and understand is that at San Onofre we were also seeing on the original steam generators a significant amount of wear; not just the cracking but we were seeing a significant amount of wear. And on one of the units, I recall it being Unit 2, the steam generators were actually approaching the end of their useful life because of the tube plugging that we were having to do due to wear on the tubes not just the cracking. So in our replacement steam generator design specification our intention was to minimize wear because that was in fact what had driven us to the replacement requirement. And in our desire to install components that we knew could operate reliably for the operating life of the plant and to be able to safely, correctly, efficiently provide electric services to our customer, we were seeking to resolve the issues that were requiring us to replace the steam generator. So our desire was to minimize wear. We also addressed the generic or general industry issue of the cracking and that came through the replacement of the tube material going from what was called alloy 600, the alloy 690. So a little bit differently maybe than other steam generator replacements at the industry which were primarily driven by the corrosion cracking, the San Onofre replacements were driven by wear as well. So that's why this wear focus in our specification to the steam generator design was so important to us.

>> SPEAKER: Thank you.

>> TOM TOMISANO: Okay. So just to recap, in accordance with the Confirmatory Action Letter commitments we've made, we've identified the caused of tube to tube contact and wear in Unit 3. That was one of the key commitments in the Confirmatory Action Letter. We understand what has occurred, fluid elastic instability, excessive vibration. And we understand what causes it in terms of adverse thermal hydraulics and the support structure. And that is one of the more corrective actions for Unit 2. Mr. Lantz?

>> RYAN LANTZ: I keep hitting the button here. Go ahead.

>> SPEAKER: When you say "support structure," you mean because there's a lack of contact between the [indistinguishable word] and the tubes?

>> TOM TOMISANO: Well I'm starting with the fact that support structure was ineffective in damping vibration. Whether it was lack of contact or lack of sufficient contact force, some of that is yet to be concluded. Okay? Those are some of the early indications that the zero contact design and in fact, if we think about it, Unit 2 is totally different than Unit 3. Unit 2 support structure was much more effective than Unit 3 with the same thermal hydraulics. The thermal hydraulics are the same for all the four steam generators. Unit 3 after only 11 months has significant damage. Unit 2 maybe has two indications.

>> SPEAKER: But the contact force in Unit 2 has been probabilistically been predicted to be twice that of Unit 2.

>> TOM TOMISANO: Yes. That's part of the difference. So as we continue to unravel this with MHI and do deeper technical work and causal analysis work, the support structure is more effective in Unit 2. Our testing and MHI's testing analysis with all the experts indicates there is both more contact and contact force between the anti vibration bars and the tubes in Unit 2 than exist in Unit 3.

>> SPEAKER: So just so we're clear, and I think you know where I'm going with this. The point is that these anti vibration bars were designed purposefully to have zero contact force and yet now the conclusion is that since after the event occurred in tube leak is that because of that lack of contact force that contributed to the phenomena of fluid elastic instability.

>> TOM TOMISANO: I think that’s a fair statement at this point.

>> SPEAKER: Well I think what's important to point out here, just let me help with a little more information. It does get very technical. And it's not our intention to lose people in this discussion but Tom had previously mentioned, Mr. Howell, the squeeze film damping. And although the steam generators were designed in a hot operating condition, there would be contact, but there wasn't a specific specification for the amount of force that would exist between the anti vibration bar and the tube. The intention was, and the technical analysis and science behind fluid elastic instability and steam generator design has showed the effectiveness of this squeeze film damping. And so what the design counted on was for there to be a film of water there. And because that film of water was there, it would in itself, provide enough resistance in addition to the essentially zero gap although no force, to provide resistance to the two moving. Those are the things we continue to study in our root cause.

It's very important to point out, and I don't mean to jump ahead, but we are talking very specifically about all these thermal hydraulic conditions that exist at 100% power. And this is the fundamental reason that in our proposed Confirmatory Action Letter response, our desire is to only operate the unit at 70% power. And Tom, we have information for you here in a few minutes what will show the improvements in the thermal hydraulic conditions. The fact that you reduced the velocity and you improve the amount of moisture in the steam to restore this squeeze film damping even on Unit 2 where we didn't see the tube to tube wear. So I do think we get to this point. There is a tremendous amount of science and research behind fluid elastic instability as I'm sure you're aware, Mr. Howell. We have learned a lot working with the renowned experts in the industry, some of the most published professors and other folks in world. But we look very much forward to the discussion around some of these very specific but important aspects of steam generator design.

>>SPEAKER: I appreciate that. And I know we're jumping ahead. So we talked about how the reduction of power will improve the thermal hydraulic conditions that is one of the big contributors to the fluid elastic instability but we also talked about the support structure. So as part of the discussion I imagine you're also going to also tell us how that factors into the justification for operating at 70% power.

>> TOM TOMISANO: I'll be glad to address that. And that is fully described in our Confirmatory Action Letter response, the roles of the support structure and again Unit 2 has a more effective support structure than Unit 3.

>> SPEAKER: If I could just tack on to that, you keep talking about an adverse thermal hydraulic condition and that is kind of the precursor. That imparts the energy to the tubes to allow an inadequate support structure to allow excessive vibration to occur. My question, you know, you're going to talk about 70% power as a reduction in those thermal hydraulic conditions. In your CAL response, do you discuss other factors in the design of these generators that ultimately created this adverse thermal hydraulic condition? You're saying it can go away if you reduced power but why is it there in the first place? What aspects of the design created that condition? That's my question.

>> TOM TOMISANO: The current CAL response, we'll get into this over the next several weeks as we get into the technical detail, describes what occurred --

[INAUDIBLE]

>> TOM TOMISANO: I'm sorry? Is the mic on? Anyway, the CAL response describes the condition, describes why it occurred, describes the role of the thermal hydraulics and the fact that they were under predicted, describes the contact force problem that occurred. At that point MHI's root cause has not been completed so as we look at longer term action there's more technical work to do to better understand the contact force assumptions, the role of contact force and whether in the end it's the number of tubes in a physical space that created the thermal hydraulics as well as the role of the contact force.

>> SPEAKER: Yeah I understand to do a full repair, restore the generators to 100% power you'll have to be able to understand how to bring the thermal hydraulic condition back in line with something normal that doesn't create this excessive force on the tubes. But I think it is important to understand what the contributors are so we can understand how effective the 70% power reduction is.

[APPLAUSE]

>> TOM TOMISANO: You'll find in the CAL response we've discussed the contributors to the --

>> SPEAKER: Tom, your next point, we're going to get into the roles of the thermal hydraulic code and talk about specifically how the thermal hydraulic code and some of the issues associated with the thermal hydraulic code factored into this situation. And there is specific information in our Confirmatory Action Letter response which shows the velocities within our steam generators at 100% power, our velocities at 70% power and experience within the nuclear industry today of similarly designed steam generators at the same velocities that we're proposing in our operation of 70% power. And it shows those steam generators are stable, those steam generators don't see this in-plane fluid elastic instability. So we're certainly more than willing to talk about all aspects of that.

>> SPEAKER: Yeah and I think, Mr. Dietrich, the reason why we're asking, you all have defined the phenomena as adverse thermal hydraulic conditions and support structure unable to control the resulting vibration.

>> TOM TOMISANO: Correct.

>> SPEAKER: So I don't know if it's part or all of the action that you're using to justify operating at 70% power is the actual power reduction and you're no longer worried about the support structure performing at a design function that it was never intended to perform which is in-plane stability for those tubes; or if you still need to rely on some support in the in-plane direction to prevent FEI occurring.

>> TOM TOMISANO: And we'll address that as we go forward. Let me talk for a minute about the role of thermal hydraulic code. In previous meetings we've talked about the conclusion that MHI's thermal hydraulic code under predicted the thermal hydraulics and effectively showed more margin to the out-of-plane vibration phenomena than actually existed.

Just real quickly the thermal hydraulic code, the second block on my little diagram here, I've made a simple diagram. You start with operating conditions. The thermal hydraulic code analyzes and models the conditions inside the steam generator the tubes are exposed to. That then feeds both the structural vibration model and tube wear models. So the key here is starting with a reasonably accurate thermal hydraulic predictions from the code. The code that MHI used, fifth three, was used in the design of the replacement steam generators back in 2005, 2006 had been in use for 15 or so years by MHI and their other steam generator designs. And in our case it under predicted the critical thermal hydraulic conditions, specifically the fluid velocity and the void fraction. We've talked earlier the fluid velocity substitutes the steam qualities or helps dampen the movement and help the support structure be more effective through the squeeze film damping. Because of that under prediction they didn't recognize the lack of margin to the vibration phenomena.

Today's work, the U.S. industry typically uses a code called ATHOS which has been around for a number of years developed by the EPRI group, the Electric Power Research Institute. As we run ATHOS today on the replacement steam generators, it predicts much more adverse thermal hydraulic conditions, higher velocities, higher void fractions.

All the analysis we've done to support the Unit 2 restart relies on ATHOS not the fifth three code which was part of the problem that MHI had in their design phase and not recognizing its former ability. And we didn't rely just on MHI running ATHOS or Southern California Edison running ATHOS. We've had ATHOS run independently by AREVA and Westinghouse who also design and builds steam generators. We've had AREVA run a separate proprietary thermal hydraulic code. All of those get very good correlated results with ATHOS today and show more severe conditions than fifth three predicted.

>> SPEAKER: Mr. Tomisano, yes, so ATHOS shows more severe conditions but the results from ATHOS also ultimately it resulted in stability ratios that were satisfactory, is that correct?

>> TOM TOMISANO: In MHI's work, even using ATHOS predictions today and the key is assuming the support structure is effective, showed stability ratios just under one in some cases which is acceptable. 1.0 would be the cutoff between acceptable and unacceptable, greater than one would be unacceptable. But the key is that assumes the support structure is effective. So clearly the support structure is a significant element of what did not work effectively in this steam generator design.

>> SPEAKER: So given that you are going to explain how or at least reference how the CAL response addresses the role of either a design change or modifications or other fixes to the support structure to justify operating at 70% power.

>> TOM TOMISANO: The CAL response discusses 70% power showing the thermal hydraulics are acceptable and in Unit 2 that support structure is acceptable at that lower power level. Again you have significantly less fluid velocity at 70% compared to 100% and I'll show you a schematic in a minute that shows that. And you have a significantly lower void fraction which means much better damping by both the fluid and the supports in Unit 2. The CAL response does address that specifically.

>> SPEAKER: It would be helpful if you could address, at least an overview, of how it is addressed. I mean, I know you can't go into all the details in the operational assessment but at least you can give us a sense whether this is a calculational methodology, a new methodology...

>> TOM TOMISANO: Hold that. Let me get through the upcoming slides and then I'll come back to that question about how we treated the support structure in the operational assessments because what's treated explicitly in the operational assessment, we did in one case.

>> SPEAKER: Mr. Tomisano, I had one other question. You had indicated that fifth three has been used by MHI for approximately, you know, for 15 years, and I assume you mean successfully by that?

>> TOM TOMISANO: Yes.

>> SPEAKER: But that it under predicted, in your case, it under predicted the thermal hydraulic conditions. Could you speak to why in your case it under predicted that whereas apparently –

>> TOM TOMISANO: Yes I can. For our specific case, fifth three, and this gets fairly detailed, our replacement steam generators have a triangular tube pitch design. Previous MHI designs that fit through is based on ahead what is called a square ray design. So there's a physical difference in the way the tubes are configured, those 10,000 or so tubes in each steam generator. So fifth three had to be modified to model the triangular tube pitch design. There's also under the Associated Mechanical Engineer's code, it tells you certain dimensions to use in your calculations. Fifth three did not take those dimensions

correctly. And that was not an input error by a person, that was embedded by how the code was built. So fifth three had some problems in how they modeled the triangular pitch steam generators and how the values that the USASME code required that resulted in an under calculation of velocity. So that in a summary level is what occurred with fifth three that caused the under prediction to occur

>> SPEAKER: And had they modeled under steam generators that they had used the triangular pitch code as well?

>> TOM TOMISANO: I believe they have. They've started with square pitch. I believe they have done other steam pitch generators overseas. But with, quite frankly, smaller steam generators with less severe thermal hydraulics. So I suspect even if an error had occurred it was not a significant contributor to a problem.

>> SPEAKER: Could you describe again the, where you talk about what the ATHOS verification does as compared to the fifth three verification. Why we should have more confidence in ATHOS as compared to fifth third?

>> TOM TOMISANO: Certainly. So first of all, ATHOS was developed by the Electric Power Research Institute a number of years ago and a code like that is verified against experimental data, so well beyond our use at San Onofre. The code is written and then test data is taken off of experimental test tubes where they mock up portions of steam generators and actually measure perimeters. Then they model that test with the code and say, does the code predict with reasonable accuracy what it actually measured? So that's how codes like ATHOS was originally developed and validated. So it's a validated code. What we did, as we looked at this problem we said, let's have MHI and us run ATHOS and look at the conditions. And the ATHOS conditions came out more severe than the fifth three conditions that were done during the design phase in 2005, 2006. We did not just rely on that. We had AREVA run ATHOS, their own version of ATHOS and confirm the calculations MHI was getting with ATHOS, the more severe calculations. We then had Westinghouse, who has a proprietary version of ATHOS, do that as well. So we've had AREVA and Westinghouse run ATHOS independently from MHI and coming up with similar answers out of the ATHOS code. And AREVA also uses a proprietary code called CAFCA and also ran CAFCA and have results in similar range as ATHOS.

So we've done some extensive work here to independently run ATHOS to confirm what MHI's calculations are with ATHOS.

>> SPEAKER: Hey Tom, just one other – we mentioned the fifth three code was modified because of the, going from a square pitch which fifth three usually used to triangular pitch. My understanding is these codes, the ATHOS codes as well as MHI are really based on out-of-plane vibration; they don't really look at in-plane vibration because it's assumed it's not going to occur if out-of-plane is prevented. So can you explain how the codes had to be modified to model the in-plane vibration?

>> TOM TOMISANO: I think what you're talking about, you know, the thermal hydraulics are done independent of what vibration mode you're talking about. So as we talk fifth three, it calculates velocity, void

fraction, hydrodynamic pressure, it is independent of vibration phenomena. I think what you're talking about is these down stream models that look at the particular vibration modes and then the wear models. Again up until this point, industry experience, and this is not just MHI, this is the other vendors as well, have basically modeled and analyzed for out-of-plane vibration and that was acceptable their experience was there was significant margin to in-plane vibration and was not explicitly outlined.

So let me move on to corrective actions: So preventing fluid elastic instability we've talked quite a bit about the role at 100% power, the velocity, the fluid, that's what transfers the energy to the tube. We've also talked about we need to improve to dampen. And this is a function -- here's where the support structure comes into play. So this is a function of the dryness of the steam around the tubes and the supports. The fluid if you will, the water steam mixture, dampens in a couple ways. One is just physically, the tube if it's moving through an area of steam that has largely water, a low void fraction, is damped more effectively from physical motion than through a very dry area, a very dry steam with very little moisture.

Secondly the more moisture of lower void fraction you have a film of water between the tube and the support even if there isn't a strong contact force that very film of water with the tube moving across the support provides damping. So that's the role of the damping. So my second bullet there, the fluid interaction with the tube, it's a function of void fraction or steam quality, how dry the steam is. So as we look at then how to prevent this, the Unit 3 phenomena from occurring in Unit 2, it's a matter of we need to reduce the velocity, we need to reduce or improve the void fraction in steam quality which results in improvement in tube damping. So the sum total of that, it's less energy input in the tube causing the tube to start to move and is better damping that prevents the tube from vibrating excessively.

So let me show you very specifically, I'm going to start with void fractions then I'm going to move on to velocity. So this chart, this is actual data out of Unit 3. See the blue bar is the number 3 Eco 88 steam generator and the yellow bar is the 3 Eco 89. On my graph here, at the bottom is maximum void fraction. So the higher numbers mean very dry steam. So I talk void fraction or steam quality, calculated a little differently but so either one is a measure of how dry the steam is. On the vertical axis: the number of tubes that were actually damaged due to tube to tube wear in Unit 3. You can see that all the tubes that experienced tube to tube wear damage were above 99% or .99 void fraction. This area, very high void fraction, very dry steam, very little water.

If I then look at the effected power level, and this is all at 100% power, if I look at power level I took a little different look at this. So on my horizontal axis it's the same maximum void fraction and on the vertical axis it's the percent of tubes exposed to that high void fraction. And my green line on the graph is at 100% power. What this tells you, that peak there on the far right, that green line, slightly over 30% of the tubes at 100% power were exposed to a 99% void fraction or higher. So that adverse, very high void fraction, the number of tubes in the Unit 3 steam generator is exposed to that void fraction.

>>SPEAKER: Tom, you mentioned that this is the thermal hydraulic phenomena and all four generators are designed the same. Wouldn't this not be representative also of void fraction for Unit 2 at 100% power?

>> TOM TOMISANO: Yes it is. In fact this graph is very representative of Unit 2. Let me back up. This is Unit 3 specifically. This graph is identically essentially for Unit 2 or Unit 3 because they're the same design, same construction, the thermal hydraulics are the same; which is why early on we concluded Unit 2 as susceptible to the phenomena. The yellow line on this graph shows you the effect of reducing power to 70%. The effect on void fraction, again this is what improves the damping and improves the effectiveness of the existing support structure, there will be no tubes. None of the 20,000 tubes in the Unit 2 combined two steam generators will be exposed above a 92.5% void fraction? That is a significant reduction in the void fraction and the dryness of the steam with that power level reduction.

>> SPEAKER: Tom, for the void fraction as well as the next slide that you have for velocities, you were going to talk about comparison between some of the units at 100% power. I didn't see that in our slides.

>> TOM TOMISANO: Hold that thought for a minute. Let me get through the slides and I'll come back.

>> SPEAKER: Okay.

>> TOM TOMISANO: So the next slide I put these two together because I want to show you the actual tube's damage in Unit 3, the yellow and blue bars. The green line, what was exposed at 100% power and as was noted by Mr. Lantz, that green line would be applicable to Unit 3 and a reduction of 70% power. No tubes, no tubes would be exposed to the void fractions that were part of the cause of the fluid elastic instability, the unstable tube vibration, the tube to tube wear. And that void fraction fundamentally improves the damping, which improves the effectiveness of the support structure for damping.

>> SPEAKER: You've said that a number of times, Mr. Tomisano. I'm just trying to understand how it proves that. Could you just, big picture, tell us either how that's demonstrated. Calculationally? By testing? Experiment? I'm just trying to understand it by the models you've used previously?

>> TOM TOMISANO: In terms of how the void fraction occurs?

>> SPEAKER: Right, and how they demonstrate that, that improves the dampening. How is that calculated? And then how does that translate into concluding that there will be no tube to tube wear?

>> TOM TOMISANO: First of all we've got our actual data measured out of Unit 3 that just relates where the damaged occurred as it relates to void fraction. Then how do we correlate a lower void fraction to better damping? That is done calculationally. And those calculations are based on experimental data. The experimental data you referred to in the 2002, 2003 timeframe developed the understanding in the equations that relates things like void fraction and fluid velocity to the amount of damping that occurs, the amount of tube excision that

occurs that would allow the vibrational code above a critical level velocity based on its void fraction. Gives you kind of a complicated answer but we take this data, we go into the calculations that are based on experimental data.

>> SPEAKER: From what the Canadians did in 2002?

>> TOM TOMISANO: Largely the Canadians in 2002-2005. Westinghouse has some experience with this from a testing standpoint as well.

>> SPEAKER: And I know you said you're still looking at why, but it's my understanding based on what you know now that this was not considered back at the time steam generators were designed.

>> TOM TOMISANO: The in-plane vibration was not considered. Again, the paradigm at the time, not just MHI was that if you have adequate margin to out-of-plane vibration, which occurs at lower levels of velocity, for example, you would have more than enough margin in-plane vibration. Clearly wrong. You know history has shown, experience has shown that was not a correct paradigm. There were many years by many manufacturers supporting that paradigm. The data from 2002 timeframe done experimentally, never seen in practice, and again we've talked to more than one steam generator designer who confirmed that mindset, if you will. But again, to answer your specific question, the calculation of the improvement of damping with void fraction is done calculationally but is based on experimental data and real measurements.

>> SPEAKER: And this is new work, I mean, as it applies to actual steam generators or has this been done?

>> TOM TOMISANO: Well the research has been done since 2002 by the way of steam generators. I think you're familiar with what Dr. Michelle Pettigrew brought in, offered that, ran a number of the experiments working quite a bit with some steam generator manufacturers. So they were look at U tube shaped steam generators.

>> SPEAKER: But the work that went into the operational assessment in this regard, has that ever been used in the design of other operational steam generators?

>> TOM TOMISANO: I can't speak broadly to the design of other operational steam generators. It is certainly probably a first time use in operational assessments.

>> SPEAKER: So it represents new work?

>> TOM TOMISANO: It represents new work as well as the operational assessments we did and submitted as part of the CAL response.

>> SPEAKER: I think what's also important to note is that the return of such a large portion of the tubes to this void fraction level, less than 92.5% as Tom mentioned, that is very benchmark able to other plants with U tube steam generators. Other plants we know operate above 90% void fraction but less than 95% void fraction and operate there successfully. So it is backed up by other industry experience from the last several years.

>> TOM TOMISANO: I was going to get to that, that was the heart of Mr. Werner's question. As I get to the next couple slides we'll come back to that. Now this shows you a different look at void fraction; in this case it's steam quality. The terms are similar. On the left you see the analysis that shows steam quality and the red and pink is very severe numbers, relates to high void fractions. This is a cross section of the steam generators. And on the right side I show you the analysis at 70% power. You see the blues and greens which are much lower steam quality values and they correlate with the reduction in void fraction. I just used the plot for steam quality in this case.

If I look at the next slide, I've talked about velocity and void fraction or steam quality is important. This is a look at velocity. Again at 100% these are the velocities that occur and you can see the red and pink which are the severe numbers of high velocities. The reduction of 70% significantly reduces the velocity. And again, in part significantly less energy into the tube.

>> SPEAKER: Tom, can you just describe how those graphs were created? What model was used?

>> TOM TOMISANO: ATHOS. So the thermal hydraulic model out of ATHOS which we are using currently which we had run by multiple vendors to ensure the results correlate, that's based on today's ATHOS calculation -

>> SPEAKER: Okay, thank you.

>> TOM TOMISANO: -- for steam quality and for velocity. So now to come back to Mr. Werner's question about, you know, how does this compare? I think essentially that was the heart of the question. At 100% power the SONGS, Unit 3 replacement steam generators and Unit 2, it's the same data for thermal hydraulics certainly from a void fraction standpoint, operated in a range with the 99, 99.5% higher than other steam generator had typically operated it. There had been some in the higher void fraction ranges as Pete said, but none as high, that we're aware of, as 99.5%. So clearly when this design was developed and upsized, it wound up with a void fraction and velocities higher than had been successfully experienced before; partly because of the under prediction of fifth three, it was not recognized, that lack of margin it created. And that is essentially part of what drove the damage in the unit 3's steam generators coupled with the support structure inadequacies.

A reduction of 70% power brings the thermal hydraulics, the void fractions or steam qualities back within the range that other large U tube steam generators had operated with successfully. And we've benchmarked that with other plants through the Electric Power Research Institute.

>> SPEAKER: So what is that value you're looking for, for the other large steam generators for other units as far as void fraction?

>> TOM TOMISANO: I think we've seen numbers around 95% for maximum void fraction.

>> SPEAKER: Yeah the 90-95% range and we've got the specifics in the Confirmatory Action Letter response but roughly in that, you know, other combustion engineering designed or modeled pressurized water reactors, those steam generators operate in that 92, 94%.

>> SPEAKER: We're talking about local maximum void fraction?

>> SPEAKER: That's correct.

>> TOM TOMISANO: This is a very localized phenomena, it is not an average void fraction. It's a localized maximum void fraction, which is your most severe condition. As Pete said, in the Confirmatory Action Letter response we've got what's called a spider diagram that shows you at 100% power how operating thermal hydraulic perimeters compared to several other plants and shows you the reduction of 70% brings us back in with the envelope of successful operating experience. And I could take you through the CAL response to show you specifically where that is. And that is thoroughly described.

>> SPEAKER: Mr. Tomisano, one other question. Earlier when you talk about the causes you indicate that both the high void fraction as well as the high velocities, what I'm seeing that you're focusing on is primarily the void fractions, is that the main contributor to FEI? Or do you have to have both? Can you explain the relationship --?

>> TOM TOMISANO: Well we're focusing on both the velocity and void fraction. They're both important. Again, velocity is what excites or puts the energy into the tube. Void fraction is what effects the damping, both by the fluid itself and by the interaction with the fluid and the anti vibration bar. So velocity is important to how much energy you put into the tube and void fraction is important to how much damping the tube experiences.

So I've talked about void fraction a couple times because it's related to adverse thermal hydraulics but effects the effectiveness of the support structure. So basically think, adverse thermal hydraulics in effective support structure by reducing power I reduce velocity and I reduce void fraction; both are important. Without putting the equations up, velocity itself relates to hydrodynamic pressure and in that calculation, velocity is mathematically squared. So velocity has a very dominant effect on the calculation of tube instability. So the bottom line here, they're both important, they both have to be dealt with. And the 70% power reduction deals with that.

>> SPEAKER: And when you did the comparisons to other plants in the conditions that were operating successfully, your comparisons are for both the velocities and the void fractions?

>> TOM TOMISANO: Yes we did. And again, that's fully described in the CAL response itself.

>>SPEAKER: Okay. Just so we're clear, so the under prediction of the velocity by fifth three was not recognized, the problem with the model when it was changed from square pitch to triangular pitch a number of years ago. But the void fraction even under fifth three while not predicting 99.6% was predicting 95% which was still high and was a matter of concern –

>> TOM TOMISANO: Correct.

>> SPEAKER: -- back in the 2005 timeframe. I know that's still being looked at but that was a matter of concern and a number of feasibility studies were conducted to try to lower that void fraction before the steam generators were fabricated, but apparently it was not. So we'll need to understand that better as we go forward.

>> TOM TOMISANO: And we have as well. We have asked MHI for a better explanation of that as well and we are looking into that ourselves because as you say the void fraction was high. It was not predicted as high as 99.5%, it was high, it was questioned. Ultimately the calculations and the operating experience showed even with that void fraction the system should have been effected and it was not. So clearly that's a failure. There are several reasons for that failure that have to be dealt with.

Okay. Operational assessments: So we go through to how the tubes are moving, why they're vibrating the fluid elastic instability, the role of the thermal hydraulics, the role of the damping and the role of support structure. We're going to talk about corrective actions in a minute. But from a steam generator program as we get ready to return a steam generator to service after any outage with any inspection we have to do an operational assessment. Early on tonight I talked about the backwards look, the condition monitoring look to say, did the tubes meet their criteria? Before we restart the plant, we now got to look forward and say, will their tubes meet the criteria with what I've learned about any wear phenomena or corrosion phenomena, as I get ready for the next operating period?

So that's the operational assessment. Typically you do one operational assessment. And there's some standard methodology, there's a couple choices on methodology under the EPRI steam generator program. So as we looked at this, we decided number one, the typical uproot program would suffice for the normal random wear we saw. It would not suffice for the tube to tube wear. The tube to tube wear was a new phenomena. There was really no specific experience with it, with this fluid elastic instability with in-plane vibration so we simply couldn't do a typical operational assessment. So we really did three different assessments using diverse methods. Okay? And I'm going to start, you know, from the simple one. We did a traditional operational assessment treating tube to tube wear as a predictable phenomena. My third bullet summarizes a result. So we did that. We said that is not sufficient for us. It doesn't give us adequate assurance, doesn't give us sufficient margin in our minds. So we commissioned Westinghouse to come in entirely independently, no recent history with MHI or our steam generators and do an operational assessment with their methodology. And they have a lot of experience successfully designing, building, and maintaining steam generators

The third piece which is probably the most significant and most unique piece, we commissioned AREVA to do an operational assessment. There were two parts to their conclusion.

>> SPEAKER: Hey Tom, I'm sorry to interrupt, I just want to make sure it's clear what a traditional operational assessment is. You do

commission monitoring, you see what wear is on all the tubes and then you say for this type of wear mechanism which we know and we can predict the wear rate –

>> TOM TOMISANO: Correct.

>> SPEAKER: -- each of these tubes worn so much they can last so long before you exceed a criteria, right?

>> TOM TOMISANO: Thank you. That is correct. Say a traditional operational assessment would have a normal wear phenomena, a predictable wear rate that I can say over the next 22 months if it continues no tubes would wear to an acceptable level and challenge steam generator tubes integrity. That's based not only by the plant's experience but a database of industry experience.

>> SPEAKER: So that's a typical operational setting you would normally perform?

>> TOM TOMISANO: Which we did. But we recognized the tube to tube wear really did not have any operating experience and was a new phenomena and couldn't be simply predicted in the traditional way. Which is why we commissioned three different approaches through an operational assessment. With AREVA we took two approaches. We did a very sophisticated approach and Mr. Howell, this gets to this whole discussion of contact force and gaps betweens tubes and anti vibration bars, recognizing that the support structure is an important part of damping and restraining the tubes. So we've spent an extensive amount of time with our eddy current data and further testing identifying contact points between tubes and anti vibration bars in Unit 2. Statistically calculating contact forces across ten thousand tubes and all the anti vibration bars, 12 contact points on each tube from anti vibration bars and then determining based on the measured data in Unit 2 a statistical analysis of contact force and we then applied that to say, you know, out of 12 contact points if four are effectively in contact, it sufficiently dampens and restrains the tube. And that is fully described in the CAL response in quite a bit of detail. So that's one approach. And that approach, we set a stability ratio target of .75. Not 1.0 but .75. We did that specifically to make sure we critically and conservatively modeled that steam generator tube bundle and the contact force and the effectiveness of the support structure and had margin to fluid elastic instability occurring.

>> SPEAKER: So I read the 60 page summary and of course it makes reference to the [indistinguishable word] I haven't gotten through all those but I will. This also represents new work, is that correct?

>> TOM TOMISANO: This represents new work which again this is unique. This represents and new body of work, which again is one reason we did three diverse methods. We recognize this is a significant new body of work, a new approach to this issue and we know this is something your staff will take some time to understand and we are prepared to bring in not only our team but AREVA and MHI to explain the results here. We also challenged this critically. Pete and I both eluded to these experts we've brought in. We set up what we call expert panels. We had multiple challenges all along the way starting with the concept, starting with the phenomena and why, starting with the approach

analytically to model this and determine what is acceptable. So we use this panel including Dr. Michelle Pettigrew, who did all the research on the phenomena, to help us ensure that her analysis was an appropriate way to model this and deal with this.

>> SPEAKER: That would suggest to me, not knowing all the details at this point, that there's still a reliance on contact at least to some degree between the ABB's and the tubes so that the natural frequency of the tubes in the in-plane direction is improved.

>> TOM TOMISANO: That is true. The operational assessment with a .75 stability ratio limit relies on some contact and contact force between anti vibration bars and tubes. And again that's fully described as you talked in the 60 page summary and all the supporting documents. The other thing we had AREVA do as we learned more about the stability ratio calculations, we said if we had no supports effected, none of the anti vibration bars had any damping contribution, what would the stability ratios be? And for Unit 2 at 70% power the stability ratio's in that worse case assumption are less than one.

>> SPEAKER: So they actually did two assessments?

>> TOM TOMISANO: AREVA did two assessments effectively. We weren't satisfied with the stability ratio one which is why we continued on with the more sophisticated detailed analysis showing a stability ratio of .75.

>> SPEAKER: Okay so was it like barely less than one or...?

>> TOM TOMISANO: I'd have to check on the highest value. Again that's documented in our CAL response. It seems to me to be in the .88 range but I'd have to look that up specifically. This is all thoroughly documented and described and discussed in the CAL response. And we'll be glad to get into much more detail with that.

>> SPEAKER: And I think it's important to point out, we've been talking about stability ratios. First off, what's stability ratio? We've talked about stability ratios of 1.0. We've talked about stability ratios of .75. Stability ratio is a ratio of the velocity. The critical velocity is the denominator and then the model or calculated velocity in the numerator. So calculated over critical. Setting a criteria that we would only operate the plant in the condition of a .75 ratio stability actually puts in 25% ratio safety margin into your conclusion or your calculation. So that's the difference between a 1.0 stability calculation and a .75. Traditionally steam generators are designed originally coming out of the factory where you won't see tubes in conditions at greater than .75 stability ratio. We do know through industry practice and industry knowledge that as tube wear occurs, right, that those stability ratios can move up slightly, right? So that's why we took a look at the 1.0 stability ratio. So some of that is influenced by the contact force and other issues associated with the steam generator. So I just wanted to point out more for the audience specifically, we go kind of fast and loose here on .75 and versus 1.0 and stability ratio. Wanted to make sure people understood what we were talking about.

>> TOM TOMISANO: Thank you.

>> SPEAKER: Just so I'm clear but that's the whole purpose of calculating that stability ratio is to feed into the down stream models to calculate whether or not you have FEI in the out-of-plane direction. So does the AREVA work, the new work also have new work that calculates a methodology for in-plane vibration determination?

>> TOM TOMISANO: The stability ratio's calculated for the restart of Unit 2 model in-plane vibration, not just out-of-plane vibration. So by modifying the equation with the appropriate damping factors we're analyzing against in-plane vibration. Again one of the big lessons out of this, the old paradigm, and this truly is a paradigm shift in the opinion of the industry, the paradigm that if you had adequate margin for out-of-plane vibration, we were okay with in-plane. We analyzed again stability ratios for in-plane vibration because that is the underlying phenomena that occurs –

>> SPEAKER: Does the OA go into how this methodology based on the testing that was done, how that was qualified and you said an expert panel I guess was involved and --

>> TOM TOMISANO: Yeah the OA describes both the methodology and how that methodology was validated against measurements in the field.

>> SPEAKER: We had the Electrical Power Research Institute and their thermal hydraulic experts as well as contracted thermal hydraulic experts through the Electrical Power Research Institute come in to challenge those operational assessments and their conclusions as well.

>> TOM TOMISANO: And these companies who did the diverse methods challenged each other's work. So we had quite a bit of -- fundamentally that methodology is thoroughly described including how well it was validated.

>> SPEAKER: This may be over simplifying this but I think if I understand correctly, to clarify, you had four different operational, essentially four different operational assessments. One of them you called the traditional. The wear rates that you used though although you're seeing this traditional, it's the wear rates on Unit 3 that you used rather than what you had in Unit 2.

>> TOM TOMISANO: Correct. We took the severe case which is Unit 3 which had significant wear after 11 months and developed a wear rate correlation and applied that to Unit 2 traditional operational assessment.

>> SPEAKER: The other operational assessments, can you explain, did they use the conditions that you believe were in Unit 3 or in Unit 2 --

>> TOM TOMISANO: All the operational assessments took Unit 3 data to either develop the operational assessment methodology or to validate it. So it is all based on the Unit 3 experience and we factored that in and the vendors factored that into their analysis of Unit 2. We felt the appropriate conservative thing to do, again Unit 2 being susceptible, clearly a difference because of the support structure

effectiveness but taking the worse case based on that data out of Unit 3 and modeling Unit 2 based on that data.

>>SPEAKER: Was the support structure though in those assessments, was that the Unit 2 support structure modeled or the Unit 3?

>> TOM TOMISANO: The Unit 2 support structure. So again taking the Unit 3 data for wear and how fast it occurred and everything else we occurred from Unit 3, when we do the operational assessment, we did many measurements in Unit 2 to characterize the support structure in terms of what the gaps are between tubes and supports, whether they're in contact, evidence of contact force and developed a sophisticated statistical model to spread that over 10,000 tubes per steam generator and 12 contact points. So the Unit 2 support structure and tubes are actually modeled in the AREVA probabilistic assessment. The Unit 3 data is used in all the operational assessments in terms of wear rates.

>> SPEAKER: Thank you.

>> SPEAKER: Just one, maybe not final but another line of questioning in this regard. So all this work, I mean, was this principally relied upon to demonstrate the acceptability of the AREVA work at operating at 70% power? I mean, I know it’s a compilation of the other two but principally...?

>> TOM TOMISANO: Principally the AREVA work. Two aspect to AREVA. One with a stability ratio of .75 and one with a stability ratio of 1.0 coupled with the 70% power.

>> SPEAKER: So given that, I mean, do you consider that a design change?

[Inaudible]

[LAUGHTER]

>> SPEAKER: Well I think if you think about the principle of that operational assessment, principle of an operational assessment is to take known conditions either at your plant or at other plants, you know, at other similarly designed and operating steam generators and apply the wear rates seen in those steam generators to your conditions and predict the future; predict your operating period. So it's not a design change, the operational assessment process is intended as the steam generator management program has developed through electric Power Research Institute with NRC's involvement and endorsement, is that it is the forward looking probabilistic evaluation of what is the maximum safe operating period based solely on steam generator wear? So in essence it is a prediction, right? A prediction of what's going to occur in the next operating period. So interestingly enough, and as we approach this as Tom mentioned, the AREVA work is the backbone operational assessment. But then we said, what if we're wrong? What if fluid elastic instability in plane begins in Unit 2 on day one of operation at the same rates it's been occurring on Unit 3? How long can the unit operation before a tube integrity issue becomes a concern? That was the approach that we had a company by the name of Aptech take. The conclusions from that probabilistic evaluation, which again is very much in line with conventional operation approaches is that, what we

mentioned in the last bullet on the slide that's up on the page is that these operational assessment predictions all showed safe operating periods in the 16 to 18 month range. Now when we applied the additional 25% conservatives' of the .75 stability ratio it brought that predicted, accepted timeframe down into the eight month period recognizing that there's still 25% safety margin in that conclusion. Using the operational assessments is what plants in the industry have traditionally used for their proposed operating periods following the discovery of a condition or situation under steam generators. That is the basis of the Nuclear US Industry Association steam generator management program.

Many plants in the past in finding new situations or new occurrences under steam generators as the NRC and these gentlemen have been aware used the operational assessment process to predict safe operating periods. And then you go back into another period of inspection, the intention is to confirm the predictions of your operational assessments. In our cases, not trying to steel some of Tom's thunder here, but the last two bullets on this slide talk about that those operational assessment techniques predicted safe operating periods with conservatisms and margin in them in the 16 to 18 month time period. Our proposed operating time period is five months. So roughly three times or a third of what the safe predicted operating period is. Then we'll go back in and conduct a whole other round of inspections to validate and confirm our conclusions and confirm the information that our operational assessments have predicted.

>> SPEAKER: Thank you for that and I understand that point of view. I guess another point of view and I'm not saying this is the agency view, is that, you know, the anti vibration bars were specifically designed to prevent FEI in the out-of-plane direction. Under the AREVA work from one point of view is now being used to prevent FEI in the in-plane and out-of-plane direction which is a new design function some would argue. So the question then becomes how is that treated under your design processes? And how does that apply to the applicable NRC regulations that govern design?

>> TOM TOMISANO: I understand the line of thinking and as you said that's not necessarily agency position but the anti vibration bars are designed to prevent excessive vibration out-of-plane, FEI and at least by experience, also suffice to prevent in-plane efforts in the past.

>> SPEAKER: Right I get that --

>> TOM TOMISANO: So that's not in that sense a change in design function.

>> SPEAKER: That's something I'll have to look at.

>> TOM TOMISANO: We understand that. And we look forward to having that dialogue. As Pete has summarized the operational assessments conclude at 70% power and acceptable operating period of 16 to 18 months prior to the next inspection even with the very conservative .75 stability ratio and there's more margin beyond the 25% that, that implies minimum of an eight month period prior to the next inspection. Our proposed corrective actions operate for only five months prior to

shutting down and conducting an inspection as Pete said to confirm the effectiveness of our actions.

>> SPEAKER: Tom, and just to belabor this a little bit more. You did four operational assessments. One was traditional and the other one was used in some statistical analysis, some different assumptions; can you just describe in layman's terms the operational assessment that you actually use, what you compiled together, kind of the assumptions, you know, the basis of that?

>> TOM TOMISANO: Fundamentally again its all thoroughly described in the CAL submittal, we'll be glad to get in to it deeper. Fundamentally, as we've said the backbone is the AREVA work. And the AREVA work had two aspects. One was an assessment of stability ratios crediting no support. Assuming the support structure is not effective at damping with a stability ratio of 1.0 which demonstrated at 70% we would have an operating period prior to the next inspection of 16 to 18 months. Stability ratio calculation is based on the thermal hydraulics principally. Okay?

>> SPEAKER: It's saying you could operate for a period of time without FEI occurring? Is that the assumption?

>> TOM TOMISANO: Without FEI occurring, not crediting the anti vibration bars for any damping. Then the more sophisticated one, more conservative with .75 stability ratio credited the anti vibration bars, used that sophisticated statistical analysis based on measured data out of Unit 2 and measured data of Unit 3 to develop a model over the 10,000 tubes and the 12 contact points per tube, that develop a statistic model of the contact points and contact force and apply that to the FEI calculations crediting damping and showing where acceptable under a .75 ratio which is conservative for at least an eight month period before the next one.

>> SPEAKER: Just a significant difference from a traditional operational assessment where you would assume a wear rate and the tube would not exceed structural integrity requirements for a certain period. This operational assessment is saying we can operate at long as we do not get the phenomena to occur? In other words the unpredictable --

>> TOM TOMISANO: That's a good point. Typically your criteria in an operational assessment is to assure you maintain steam generator integrity and assuming some sort of wear or corrosion phenomena would continue. In frequently treating that statistically, sometimes deterministically. Okay? In this case we set an even more conservative trigger, you know in the AREVA work. The assumption is not that FEI occurs and it's okay for 16 to 18 months or eight months. There's a 95% probability that FEI will simply not occur. That, that's the difference in the criteria I believe you're eluding to. And again that's fully described in the CAL response. And again we're looking forward to getting into more depth of that with the staff in subsequent meetings.

Let me summarize the actions. I've talked quite a bit through the evening about this, fundamentally power reduction is 70%. It significantly reduced fluid velocities, that's less energy causing the

tubes to vibrate. It significantly reduces the void fraction or steam quality which leads to better damping in the support structure. And that power reduction keeps us out of a thermal hydraulic regimen or fluid elastic instability will occur.

Secondly, preventive plugging of tubes: this gets to some of the earlier questions. We looked at Unit 3 where the tube damage occurred, we look at the thermal hydraulic calculations and we said there are X number of tubes that are susceptible at 100% power. We elected to be conservative and add even more margin and plug all those tubes. Even though at 70% I could realistically show they're not susceptible, we'd plug those tubes. And that is fully described in the Confirmatory Action Letter response. Furthermore, we're proposing a five month operating window prior to the next shut down and inspection. Significantly shorter than our analysis would support. We feel that's an appropriate conservative decision based on adequate safety margin and we'll do 100% tube inspection, repeat all the work we've done during that mid-cycle outage. So to summarize as you think about this, the power reduction takes us out of the regime where fluid elastic instability would occur, with significant margin. The preventive plugging of tubes adds even more margin that I took tubes that would be susceptible at 100%, I took those out of service. And thirdly a relatively short operating window, virtually a third of what could be justified by analysis.

>> SPEAKER: I just want one clarification, I just want to make sure, there's something that Ryan said that given that -- I'm not sure if I heard it all correctly. You're saying this power reduction is preventing fluid elastic instability, I thought I had heard before that there was a time period basically that it would prevent fluid elastic instability for a certain time period from occurring, is it always prevented at 70%, is that what you're saying? Or is it prevented for the time period that you're proposing?

>> TOM TOMISANO: In one of the calculations the statistical approach we used for AREVA, when we set the conservative .75 stability ratio, the criteria we set was not tube wear and tube integrity, it was much more conservative. We said no more than a 5% chance of FEI occurring. So the analysis shows that for up to an eight month period at 70% power FEI would not occur. Now with further work and further analysis we're confident we can extend that. This is a very conservative look at this. A very conservative analysis which quite frankly is appropriate given the uniqueness of this phenomena and the first time occurrence of it. Does that answer your question?

>> SPEAKER: I think so. So the probability of FEI occurring, it's not going to occur within the eight month period is what you're saying?

>> TOM TOMISANO: That is correct.

>> SPEAKER: But it could occur after that time period?

>> TOM TOMISANO: From a very conservative standpoint what we assumed was at the start of the operating period, the support structure we analyze with the statistical analysis provides certain support, certain damping. Just through normal wear we're assuming some of those supports could become ineffective over an operating period. So we

treated that statistically to say, at what point potentially would enough supports become ineffective due to normal wear that would get us too close to a margin issue with fluid elastic instability? And we cap the operating period based on it.

>> SPEAKER: So the fluid velocities and the void fractions would stay the same?

>> TOM TOMISANO: Correct.

>> SPEAKER: That wouldn't change regardless of how long you were operating. It's just the support structure that's wearing and allowing the tubes to start to move.

>> TOM TOMISANO: Wearing and becoming say less effective in providing dampening. And that was a very conservative assumption but we felt that was very appropriate.

>> SPEAKER: All right, thank you.

>> TOM TOMISANO: To summarize some additional Confirmatory Action Letter response actions: Our operators responded well to the leak. We looked at our ability to detect even more minor leakage given the significance of this and we've approved our ability to detect minor primary to secondary leakage. We've established more restrictive limits than had existed previously. And again we wrapped the plant down and took the plant off very quickly. We now have more restrictive limits in place. We've enhanced the radiation monitors even further on the secondary system. And we've upgraded the vibration monitoring instrumentation around the outside of the steam generators to allow us to gather more data as we get ready to return to more service at 70% power to further better understand the condition of the steam generators.

>> SPEAKER: I've got a couple questions on this slide. Could you kind of compare and contrast your detection capability between previously and now as far as the difference, the delta?

>> TOM TOMISANO: Doug, would you like to step in?

>> DOUG BROADDUS: I sure will. When the leak occurred in Unit 3 on January 31st, the maximum leakage was about 80 gallons per day. Our systems alarmed at 30 gallons per day and as Tom indicated we safely shut down Unit 3, did a rapid down power. The operators responded properly and the systems responded properly. We have implemented several different methods to improve our leakage detection capability. Without getting too technical, one method is we're using, lets call it N16, nitrogen 16 monitors on the main streamline headers. Those monitors have a lower threshold of about 5 gallons per day. We've also improved our system response by injecting an inert gas called argone 40. Argone 40 in the reactor coolant system becomes argone 41 over time and that, if you have a leak using your off-gas system from the argone 41 is more easily detected by the system and so your detectors become more sensitive and we calibrate to that. Using the improved sensitivity we've been able to go back and look at our operating response and our procedures and improve those procedures such that right now if we have a leak and it's a sustained leak of 5 gallons per

day, at the lower threshold, we will perform a normal shut down. And so we've made those changes to improve our sensitivity. We've changed and improved the procedures and we've also, you know, tested and run those procedures on our simulator with all of our operating crews.

>> SPEAKER: So the procedures haven't changed so 5 gallons per day would be shut down verses like a [indistinguishable word] which would be a temporary?

>> DOUG BROADDUS: That's correct. It's called an abnormal operating procedure, AOI as our operators call it. That procedure has been changed for the 5 gallons per day lower threshold and the operators have been trained on it.

>> SPEAKER: All right, thank you.

>> SPEAKER: And then for the tube bundle detection you talk about your additional censor. The question I have here is how has that detector especially in the upper bundle been verified or show that it could potentially pick up --

>> TOM TOMISANO: What you're talking about, the additional vibration monitoring we put at the tube sheet and up near the top tube support plate to better collect data related with what vibration might be going on inside the steam generator. As you're probably aware the censored are monitored on the shell of the steam generator. To test those and calibrate those with the plant shut down, we open the steam generator and use a calibrated impact hammer to see if a certain impact occurring between, on a tube support plate, is transmitted to the [indistinguishable word] pick up and detected. And that's how we tested and calibrated that to give us some better indication of what is occurring inside the steam generator.

>> SPEAKER: All right, thank you.

>> TOM TOMISANO: Thank you.

>> SPEAKER: Tom, just one more question. You know, a couple of components left in place, you've got, you're going to have vibration monitors and the enhanced radiation monitoring system, so some components. If those components become, you know, they need maintenance, they break, what kind of commitments have you made to repair those in a certain amount of time, you know, treating them like any other piece of equipment that's covered in your tech specs or --?

>> TOM TOMISANO: You know they're not tech specs –

>> SPEAKER: Correct, that's why I asked the question.

>> TOM TOMISANO: The key issue here in detecting leakage is well covered. The additional vibration monitor, we treat it as a high priority piece of critical equipment and repair it in a timely manner.

>> SPEAKER: The vibration monitor system has actually four censors, two different channels and two different locations. Tom indicated the ping testing that we did. So there's a redundant censor on each of the two main channels and although those are in the containment, the

censors during all operation, at the first opportunity we would have, our procedures would require getting after and fixing the redundant censor that had come out of service for whatever reason. Now we know that during this first run on Unit 2 using the vibration probes, we intend to collect data, we know that there's background vibration associated with operating the steam generator so we understand that the primary goal during the first run here is to collect data and understand what those background noise levels are. And then in the future when we see an anomaly we'll understand that and be able to compare it against background data. The radiation monitor system detectors are worked on based on operational priorities. They are not technical specification detectors. There's other back up redundant systems like drawing liquid samples from the steam generators that we can do if we lose a channel. However there's a high operational priority based on restoring those to service and before we enter any sort of power operation on Unit 2 we will ensure that all of the radiation monitoring channels are in service.

>> TOM TOMISANO: Yeah.

>> SPEAKER: Is that described in the CAL response also? The reliability of the this additional equipment and how it will be maintained and all that, I don't know if that's in the CAL response or not?

>> SPEAKER: I don't think how the equipment maintained is in the CAL response. We have other procedures and operational priorities for doing that including adding items to our operational focus list. It is driven every day out of the plant department. But we'll definitely take a look at that.

>> SPEAKER: Thank you.

>> TOM TOMISANO: Thank you. Okay, conclusions --

>> SPEAKER: I just had one follow up question so I understand. So for the new vibration censors, you really don't have any operational limits associated with the just data collection and then you'll go back and make that during the next operating cycle?

>> TOM TOMISANO: At this point it's data collection as Doug has described.

>> SPEAKER: Thank you.

>> TOM TOMISANO: Conclusions: First of all, in accordance with the requirements we committed to in the Confirmatory Action Letter, we have performed a thorough investigation to determine the causes of the tube to tube wear that occurred in Unit 3 We've determined again in conformance with the Confirmatory Action Letter, the corrective actions to prevent loss of tube integrity in Unit 2. We've implemented those actions and those are fully described in the Confirmatory Action Letter response. The corrective actions we've taken and summarized tonight are conservative and there is considerable safety margin there. We've met the requirements for the Confirmatory Action Letter and the bottom line as stated in the beginning of the meeting, we've taken a very deliberate conservative approach to the restart of Unit 2 to assure

public health and safety. We recognize the significance of the phenomena in Unit 3, the potential susceptibility of Unit 2 and have been very deliberate and conservative in our approach to the restart of the Unit 2. And again that is well described and we are looking forward to further dialogue with the staff to explain the basis for that.

>> SPEAKER: I just had one question, Tom. We're going to talk about path forward, next steps in terms of our reviews and future inspections in a few moments and so some of this issue obviously will be inspected but were any of these actions that were taken [indistinguishable word] -

>> TOM TOMISANO: We've evaluated all this under 10C, 5059 and it has been done in conformance of NRC requirements.

>> SPEAKER: Thank you.

>> SPEAKER: Thank you. Let me turn it back over to Pete.

>> PETE DIETRICH: Yeah, thank you , Tom. I know we've gone through a very specific and deliberate technical discussion here and we've talked about a number of things. I'll just bring it back to Southern California Edison's commitment and that is we take the safety of the public as well as our employees very, very seriously. And we feel that the technical level in which we've gone to over the last eight months to fully understand the situation that we have and apply the appropriate and best levels of conservatism and safety margin to our conclusions is absolutely what is prudent. We've talked about the methodology for the decision making related to the technical evaluations and the technical challenge but I'll also share with you that from an executive decision making standpoint I mentioned at the beginning that this was a very significant decision for the company. And you know, reached the highest levels of the company including reviews with the board of directors. In the reviews that the executives had, we brought in additional challenge, personnel, people with specific experience from within the industry as well as some of the personnel from MPR who participated in that and asked them their conclusions on the same issues. So certainly viewed as a very significant decision within the company. And that aligns with our commitment which is protecting the health and safety of our employees and the public.

We recognize that this is a lot to take in on a Friday evening. I do want to share with folks if we can go to the next slide that, you know, once again all of our Confirmatory Action Letter information is up on our website. Also this presentation will go up on our website after this presentation tonight. On top of that, we have been conducting open house opportunities for members of the public to interface with the members of our steam generator team, with our employees, the folks who have been involved in this analysis. We've already conducted two open houses, one in Vista back in October, one in San Clemente here a few nights ago, and we do have one more plan this year in Laguna Hills. And as we go into the first of the year we will be conducting additional open houses and we'll make sure that information is available to the public. We view that transparency and availability of our employees and our information to be very, very important and we

recognize the importance in ensuring that, that information is available to the public. So Mr. Howell we thank you for the opportunity to present this information tonight and we'll turn it back over to you.

>> ART HOWELL: Thank you, sir. We do have some additional remarks but given the time we thought we'd deviate a little bit from the schedule and our plan. We would propose that we go ahead and take our break now and close this part of the meeting and then we'll finish out with some closing remarks after the Q and A section.

>> SPEAKER: Actually, I apologize, I do have one final question.

[Inaudible]

>> SPEAKER: Please, we're still talking up here.

[Inaudible]

>> SPEAKER: That's right. And the purpose of this meeting is for these people to talk.

[Inaudible]

>> SPEAKER: Okay, we're going to take a break.

[Inaudible]

>> SPEAKER: I do have one final question here --

>> SPEAKER: We'll talk to you on the break, ma'am.

>> SPEAKER: You've described in your CAL response being to, you know, your plan for operation for the five month cycle, 70% power, I guess, can you address what your long term plan beyond that would be both for Unit 2 as well as Unit 3?

>> SPEAKER: Well, you know, we continue to conduct work using both our own staff as well as Mitsubishi and also the experts we have assigned. It's our intention to operate Unit 2 safely at 70% power to confirm the results of our analysis and conclusions and then continue to look forward to the future as far as what other operational opportunities or considerations need to be considered for Unit 2. We can see both longer periods of operation, you know, based upon a successful period of operation, which we fully anticipate. Longer periods of operation potentially at 70% power or with additional analysis and confirmation through our inspections, potentially raising the power output or proposing a raise in power output for Unit 2. We want to start with something that we know is safe, that we know has significant amounts of conservatism and safety margin in it and then we'll move forward as we continue to gain information. And you know Mr. Broaddus, that is how the industry has approached many elements associated with steam generator issues from the original detection of cracking to identifying some of the new phenomena and other things within steam generators. Did I answer your question?

>> SPEAKER: Yes, thank you.

>> SPEAKER: Okay, let's take a break. Its 8:30 now, lets come back --

[Inaudible]

>> SPEAKER: -- let's come back in ten minutes and then we're going to go for question and answer to all of you.

[Inaudible]

SPEAKER: So --

[Inaudible]

>> SPEAKER: Ten minutes.

>> SPEAKER: You don't have to leave the room if you don't want to.

[BREAK IN MEETING]

>> SPEAKER: Okay, if we could get everybody back we're going to resume. I'm going to walk through here and walk around there and walk up there and see who has questions but we're not going to be able to get -- Okay. Welcome back. We're going to deviate in a couple ways from our original plan. We do want to go out to you for some questions and we are going to extend the meeting from 9:00 to about 9:25 because we have to be out of the room and we do want you to hear Mr. Howell's closing remark about the path forward in terms of what the NRC is doing. So I'm going to go out to you for questions and circle through and get to all sections. I can tell you we're not going to be able to get to everybody at this point. You can fill out the comment forms, submit questions, submit comments to the NRC in writing about this. The primary purpose of these Category 1 meetings is so that there can be a frank exchange between the licensee and the NRC so that the NRC can evaluate what the licensee is proposing. But it's done in public for transparency purposes so you can see what's going on. Please keep the questions, we got to try to keep it to three minutes, okay? Keep it to steam generator issues. Everybody wants to get a chance to talk but if something has been said already that you want to say, you don't need to say it again. We're going to start here and we're going to go around and I see a lot of enthusiasm out there. We'll be back. Yes?

>> SPEAKER: And please introduce yourself.

>> SPEAKER: Hi, my name's Gary Headrick and I have a graph that I'd like everybody to be able to see, can I step up there?

>> SPEAKER: Gary, I think you need to put those in the back, we're not going to do the signs now, okay?

>> GARY HEADRICK: This just shows all the tubes that have been closed. The two red ones are the tubes that have been closed at San Onofre. The little lines that you can't see at the bottom, those are all the other steam generators in the United States with very few tubes plugged. So when they say Unit 2 is better than Unit 3 they're being honest with you, but it's not average, it's not normal, it's not what

we want them to restart just because its better than Unit 3. I've also --

[APPLAUSE]

>> GARY HEADRICK: I've also, I got into --

>> SPEAKER: Would you put those down because people are going to get poked in the eye. Just put it down.

>> GARY HEADRICK: I got into this inadvertently. We started a group to become a sustainable living type effort. We were approached by whistle blowers and just as recently as last night, I spoke to a whistle blower who also spoke to the Huffington Post and there's a big problem right now. There's sabotage going on and the FBI's been called in to investigate how safety equipment has been compromised. So here we have this sabotage and environment where there's damaged defective reactors. They want to start up at 70% and see what happens. And we're going through all this effort, these guys who are really qualified, I know they're putting a lot of effort to make sure that their theories are right because we've seen, not in theory but in reality, what can happen in Japan. And we're not willing to take that risk no matter how careful they are with their predictions and their theoretical hypotheses. It's just not worth it when there's so much going on. Even the union leaders are saying they would not support a restart of Unit 2 because it's the lack of support from the work force. There's so many things going on. I know I've used my three minutes but I appreciate you listening and there's lots more to be said.

[APPLAUSE]

>> SPEAKER: Thank you, Gary.

>> SPEAKER: Chip, I just want to comment. I just want to say that the NRC is well aware of an incident that the licensee is reviewing, has been reviewing for a number of weeks. It does involve a diesel generator. Their review is on going. They did make a report to us on November 27th and because our review is also ongoing it involves a security related incident we really don't have any further information to offer at this time.

>> SPEAKER: But Mr. Headrick, you talked about a meeting with a whistle blower so we'll be more than happy to meet with you after the meeting is over to talk about that further if you'd like to provide further information about the concerns that were relayed to you, sir.

>> SPEAKER: It's all in the Huffington Post.

>> SPEAKER: Okay, and if an opportunity you've heard from something Southern California Edison, NRC, you have an opportunity to ask questions also. Yes, sir? Please introduce yourself.

>> SPEAKER: Thank you very much. Hasan Ikhrata, I'm the executive director of Southern California Association of Government. This is planned organization for the six counties. We have 19 million people that we plan for; transportation, housing, energy, water. And when people talk about let us do this and do that, I think there is a very

significant implications of the [indistinguishable word]. I appreciate the presentation and I appreciate the questions; but I have no doubt that neither the NRC or Edison will open this plant unless its 100% safe. The question is if it's not safe then what? How are we going to bring the 20% generation into the mix if it's not that?

>> SPEAKER: You know we're going to treat that as comment because we really want to stick to the technical issues. I know these are important issues but we got to stick to technical on steam generator issues. Let's go over here to Gene.

>> SPEAKER: Gene Stone, Residents Organized for a Safe Environment, San Clemente. And I must say, I really enjoyed listening to all of you really qualified engineers talk about this at this level. But what I hear, what I heard here this evening was a bunch of engineers talking about how they can get this plant going because they all basically believe in nuclear power. But what worries me the most is the group think that I hear and see here tonight. You have unit number 3 which has extreme amount of problems. You have unit number 2 exhibiting the beginnings of the same types of problems and yet you're trying to ignore that by saying that it's different. And that if you restart you will find at some point in time even if you only start at 70% power, these same problems will occur in the same places that these beautiful charts and all this work that you've done to find out where the problems exist will continue. Because in your first two, in your examples of the two, in the two - what did you call it there at the bottom where the tubes were and there were clusters? Well that was still happening in your other photo of Unit 2; Unit 2 they were still in the same related place. So I think you will find overall that you're going to have the same problem. It's going to be a major mistake to put all them at risk. I understand, I believe every worker at the plant wants safety obviously, except for the person that did the sabotage. But you said Edison is going to stand behind and be responsible. But you're not going to be responsible for an accident because you're not going to be able to afford a trillion dollars in damage to Southern California economy. So it's nice to say that you're going to be responsible but how are you going to be responsible? You're not required by law to be responsible. So --

[APPLAUSE]

>> SPEAKER: Let's see if I, I don't know if anybody on the panel want to say anything on that, Pete?

>> SPEAKER: Mr. Stone, I appreciate your point of view, I appreciate the discussion. You had mentioned that we're ignoring the condition on Unit 3, I would offer up that in fact we're doing exactly the opposite. We're assuming on a unit where we didn't see any problems after 21 months of operation at full power we are assuming that the same thing happened on Unit 3 will happen on Unit 2. So we are not ignoring, we are in fact applying the lessons learned and the information from Unit 3 directly over to Unit 2 and that's why we are only requesting based on safety and an abundance of caution that we operate the unit at 70% power even though it operated successfully for 21 months at 100% power. Our proposal is to operate the unit for five months at 70% power and then go in again and confirm all of the information that we have concluded. So for a unit that is not seeing the same type of damage

and wear as Unit 3 we are applying that criteria. I feel that, that's prudent. I feel that, that is firmly bounded in safety and conservatism.

>> SPEAKER: Okay, thank you. We're going to go to four people here --

[APPLAUSE]

>> SPEAKER: -- and then we're going to go back over there. Okay. Yes, Question?

>> SPEAKER: I'm Vicky Medina with Antelope Valley Board of Trade and I do have a question. The Antelope Valley as you may know is north LA County south Kern where we're actually growing solar and wind farms.

[APPLAUSE]

>> VICKI MEDINA: But my question actually is, does the NRC have the right expertise and resources to assess the safety of the Unit 2 restart the plan?

>> SPEAKER: Great question. And Art ...?

>> ART HOWELL: Yes. I think absolutely do, what you were going to hear me say during opening remarks is that we still have a lot of work to do that includes performing a technical evaluation reviewed by our headquarters' experts; one of them is here tonight sitting in the audience. And we also have submitted pit inspection work to do that will be led by Mr. Werner. It will take a lot of resources as you've heard, you've gotten a sense for tonight, we have significant questions. We need to delve into their submittal. It is voluminous, technically complex, and as you heard some of it represents new work that's going to have to be reviewed by us and perhaps other experts as well that will help us. But we have applied the appropriate resources. It will take whatever time it takes to make a judgment about safety but that's what we intend to do.

>> SPEAKER: And just to add to that Art, if we don't have the recourses that we think we need we hire contractors, we hire experts and we're doing that. Greg's already got contracts with two individuals right now who are helping out in the inspections.

>> SPEAKER: Currently we have one individual whose academia who has expertise in vibration and thermal dynamics as well as an individual who retired from a vendor who has 30 plus years of design and manufacturing experience we're bringing him to help us on our assessment.

>> SPEAKER: Thank you very much. Yes, sir?

>> SPEAKER: Gabriel Buelna, Executive Director of Plaza Community Services in Los Angeles and the non profit network represent over 1,200 Non profits. In terms of the process review being focus and expeditious, if SONGS is not allowed to reopen, the concern is, will other plants be forced to come online forcing transmission lines and potentially removing properties through out Southern California for those plants because of SONGS not coming online? In your review

process we'd be moving forward swiftly in order to not have to bring other plants online.

>> SPEAKER: I think we can address the behavior review process issue part of that. Art? Or Ryan?

>> SPEAKER: In terms of the review process, it's already begun. So the goal is to apply the right resources with the right focus and priorities such that the technical review and head quarters can be done in conjunction and alignment with the independent inspection work. We're well along the way in conducting those reviews and inspection activities and as a result of that we believe some time in the mid to late February time frame we will at least be able to provide a status of where we are with the evaluation report being conducted in headquarters and also the status of the inspection to date.

>> SPEAKER: Okay we're going to go, yes ma'am?

>> SPEAKER: My name is Libbe HaLevy , I'm the producer in house of Nuclear Hotseat podcast and I was one mile from the nuclear reactor in Three Mile Island when it malfunctioned. So I know what it means when the experts get it wrong. Gentlemen, there are others here who can speak more specifically to the steam generator problem. What I'm concerned about is that Southern California Edison and the Nuclear Regulatory Commission have been dealing with each other for decades, since the beginning. The question being, with this kind of a closed group, where is the place for the public and our experts to have direct interface on the subjects that are up here for discussion who can speak with much more specificity than any of the rest of us? So we had asked repeatedly for an adjudicatory evidentiary hearing which simply means that we should have a legal environment, under oath, where our experts and your experts can duke it out with each other for webstream, for streaming video, put it online, so that the world can see; so that we can put San Onofre on trial. If you say what is true, gentlemen, and I really do hope it is, that San Onofre is absolutely and completely and perfectly safe and nuclear is safe, what do you have to hide from such a hearing?

[APPLAUSE]

>> SPEAKER: Okay, thank you. As many of you may know the commission, it's already directed the Atomic Safety and Licensing Board to look at the issue of an adjudicatory hearing.

>> SPEAKER: Good evening. My name is Bill Craycraft, I used to be the mayor of the largest city here in south county and I have a question for you. It's my understanding the CAL report has been in the NRC's possession for maybe a month since sometime in October. Have you four gentlemen or your colleagues at the NRC had an opportunity to begin to review that CAL report and what it has? A lot of the questions asked tonight seem to be maybe possibly covered in that CAL report.

>> SPEAKER: Yes, thank you for your question. Yes in fact we have begun to review. We did in fact receive it back on October the 3rd. You heard tonight through this meeting that we ask a number of questions, technical questions that we'll seek to follow up on but as a result of the preliminary reviews of the report by the office of

nuclear reactor regulation which is in our headquarters office, they have prepared a number of questions for the licensee that will be submitted in writing and on a docket.

>> SPEAKER: Okay. We're going to go to these two women and then I'm going to go back over to all of you over there. Yes?

>> SPEAKER: I'm Dr. Marilyn Ditty, executive director for large senior citizen programs here in about 17 cities. You know, we've been working with San Onofre for probably about 30 years and I really respect the work that they have been able to do. I also look at the research that has been done. And our seniors are very concerned about the rates. They're very concerned about the reliability. We have more seniors now on medical equipment that are very reliant, they're relying on electricity. So I hope this can proceed in a timely manner. We respect the work you're doing.

>> SPEAKER: Thank you very much.

[APPLAUSE]

>>SPEAKER: Good evening. My name is Vicki Fetterman and I'm the executive director of the Regional South Orange County Chamber of Commerce and Economic Coalition. We serve more than 400 members and have approximately 30,000 employees through out the south Orange County region and foster economic fatality by supporting our south Orange County business community. A common denominator among business owners is knowing that their operations will run safely and smoothly without interruption. SONGS has provided that safe, reliable and clean air energy source to southern California residents and business owners. My question is, if what I'm hearing is that independent experts support the safe operation of Unit 2 at 70% power level, then what more is the NRC looking for in order to make a distinct decision? Thank you.

[Inaudible]

>> SPEAKER: Okay. Art or Ryan, you might want to say something about what the NRC still has to do on this to --

>> SPEAKER: Yeah, thank you for that question. The licensee took about eight months to come up with this analysis with their independent experts and it's a lot of work. Our obligation for safety is to make sure that that work was done correctly and that we can validate that work. So we're going to have to take the time to go through all that material and ensure that we feel that it comes up to the right answer, or the wrong answer. If it comes up the wrong answer we'll have more questions and justification.

>> SPEAKER: Okay thank you. Yes?

>> SPEAKER: I'm Betty Jo Toccoli and I'm a small business owner and a president of the California Small Business Association and my question to you is, small business creates jobs and we have responsibilities to our employees and if you don't restart Unit 2 how are you going to provide us with the electricity to keep these jobs and keep the money flowing for our employees?

[APPLAUSE]

>> SPEAKER: Okay. Um, yeah there's lots of important issues here but we're really focusing on the NRC's safety responsibilities here and on the panel discussion tonight, so let's try to keep it on the steam generators. Yes, sir?

>> SPEAKER: Yeah. This goes to the safety question and it also addresses the elephant in the living room. People say let's restart San Onofre when life and death are very [indistinguishable word] it's what's at stake. They talk of validity, elastic instability and Fukushima arises like a mushroom headed snake. What part of Fukushima do you not understand when nuclear contamination hits the fan. Plutonium is everywhere; it's in the sea, it's in the air and we don't even have a good evacuation plan. What part of Fukushima do you not understand? I would like Peter Dietrich to answer that.

>> PETE DIETRICH: I don't think I need to say anything about that. Thank you.

>> SPEAKER: Yes ma'am?

>> SPEAKER: Thank you. And I do have a question about steam generators. First of all, my name is Donia Moore I have lived in work San Clemente over 20 years, love living here. Edison has always been a fantastic neighbor and they've contributed very, very greatly to the community, glad to have them there. My question is, are there any examples of other nuclear plants that have operated safely at reduced power? And if so, what did you learn from those plants?

>> SPEAKER: Thank you very much.

>> SPEAKER: Yes, there were the plants that have, for various reasons had to operate at reduced power for extended periods. One would be if their, what's called is a heat sing, which is the water that they get to cool the plant is too warm or if it rises up to the point where it gets close to the limit, they may have to reduce power to ensure that they're not putting too much heat into the river or something like that and so they would operate at reduced power for extended time periods, until the temperatures go back down. So that has been very, you know, they have been successful at operating reduced power and at levels that South California is talking about as well and even lower in some cases.

>> SPEAKER: Thank you for that question and thank you, Doug. Yes, sir?

>> SPEAKER: Wanted to correct one earlier statement was said that the unions are opposing the restart of San Onofre the tube from IBEW local 47. Local 47 is equally concerned about safety for our members and I was speaking with the utility worker's business manager earlier today and confirmed with him, both of us support restarting SONGS but I can't speak for all of the unions. I do have a question to help put me in perspective and maybe some of us in here, how many fatalities have there been either to workers or the general public from the operation of commercial nuclear power plants in the United States?

>> SPEAKER: Okay. Important question. Not really on steam generators but we'll let it stand for itself. Yes?

>> SPEAKER: My name is Beverly Finley Konecko. I am on from Japan. My son and I came from Yokohama. My husband commutes now, my husband is Japanese, he commutes now from Yokohama. We are here to protect our son from the ongoing effects of the Fukushima accident which are spreading throughout the northeastern region of Japan. My question today is for Mr. Dietrich. You talked about extra testing and data collection that your plans will entail that you will be conducting if Unit 2 does go back online. How are you going to add extra inspections with a reduced work force if you're reducing your work force, I've heard by 750 people, and how can you assure us that these extra checks will be done when it is already public knowledge that your workers have previously falsified routine inspection reports?

[APPLAUSE]

>> SPEAKER: I think that probably not the falsification part but the part about doing the inspections and having the resources. Anything to say about that, Pete.

>> PETE DIETRICH: Yeah, I would just add that first off our efforts and or work to set the staffing levels of the station is based on benchmarking throughout the industry similar design plants and what the staffing levels are at those plants. We've gone through a very rigorous process there. As far as the inspections and testing of the steam generators we will talk whatever time is necessary to ensure that all of that testing is accomplished and meets all the requirements. Those tests are not just verified once or twice; they are actually verified three times by different qualified members qualified to Electric Power Research Institute requirements as well as NRC requirements to be able to read and interpret and validate any current testing information.

>> SPEAKER: Okay, thank you. Yes, Ray?

>> SPEAKER: Thank you. Ray Lutz with Citizens Oversight. There was quite a few statements made and there was a big slide about all the people that are involved. The different people that have been hired by Edison to do their work, those are not really independent experts. Someone said they was a lot of independent experts that reviewed this. I didn't see anybody independent on that list. They're all hired by Edison. So the concept that they're independent is under question. So you said that this time you've done a really good job of analyzing everything and that this time you're sure that everything is fine but I would be willing to bet if you when you first designed these steam generators, that same question you would have exactly the same answer that you have the experts on it and that you've done everything that you can. So there's a problem here that what Gene brought up, it's a group think thing. And I've done this myself; I'm an engineer. I can see down a spreadsheet and figure out a way that it looks really good for this plant to start and that's exactly what you've done. And you turned this race stipulation thing around backwards. And I want to know how this is supposed to work because you have a regulatory agency that is supposed to be regulating the industry here and yet the industry is telling the regulatory agency what they're going to do.

And it's well within any of those technical specifications that you have. There's tons, I mean, it's hundreds of pages of requirements about how to run a plant. But very few requirements about how to run a plant that's wiggling itself to pieces and has to be run with all kinds of support and plugs and is about to go out. The tube to tube wear, you brought up this the main item, but most the wear is not tube to tube wear. Most of the wear in this steam generator has to do with support wear and other things. As Mr. Headrick held up the chart, most of the wear has nothing to do with tube to tube wear. So to concentrate on that is completely, you're going down the wrong path so. I'm really concerned, how are you going to be and analyze, why it have been that you said we have everything right the first time? Why should you, why should we believe you this time that you have it right? Why do we believe you this time?

>> SPEAKER: Thank you, Ray. I don't know if Pete or anybody wants to address to that but I think to be fair, I haven't heard the company telling the NRC what to do; and I think that the NRC has further review to do on this; and I think Art addressed that. Art, you may want to just re-emphasize that.

>> ART HOWELL: Well the only thing I would add, and I was going to say it in my closing remarks is that it's very seldom that -- and I'm speaking about tube to tube wear primarily, which is a new mechanism -- it's very sobering that a new wear mechanism has been identified after all these years of designing and fabricating steam generators in the industry. And that suggests that any entity that was involved over the years needs to take a sobering introspective look about why that is. You've heard tonight the submittals that were submitted by Edison. They also mentioned, Mr. Tomisano, mentioned that they have some more work to do at looking at what happened back in the design. I was going to talk about it again in the closing remarks. We similarly have additional work to do including the technical evaluation review, the inspection of the CAL response, as well as some other work that we're evaluating at this point in terms of looking at the root causes of the overall events. So yes, there's learning for everyone. You make a good point. When things like this happen you do your best to learn from them and move forward.

>> SPEAKER: Thank you. Yes, sir?

>> SPEAKER: Steve Adams, resident of Laguna. Question: As you went through the details of what you believe went wrong with the tubes and talked about plugging the tubes in Unit 2 to restart it, by plugging those tubes does it create any rigidity in those tubes that would create a problem with the other tubes if the FEI continues and rub tubes that way?

>> SPEAKER: Yeah, thank you for your question. As I understand it, by plugging the tubes we did preventatively, do we create a problem where there is a root cause, a problem elsewhere? We have analyzed this steam generator tube bundle to make sure we don't simply move the problem around by taking those tubes out of service. And our analysis shows that 70% power, again the conditions are reduced, the problem does not reoccur anywhere in the tube, no.

>> SPEAKER: Thank you. I guess I would add to that, you know, nuclear industry has for many years used tube plugging and tube stabilization as corrective actions to address phenomenon related to wear and related to cracking. And if not seeing any additional problems created by any rigidity or those types of issues. Thanks.

>> SPEAKER: Okay, thank you. Yes, sir?

>> SPEAKER: Joe Holtzman, Mission Veijo. After spending about 50 years myself in the industry and engineering assignments, management assignments and manufacturing assignments, I go back to an operative question I gave Mr. Dietrich before is, why would a failure mode effect analysis done before? You know we've got -- and the NRC prettied it out tonight -- we've got a design change.

[APPLAUSE]

>> SPEAKER: So with the design change we have now got two different units. They were designed use the same methodology and criteria, the same models, the same algorithms and they're both defective. One's more defective than the other one. We've got the same manufacturing company and operations and they have produced defective equipment. It's not operative. We've got two units that you're proposing to operate one at 70%. Now according to my calculations we, the rate payers, are getting 35% of what we paid for. We paid for two units; we're getting 70% of one. My question to the NRC is, what are you going to do about the disparity in the models? The different model applications? The varying experts that are used? And I have looked closely at EPRI's work in the past as far as EMF goes and they have absolutely no idea what they're talking about. Thank you.

[APPLAUSE]

>> SPEAKER: So anybody want to address the disparity in the models issue?

>> SPEAKER: We definitely will be looking into that. That's a very good question from the standpoint of the models. We will be looking at how the original model was misapplied, how there were some problems associated with that, and how the model that they're using now, whether that is the design applicable to the conditions and whether or not that is an appropriate code to be using from that standpoint.

>> SPEAKER: Thank you.

>> SPEAKER: Hi, Diane Thompson. I'm a small business owner in Huntington Beach. Can you speak to the comparison of the safety of San Onofre versus other steam generator stations in the United States that you work with?

>> SPEAKER: That's a big question and it really doesn't –

>> SPEAKER: Yeah, that's an interesting question but I'll have to briefly -- you know, the NRC determines whether the plant is safe or not to operate. Up until January 31st SONGS plants were safe to operate and then the experience showed that there was more work and more analysis to be done to be able to say that again. And we're still

working on that and we're going to keep working on that until we can say it or not say it.

>> SPEAKER: Okay. Thank you, Ryan.

>> SPEAKER: I'm [indistinguishable word] from Laguna Beach and I would be in the city that would be within the range if these predictions end up wrong where we would be closed down for somewhere over 20,000 years. If the prediction, and I hear the word over and over again, prediction, probability where now the in-plane vibration is something that I'm starting to learn is frightening going this way instead of this way and I'm not - I have been to every one of the meetings that you have had for all of this and I continue to be very much more frightened every time I attend. We've watched the horror happen in Japan. We don't want it to happen in South California. Eight million lives depend on your decisions so I'm so thankful for the Nuclear Regulatory Commission's questions tonight. I have hope that you're looking so carefully at this for us but I wanted -- there is a question - the question is because of the safety reactor being so poor at the plant, where employees have a busy day, and drink their coffee and check something off the list they shouldn't be checking. Something that could cause a melt down and we already have that on our records then I'm even questioning if you had a 170 tube inspections to come up with your initial data, how many employees were in charge of that 170,000 tube inspections? Can we rely on even what they did? I calculated that in 10 months, 7 days a week there would be 570 tubes tested a day. Who is watching that? I just don't trust the process at all that I hear. I know how much energy and money you're putting into it but a mistake isn't just gas in the air. This is forever and I would love to know how that process works.

>> SPEAKER: Is this a quality assurance question? I don't know if you want to talk about it, Pete.

>> PETE DIETRICH: Well, I mentioned before that in any current inspection or steam generator tube inspection is a very specialized technique. It does require a high level of training and skill. Traditionally these inspections are accomplished by and invalidated by well they're always performed by and invalidated by people who have qualified to meet the national standards for being able to conduct steam generator tube inspections. That qualification standard is reviewed internally by the industry but it is also overseen by the Nuclear Regulatory Commission. For each of those tube inspections, it does go through a series of three reviews by an increasing level of qualifications by qualified personnel.

>> SPEAKER: Okay thank you. We're going to go four people here and then I'm going to go over there and see who we have. Yes ma'am?

>> SPEAKER: Yes, I just want to ask, is it true that the only way that you would really know if the tubes don't leak is if they do leak? In other words the thing starts up and, you know, 70% power or whatever, and its going along and going along and all of a sudden it leaks and that's how you know that if it's going to leak or not, is that true? So we have to wait for a leak?

>> SPEAKER: Is that a argone 40, 41 --

>> SPEAKER: Well argon 40 and 41 as Doug mentioned is used to detect leakage. But I will share with you that one of the fundamental premises in our proposed five month operating period is that by our evaluations that shows that we would have roughly one third of the operating period that could approach a situation where we would have a potential leak or a loss of tube integrity criteria. So what we would expect to find, the answer to your question is, the answer is no. The only way we would know if they leaked is if they don't. Than is why we go in and measure wear and why we have plugging criteria for tubes. If a tube does show wear greater than 35% through wall, which we know is not leaking, we then remove it from service. That's the whole purpose of the steam management program is to observe it, trend it, predict it and then go verify the predictions, validate and confirm the predictions. And based on tube wear observed, take tubes out of service before they leak.

>> SPEAKER: Yes, quickly.

>> SPEAKER: I was really gratified to hear the NRC ask kind of the essential question, which is, what is causing the higher fluid velocity? And the answer I heard was, we're going to study that. And while we're studying it we want to go ahead and restart this defected unit before we figure out what the actual cause of these symptoms are. Wouldn't that be like, instead of treating somebody's cancer, treating the symptoms of it and just going ahead along while the cancer actually kills the patient?

[APPLAUSE]

>> SPEAKER: Thank you. Yes, sir?

>> SPEAKER: Chip, I think it's important for me to answer that. We do know the reason for why the steam velocities and the void fractions were under predicted. And that was that there were mistakes made in the modeling and mistakes made using the fifth three model as well as some of the design assumptions and work that Mitsubishi did. We continue to work on our causal analysis but we know why the steam velocity we under predicted and why the void fractions were under predicted. Our proposed actions by reducing power to 70% addresses that specifically. On top of that we have taken three different models based on the US accepted American Standards of Mechanical Engineering model code and validated that the models we are using today accurately predict the thermal hydraulic conditions within the steam generator. So we are not ignoring the cause, we are addressing the cause in our proposed corrective actions.

[Inaudible]

[APPLAUSE]

>> SPEAKER: Good evening, my name is Dennis O'Connor. I'm with the Orange County [indistinguishable word] of realtors and also the south Orange County Economic Development Coalition. I have grave concerns about SONGS not providing power to our homes and economies here in Southern California. But most of all I am a long time resident of Mission Veijo. And my number one concern is safety. And listening to

Southern California Edison's plan to go forward to me sounds like a reasonable plan. I'm more encouraged by the Nuclear Regulatory Commission asking tough questions and their 50 or more year record of extreme safety in the nuclear power industry in this country in spite of what we've heard here tonight about some relatively minor incidents, one or two major ones but overall an extremely safe record. My question is really to the NRC is, and by the way I don't mean to imply that I want you to hurry or anything along with your procedures because first thing is to get it right. But if you decide this is a good plan and go forward, is that the final word or will we have to sit through some appeal process or other delay tactics before it happens?

[APPLAUSE]

>> SPEAKER: Good question. Right now we have no direction either from the members of the commission or the Atomic Safety and Licensing Board or the staff not to continue to perform its work to review the submittal made by Southern California Edison. So that's subject to change obviously. But as of today that's not the case and so we continue to do our work and that's what we plan to do until directed otherwise.

>> SPEAKER: Thank you. Yes ma'am?

>>SPEAKER: Good evening my name is Sabrina [indistinguishable word] I am not an engineer expert. I'm a teacher. So I have some experience with critical thinking. What I've heard tonight from Southern California Edison is a lot of shifting responsibility to MHI. I've heard you admit that your theory on predicting FEI is based on experimental data and this would be the first time your correction running at reduced power is used operationally. You want to experiment. I have one child, a daughter. Her name is Esme, she's three and a half years old. She wants to be an astronaut or a paleontologist. Edison says that there’s a five percent probability that FEI will occur by inference at 70% power. This risk is unacceptable to me. This is not conservative or safe. You must not and you cannot place Esme in harm's way in the name of profit. You cannot risk her life on an experimental corrective action in the name of profit. To do so would not only be irresponsible, it would be maleficent. Mr. Dietrich, you said you take full responsibility if there's an accident. Can I come to your house and expect shelter? Members of the NRC, I appreciate your tough questions tonight but I implore you to place the health life of my daughter above corporate profit. My question is, why don't you challenge us to conserve enough energy that San Onofre is superfluous and unnecessary? Thank you.

[APPLAUSE]

>> SPEAKER: Thank you very much. I think we have time for maybe one or two more questions here. Yes ma'am?

>> SPEAKER: Hi my name is Carina Rigara. I live in San Clemente and I work at SONGS. My question to NRC is, could you provide a little more detail on the components and the rigor that goes into developing a technical evaluation report? Thank you.

>> SPEAKER: Thank you very much. Doug?

>> SPEAKER: Sure. Our technical evaluation is going to be looking at all the aspects of what was laid out tonight. We're going to be looking at as a mentioned before the modeling, how it was applied. We're going to be looking at the requirements that we have, the steam generator, tube integrity, performance criteria and other requirements and how. They're also going to be looking at the work that they've done previous to this. Their condition monitoring. The assessments they did of the degradation that was done, where they properly identify the degradation mechanisms and have they then assessed how that's going -- how they would proceed at the operating conditions that they're applying here? That's what our approach is going to be is to look at each of those individually and then collectively as well to see whether or not we have reasonable assurance that the plant could be operated safely under the proposed conditions that they're providing. That is really what our ultimate criteria is, is that, you know, have they met the performance criteria in ensuring that the tubes are going to maintain their structural integrity.

>> SPEAKER: Okay. Thank you. And we don't, we really are running out of time here so we can go to this gentlemen and then I think we need to hear from Art Howell. Yes, sir?

>> SPEAKER: I have a question for the NRC. I'm Roger Johnson and I live in San Clemente. At these meetings we hear Edison say they're only interested in public health and safety but all we talk about is engineering. And the assumption is that engineering is the only question and if we can make the generators work, there aren't any other questions. So what I'm going to talk about things like cancer? I'd like to see a meeting where you have only epidemiologists, and oncologists. No engineers allowed and seriously talk about public health and safety. You've been relying for the last two decades on a study by the National Cancer Institute which failed to find an effect on populations living near nuclear reactors. Well that study is now out dated and invalid and you admitted it in your press release and that's why you commissioned the National Academy Sciences to study cancer streaks in this area. We were chosen as of one of the six areas in the country. Why aren't we talking about that? There's kids in San Clemente with cancer. There's kids at and Camp Penalton with cancer. The sheriff of Orange County was in the papers last week, she came out with cancer. These are anecdotes. They don't prove anything. But a lot of people are concerned about this. If you start up these reactors, we know Edison dumps about ten hours a week of low level radioactivity into the ocean. We know they pump it into the atmosphere. Well it's over populated areas. Why aren't we talking about this? This is public stuff.

>> SPEAKER: That's a great suggestion. Thank you. We're going to go to Art. Art you want to talk?

>> ART HOWELL: Thanks again folks. Again my name is Art Howell. I've been here for the last three and a half hours asking questions and I want to thank you for your patience. Some of you I know in the audience certainly at that table know Mr. Collins who has been here representing the NRC for the last couple meetings. Mr. Collins is the region four regional administrator. We've worked shoulder to shoulder for the past 20 years and I've had the good fortune to work for him as

his deputy regional administrator for the past couple years. I just want to mention briefly that as you heard me in my opening remarks that in our region four office and the headquarters office has formed two special project organizations to help facilitate where there's already a very high level of focus and coordination on the assessment and licensing actions at San Onofre. We're also forming an oversight panel that consists of members of region four and their office nuclear reaction regulation. We haven't selected all the members yet but I will be on that panel as well as [indistinguishable word] regulation as well as other senior staff members. So that will help us coordinate the licensing and inspection functions. Other than that, a number of my other closing remarks were covered in the Q and As. I do want to say that, you know, Southern California Edison had an obligation, a commitment to respond to us in response to the Confirmatory Action Letter. They believe they have identified the causes and corrective actions to prevent the loss of structural integrity as it relates to Unit 2 operating at 70% power for five months. The NRC now has the obligation to review that work. We've discussed that at length. We have significant work ahead of us but it has started and we plan to do that in our headquarters office and independently.

We also want to take a moment to thank the Edison folks for taking the time to explain it to us. They did clarify a number of points at least I had in my mind, I'm still coming up to speed in this new assignment so it was very helpful. As you can tell we do still have a number of questions that need to be answered and we will seek to identify, or get answers to those questions. I also want to thank all the folks out in the audience for coming, for observing, for your questions. I want to thank the folks that listened in on the audio and watched on the webcasting. I personally can tell you that in the few weeks that I've been becoming more involved in the oversight of San Onofre, I have seen many comments provided to the commission by members of the public that are very thoughtful and thought provoking and very insightful and helped me personally. Many of them are have to do with the technical analysis. We do get those comments and review them and factor those into our agenda. So having said that I want to thank everybody. I hope you have a safe trip home and enjoy the weekend. And as long as there aren't any more comments by the NRC staff we'll go ahead and close the meeting.

>> SPEAKER: Thank you. We are adjourned.