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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

PLANT LICENSE RENEWAL SUBCOMMITTEE MEETING

OPEN SESSION

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WEDNESDAY

JANUARY 12, 2011

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ROCKVILLE, MARYLAND

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The Advisory Committee met at the Nuclear Regulatory Commission, Two White Flint North, Room T2B1, 11545 Rockville Pike, at 1:30 p.m., John D. Sieber, Chairman, presiding.

COMMITTEE MEMBERS:

JOHN D. SIEBER, Chairman

SAID ABDEL-KHALIK, Member

SANJOY BANERJEE, Member

HAROLD B. RAY, Member

JOY REMPE, Member

WILLIAM J. SHACK, Member

NRC STAFF PRESENT:

RAJENDER AULUCK, NRR/DLR/RASB

FARHAD FARZAM, NRR/DE/EMCB

MARK FRANKE, R-11/DRS/EB3*

MELANIE GALLOWAY, NRR/DLR

ALLEN HISER, NRR/DLR

BRIAN HOLIAN, NRR/DLR

WILLIAM HOLSTON, NRR/DLR

MEENA KHANNA, NRR/DE/EMCB

ROBERT KUNTZ, NRR/DLR/RPB2

LOUIS LAKE, R-II/DRS/EB3*

ALI REZAI, NRR/DCI/CPNB*

ABDUL SHEIKH, NRR/DLR/RASB

GEORGE THOMAS, NRO/DSRA/SRSB

DAVID WRONA, NRR/DLR/RPB2

KENT L. HOWARD, Sr., Designated Federal Official

ALSO PRESENT:

JOHN J. BARTON, ACRS Consultant

STEVE CAHILL, FPC

MIKE HEATH, FPC

JEFF LANE, FPC

CHRIS MALLNER, FPC

RICHARD PORTMANN, FPC

ROBERT M. REYNOLDS, FPC

KEN WILSON, FPC

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

1:27 p.m.

CHAIRMAN SIEBER: The meeting will now come to order. This is a meeting of the Plant License Renewal Subcommittee. My name is Jack Sieber. I'm chairman of this Subcommittee meeting. ACRS members in attendance are Said Abdel-Khalik; Sam Armijo, whom I don't see at the moment; Charles Brown, whom I also don't see; Michael Ryan is supposed to be here, but not; Bill Shack, Harold Ray, and Joy Rempe. Our ACRS consultant, John Barton, is also present. Kent Howard of the ACRS staff is the Designated Federal Official for this meeting.

This Subcommittee will review the license renewal application for the Crystal River Unit 3 Nuclear Generating Plant and the associated Safety Evaluation Report with open and confirmatory items.

We will hear presentations from the Florida Power Corporation, representatives from the NRC staff, and other interested persons regarding this matter.

MR. HOLIAN: This is Brian Holian. Just a reminder for people on the phone to put their phones on mute. Thank you.

CHAIRMAN SIEBER: We have not received

written comments and request for time to make oral statements from members of the public regarding today's meeting. The entire meeting will be open to public attendance. The Subcommittee will gather information, analyze relevant issues and facts, and formulate proposed positions and actions, as appropriate, for the deliberation by the full Committee.

The rules for participation in today's meeting have been announced as part of the notice of this meeting previously published in the Federal Register.

A transcript of this meeting is being kept and will be made available as stated in the Federal Register notice. Therefore, we request that participants in this meeting use the microphones located throughout the meeting room when addressing the Subcommittee. The participants should first identify themselves and speak with sufficient clarity and volume so that they may be readily heard.

We will now proceed with the meeting and I would like to point out that this is sort of an anniversary meeting, so to speak. The license renewal rule was published as final in 1995 and the first license application to be approved under the rule was approved in the year 2000. And last year, was 2010, so we have completed 61 license renewals in that 10-year period and we have several now pending, but that represents a lot of work by the NRC staff and also by ACRS members in reviewing all of this material.

Of the 61 units that were approved, 7 of them are now operating in the license extension period. Those are Oyster Creek, Nine Mile Point One, the Ginna Plant, Dresden 2, H.B. Robinson, Monticello and Point Beach Unit 1.

And I would also point out that when the original rules for licensing of plants were decided the term of 40 years was decided more on a economic basis than on a materials issues basis. On the other hand, the plant licenses were written for 40 years and from my own personal experience in having worked in plants that were built, even one of them was started in the 19th century, the management of material degradation is an important aspect of extended life in power plants. And the life extension rule pays particular attention to that.

I would point out that one of the attributes of license renewal was use of the Generic Aging Lessons Learned publication and worked on by Argonne National Laboratory and that is in its third version now. And has been used in one form or another in all of the 61 plants. The Crystal River Plant is, to my knowledge, the last plant that is in a transition between version two and version three of GALL, and that accounts to some extent for the number of open items that remain for this application at this stage in the license renewal process. However, not all of the open items that exist at this time are the result of the transition from version two of GALL to version three of GALL.

I have already reviewed your presentation slides and it would appear to me that you are covering one way or another all of the open items with particular emphasis on the containment delamination which we consider to be a serious issue and I request that you pay particular attention to the presentation in that area and your current and future plans for making sure that this important system in your plant maintains its full capability through its current life and its extended life.

What I would like to do at this time is introduce Brian Holian of the NRC staff who has been through a lot of license renewals as I have and he will introduce the staff who worked on this and also the presenters from the applicant.

Brian?

MR. HOLIAN: Thank you and good afternoon, Subcommittee, and thank you, Chairman.

My name is Brian Holian. I'm the Director for the Division of License Renewal and I'll just have some brief opening comments and go over the agenda before we turn it over to the applicant for the license renewal.

First, I appreciate the comments on the ten-year anniversary of kind of issuing the licenses. We did pause briefly with the staff and recognized that with a little memento for many of the staff who have worked both currently and previously over the years on license renewal. And we did with a note that we gave -- just for the record, repeat it here, that any success in license renewal program really, the we way we view it is how well they operate in that extended period and how well the Aging Management Programs work. So we're continuing to do work on that, even with research now, to see how effective some of these Aging Management Programs are and the Committee will hear more from that in the future, I'm sure.

One item on GALL Rev 2, it is Rev 2, it's the third revision but I'll officially call it GALL

Rev 2, since we didn't number GALL Rev 0, I guess, but that did go out in December and we had a very good meeting with the Subcommittee and good comments. It's been received well from the public from what we can tell. So thank you.

Other introductions, I'll just start here. To my left is Melanie Galloway, Deputy Director, Division of License Renewal. To my right, Dave Wrona, the Branch Chief in License Renewal that has his project, Crystal River, and several other projects we have in-house. Behind me is Rob Kuntz. You'll be hearing from him primarily later on in the NRC presentation. He's a Senior Project Manager in License Renewal and has the Crystal River project and has had it for the extent of the review. To his left is Meena Khanna and she's a Branch Chief in the Division of Engineering. She's here today also, has been working with the region very closely on just the restart applications, restart issues for Crystal River and the containment issue, in particular, her and her staff.

On the phone we have, hopefully, I'm just going to check again, we have Lou Lake, the Senior Inspector at Region II. Lou did the license renewal inspection and also the special inspection, was the lead for the special inspections of the delamination issue of containment. We also have Mark Franke, his Branch Chief in Region II.

Lou and Mark, I'm just checking and verifying you're on the phone?

They're checking on their mute button and if one of our staff will go ahead and make sure they have the right tie-in code, so we'll do that. Let us know when you're on, but we'll get done and make sure they're tied in. They are snowed in in Atlanta. I guess this is the second or third day that Atlanta with their half inch of snow has shut down the city.

(Laughter.)

I don't know if that's true. That's what I tell my Region II folks when they can't make it up here. But they did try and we got a few meetings impacted by that, but we'll have folks here on the table that will be able to help on the presentation.

MEMBER ABDEL-KHALIK: For the record, it was four inches.

MR. HOLIAN: Was it?

CHAIRMAN SIEBER: People who live in glass houses shouldn't --

(Laughter.)

MR. HOLIAN: The agenda for today's

meeting, once again, is to hear from the applicant first, take a short break, and then we'll follow up with the NRC perspective on the open items.

Today's presentation will be a little bit different than Subcommittees have seen from license renewal in the past, five, six months at least, maybe the final year. We often have issues in license renewal that cross both Part 50 and Part 54 of the license renewal. Examples, we've had buried piping, electric cabling. The Committee often asks what are you doing now on that issue? And we answer with generic correspondence and issues along that way and in these meetings we and license renewal staff particularly look forward to how well and how robust will their Aging Management Program be. Although that's our priority, we try to answer the Committee.

We have one big open item, as you mentioned, the containment issue. And we've taken that issue seriously. We delayed this Subcommittee twice. It was originally scheduled for June. We moved it back again to September. We didn't feel the applicant was ready on the issue, mainly in Part 50 space, to even come to the Subcommittee. So I just want to recognize for the record that that's been delayed.

In some ways this still might be a little bit early from the fact that it's not up and operating yet and the regional perspective and the headquarters perspective is that's the primary issue there. The plant obviously doesn't restart until they've had successful operable containment.

The open items that we have today, there's a few open items that the region will talk about until they're satisfied for start up. And then, of course, the license renewal staff will talk about the open items that are also still there until we're satisfied that they have an Aging Management Program that can successfully ensure us that the longer term, aging and operability and containment is effective. The open items for that, you'll see on checking of the vertical cracks, checking of the bulging seam on the liner, even recent inspection from the region identified some cracking in the dome that had been from a previous repair, identified at this outage. The applicant will probably still get another request for additional information from us on have you looked at that for an Aging Management Program incorporated in so far the other cracks that are seen in the vertical buttresses.

So we have more work to do. I put that out as a warning for the applicant because it's only by schedule several months until the final SE is to be finalized, but once again, we'll delay that, we'll delay a final Subcommittee as necessary until we resolve the containment issue and all the open items are satisfactorily resolved.

With that, I would just like to turn it over to the applicant. Steve Cahill is Director of Engineering. I'll turn it over to him. Thank you.

MR. CAHILL: Thanks, Brian.

CHAIRMAN SIEBER: I might ask a question, a couple of questions. The applicant is Florida Power?

MR. CAHILL: Yes. In licensing space, we are Florida Power.

CHAIRMAN SIEBER: Okay, and that's part of Progress Energy?

MR. CAHILL: Yes.

CHAIRMAN SIEBER: Which was recently bought by Duke Power or --

MR. CAHILL: We announced it.

CHAIRMAN SIEBER: You announced it, but you have to get Public Utility Commission approval. I need to know, the licensee is still Florida Power?

MR. CAHILL: It's still Florida Power.

CHAIRMAN SIEBER: It's very complicated.

(Laughter.)

MR. CAHILL: We're just trying to make it more complicated.

(Laughter.)

MR. CAHILL: The first thing I'll do is introduce my team that I have here with me here today. Normally, the first person on my list would be Mike Heath. He's back at the table back here. Here's our supervisor for license renewal. He managed to lose his voice last night very conveniently, so he's giving me most of his speaking assignments.

Up here at the table I have Jeff Lane. He is our lead mechanical engineer. I have Chris Mallner who is also a mechanical engineer on our license renewal staff. At the back table I have Bob Reynolds. He is our lead civil engineer. Right next to me I have Ken Wilson. Ken is the supervisor for major projects licensing, so he'll be talking about some of the major projects and aspects we're working on. And also at the back table I have Rick Portman from my normal CR-3 staff. He is my containment programs engineer.

Next slide, Jeff.

This just covers what we're going to be doing for the agenda today, very high level. We're going to go through a site description, talk about some license renewal aspects. The opening confirmatory items is the main part of our presentation and as you mentioned we'll be talking a lot about containment in there and then we'll touch on some major upgrades that are going on at the site as well at the end.

As far as the site description, Crystal River is a Babcock and Wilcox NSSS plant. They're a BWE plant. We use Gilbert Associates as our architect/engineer and we've been operating since our license was approved in 1976. We are currently licensed for a 2609 megawatts thermal which correlates to about 912 megawatts electric. Ken will be talking about some of our major projects. We do have a power uprate that we're in the middle phases of going through.

Some key features about Crystal River, we are pressurized water reactor. We feature a very large dry containment. We have once-through steam generators, both of which were just replaced in the outage that started last fall.

We use the Gulf of Mexico as our ultimate heat sink. We're actually part of the Crystal River energy complex, so there's four COL units there.

Units 1 and 2 are very close, adjacent to Unit 3 and they share the actual discharge intake canal where we use the Gulf of Mexico as our heat sink.

We do have helper cooling towers in our discharge canal and they are primarily just to mitigate the point of discharge temperature effect. So they're not used except in the peak days of the summer when temperature for all three units operating becomes a peak.

At this point I'll turn it over --

CHAIRMAN SIEBER: Before you switch slides, I do have a question. You have four COL units and a nuclear unit there. Are there any shared systems between the nuclear unit and any of the COL units?

MR. CAHILL: There are some shared systems and the point of there's things like some water like our distilled water, demineralized water, those are some shared systems that are operated outside of our fence. But we do maintain, I guess, oversight and operating of them. So aside from that and just electrical ties, there's really not many shared systems. We also get our auxiliary steam from Units 1 and 2, but there's a line of demarcation there.

CHAIRMAN SIEBER: The auxiliary steam, is that -- any of that safety related? If that line were isolated or not available, would it affect the operation of Crystal River 3?

MR. CAHILL: No, it would not.

MR. BARTON: What happens when both fossil units are down, Crystal River is down, you need aux. steam to get started. How do you do that?

MR. CAHILL: We would have to basically come in and use an auxiliary boiler.

MR. BARTON: Get an auxiliary boiler, bring it on site?

MR. CAHILL: We've not had that situation. We always maintain --

MR. BARTON: It's a possibility.

MR. CAHILL: It's possible. Looking long term at Unit 1 and 2, the longevity of those plants, that is something on our long-term horizon.

MR. BARTON: I was wondering whether it would be decommissioned before Unit 3, which would create that problem.

MR. CAHILL: We've been exploring what type of auxiliary boiler system we would put in place if they were decommissioned.

MR. BARTON: Units 1 and 2 also have some off-site power, DC control power with some breakers.

And that DC control power is located in Unit 1 and 2 battery rooms.

How does Unit 3 maintain control or assure that those systems are well maintained, since it is a power source?

MR. CAHILL: We do maintain some control of that.

Bob, you want to take that question? Bob has some more details on that beyond just my general answer.

MR. REYNOLDS: Yes, I'm Bob Reynolds, lead civil. And we included those portions that come from Unit 1 and 2 in the scope of license renewal. There's battery rooms, battery racks, conduit cable tray, supports that come from Units 1 and 2 over to the switch yard. And what we would use to do that is the monitoring program which will do the inspections on that facility and those components. And similar to what we do with the rest of our plant, we would initiate corrective actions if we find degradation of any of the components in the system.

MR. BARTON: Thank you.

MR. REYNOLDS: Yes, sir.

CHAIRMAN SIEBER: Now you basically use one-through cooling on Unit 3 or condenser cooling?

MR. CAHILL: Yes.

CHAIRMAN SIEBER: With an auxiliary cooling tower. And the water intake comes from the Gulf of Mexico?

MR. CAHILL: Yes.

CHAIRMAN SIEBER: Were you affected at all by the BP oil spill?

MR. CAHILL: No. We had several contingencies in place and we were looking for any effects of that, but it did not have any impact on us.

CHAIRMAN SIEBER: The cooling towers, they basically circulate and cool water from the Gulf of Mexico. That's where it's origin is?

MR. CAHILL: The helper cooling towers you are referring to?

CHAIRMAN SIEBER: Yes.

MR. CAHILL: Yes, they're actually solely located on our discharge canal and they are just there to cool down the discharge after it has left Crystal River Unit 3. So it really doesn't interface directly with the Unit 3 at all.

CHAIRMAN SIEBER: How do you deal with chlorides? Because if you're operating a cooling tower, water vapor is leaving distilled. All the chlorides end up in the basin.

MR. CAHILL: I'm not really familiar with it. They operate very infrequently.

Do you have any more information on that, Jeff?

MR. LANE: This is Jeff Lane, lead mechanic. As a matter of operating the plant, I can't speak to how they blow down or what they do with that. As a matter of license renewal, they're not in scope.

MR. BARTON: I think the issue Jack's bringing up, though, is what comes out of those cooling towers is salt-laden vapor. And what effect does that have on equipment at the site, for example. Does it affect the transmission yard, the switch yard?

CHAIRMAN SIEBER: That has been a significant issue on the east coast of Florida. There are studies done by NASA at the Cape Canaveral installation and salt plume travel actually goes for miles and does affect the nearby equipment became an important issue in spent fuel storage cask construction and age life determinations. It's got to have some effect on the equipment at your plant.

MR. CAHILL: The helper cooling towers and I cannot give you specific details, they operate very infrequently, usually only in the very peak months of the summer, like I said, when we are temperature limited and that usually is only the case when all three units are running, Units 1, 2, and 3, simultaneously. And that's usually only a matter of days at a time.

When truthfully, for your question, the more relevant concern would be Units 4 and 5 use hyperbolic cooling towers that are right next door to us. We have not had any issues really with the salt from that. We do have to monitor salt and clean off things in our switchyard periodically, but that salt is primarily associated with weather events coming in from the Gulf.

CHAIRMAN SIEBER: I brought the satellite photograph maps of the site. It seems to me you have five cooling towers there, right?

MR. CAHILL: We have two main hyperbolics, that's Units 4 and 5 and then the other cooling towers are these little helper ones which are on the discharge canal.

CHAIRMAN SIEBER: Okay. Why don't you continue on?

MR. CAHILL: Okay. At this point, I will turn it over to Jeff.

MR. LANE: Thanks, Dave. I'm Jeff Lane,

mechanic lead. I'll talk a little bit about the process that we use to develop the license renewal application of Crystal River. I'll point out that Crystal River license renewal applications are four license renewal applications. We formed our license renewal project around the year 2000. We put together four teams to do that.

The initial application was the H.B. Robinson Plant application. That team developed that application, stayed together through the review of that and then subsequently the development and review of the Brunswick and Harris license renewal applications. So Crystal River applications is basically our fourth application.

Our staff has been heavily involved in administering Working Groups for license renewal. Staff members have chaired both the Mechanical and Electric Group meetings in recent years. We've also been involved in the development of the revisions to NUREG-1801, provided input on the front end and comments to the draft revisions for NUREG-1801.

Recognizing that the site will ultimately inherit our Aging Management Programs, we did get the site involved in the review of Aging Management Programs and the development of that part of the application. Plant staff were responsible for the review of all the Aging Management Programs that eventually they will inherit.

From a process standpoint, our application was developed consistent with the regulatory requirements of 10 CFR 54, as well as based on NEI 95-10 industry guides. Our sources of information included our equipment database which is a quality control database for Progress, design basis documents, plant procedures, final safety analysis report and document correspondence.

And aging management reviews, again, they were also consistent with regulatory requirements and industry guidance. We did extensive reviews of plant operating experience and utilized that in both developing the Aging Management Reviews and Aging Management Programs and we made consistency with GALL a priority in the development of our Aging Management Review and Programs.

We'll spend just a minute and talk about GALL consistency. Our application was based on NUREG-1801 Rev. 1. That was the revision that was current at a point in time that put together the application. Based on Rev. 1, our application has roughly 82 percent consistency with GALL Aging Management Review line items. Consistency in this regard being standard notes A through D, Tab 41 Aging Management Programs, 17 programs are consistent with GALL; 22 programs have exceptions or enhancements.

There are two plant-specific programs, one of them relating to fuel pool reactor neutron global monitoring and the other related to high-voltage insulators in 230 kV switchyard.

Relative to the exceptions associated with our 22 programs, a number of those are related to upgrading our programs in recent months, to go from Rev. 1 to meet the requirements of Rev. 2 of NUREG-1801.

A brief overview of our time-limited aging analyses in the application. We had TLAA associated with the reactor vessel neutron embrittlement, metal fatigue, environmental qualification of electrical equipment, containment tendon prestress, containment liner plate, metal containments and penetrations fatigue and a plant-specific PLA relative to bedrock dissolution from groundwater.

Commitment management. At present, we have 30 license renewal commitments. We are tracking these commitments and using Progress Energy's commitment tracking process. This is the same process that we've used for both the Harris and Brunswick plant as well as Robinson which recently completed its IP 71003 inspection process and extended operation last August.

Basically, this process develops an implementation plan for each commitment. Each implementation plan will identify all the activities required to satisfy that commitment and a piece of those activities is entered into our Corrective Action Program.

We'll go the open items and confirmatory items as part of our presentation. At this point, I'll turn it back over to Mr. Cahill.

MR. CAHILL: Thanks, Jeff. Okay, as we discussed before, we'll be covering our opening and confirmatory items and the one on the cover is the containment delamination. So I've got a sub-agenda there. This is basically the scope of what I'll be covering as we go through containment.

I'll talk about the root cause. I'll talk about basically the overview of the repair that we have done. I'll talk briefly about the impacts that we have assessed and seen on the liner. I'll talk about our liner bulges and then we'll just go through in the detail, very details of our pre-startup and post-startup inspections, as well as our monitoring and overview program.

The first slide is really just to get us oriented. This is actually a picture after the steam generator placement opening was created and before we have done any repair efforts. So as you can see there, the opening is right there in the middle. There's a yellow outline there that shows the actual scope of the delamination. This was after the efforts for condition assessments which I'll talk about in a minute defined it. But just to get you oriented before we did any excavation efforts, that is the scope of the delamination.

If you notice, the extent of it is mitigated up at the top. That's where the ring girder reinforcement limited the scope of the delamination. I'd just also to point out this area between the two buttresses, the buttresses being on the left and right side of that opening, we call these bays. I'll be referring to this as Bay 3-4 because that is between Buttresses 3 and 4. As you can see at the bottom of the picture that is our equipment hatch down there that was not selected for taking the steam generators out.

MR. BARTON: This containment was designed by who? The design of containment, the design of the containment building?

MR. CAHILL: The design was done -- Gilbert was our IE. Worley Parsons -- we go back to him for our design records.

MR. BARTON: Parsons?

MR. CAHILL: Yes. I can note, too, this root cause I'll be discussing here, we presented this in public forums a couple times before we were up here on June 30th talking with the staff about our plans for the repair and so forth and at that point the root cause is completed. And we also just had a public exit in September for our special inspection team where we also went through this.

So I'm going to have a few slides to give a basic overview of the root cause. I've got the problem statement up there. I will not read that, but that problem statement really reflects what we knew at the time when we started this investigation. As we found what we were looking at, we really understood that we needed to have a pretty comprehensive effort going forward.

So we pulled together a very comprehensive team to conduct this root cause. A lot of Progress Energy personnel, we actually tapped their expertise across the fleet, brought a lot of folks down from our Carolina sites as well as headquarters to help us out with this effort. And they've been dedicated to that effort since and they're still engaged.

We use a lot of industry peers as well. We had some other utilities providing civil and containment expertise. Folks who had actually been employed by Worley Parsons in the past and had a lot of knowledge of our type of containments.

We also went externally. We had to tap a lot of external expertise. Industry vendors with civil pre-stress containment and engineering analysis expertise. And then there was extensive effort to pull both for field data obtaining as well material lab support. We did a lot of data reviews, a lot of data was obtained for this and there was a lot of testing that was done to support both the root cause as well as our subsequent repair efforts. So those are a significant part of our team.

This next slide is a graphic to get in a little more details so there's I guess a consistent understanding what we're talking about when I say delamination. This is a cross section of our containment wall. The outside of containment being on the lefthand side. Note that the dept of our containment is about nominally 42 inches of concrete and there's a 3/8ths inch steel liner on the inside of that.

This graphic does depict the tendon sleeve so as you can see these are horizontal tendons which run in pairs and then you can see a little deeper in on the inside plane of those is where the vertical tendons run.

I'd also like to point out, note that there is a complete lack of reinforcement inside the plane of the tendons. There is no structural rebar in that plane inside of the tendons.

There are a set of outer map rebar, number 8 bars that were part of the original design, mostly just to resist thermal cracking, though they're small bars, number 8s and that was just on the outside plane beyond the tendons.

The delamination is depicted there. It is the red line. You can see it and it is run consistently in the plane of the horizontal hoop tendon, so it's nominally about 9 to 10 inches deep from the outside of containment.

Any questions on this before I move on because this is an important one and I want to make sure everybody understands what we're talking about?

The next slide just talks about our overall strategies as we approach this. We really had four main teams. Obviously, we had a dedicated team for the root cause analysis, but we had to have one for condition assessment. There was a pretty significant effort just to understand the scope of what the problem was that we were facing. Also, dedicated team we had for design basis analysis.

We had a team charter from the very beginning of this effort to make sure we understood all the aspects of our design basis and what we were going to be doing in both the investigation and repair to make sure we could maintain that and restore it.

We also had a team looking at repair alternatives because quite frankly in the early end stages of this, we didn't understand the full scope of it. We really assessed a lot of different ways of repairing this.

The condition assessment came first though because it really fed the root cause in the design basis analysis. And I point out the yellow box in the middle. This is very key. We recognize very early on that we had to reconcile any of our repair efforts and our reconstitution, I guess a restoration of our design basis. It had to be reconciled with the root cause. So we had to understand this well enough to make sure that we could understand what we were going to do to repair it and make sure we could do a proper restoration.

As I mentioned before, next slide, initial focus was on condition assessment. In the condition assessment, we chartered a team to determine the depth, the extent, and the boundary of the delamination. That was primarily done a lot with non-destructive testing of the containment wall surfaces. The primary method we went of selecting and using going forward was impulse response method. We took over 8,000 impulse response data points throughout the wall.

MEMBER SHACK: What is this technique?

MR. CAHILL: Impulse response, it's a company, CTL Labs, Concrete Testing Laboratory. It's a technique that they had where they actually use a calibrated hammer and basically put a pulse into the wall and they have a measuring -- basically listening devices and the result they get out of this is called a mobility factor. From that calibrated hit with the hammer, they can see how it travels and where it hits things and basically there's a lack of mobility as that pulse moves through the wall.

MEMBER SHACK: Is the sensor on both surfaces?

MR. CAHILL: No. It's totally done on the outside, so it's complete non-destructive evaluation. So you've got people set up on the outside and you basically have at a set spot with sensor locations set up that they take this measurement. So it's a tedious, you go through discrete points going through, but -- I was going to mention going forward, you might wonder well, how can I get anything from that? Because it doesn't give you, it doesn't give you a map or anything like that. It gives you a mobility number.

And a mobility number has to mean something. We took a significant amount of core bores through our containment, over 170 of them in total at the end. We had to use those to calibrate this technique on our specific wall to make sure we knew what we were seeing with this mobility factor, otherwise, it would just be a meaningless number.

MEMBER SHACK: And so you saw a dramatic change in the mobility number as you went from the cracked region to the --

MR. CAHILL: Yes. We spent a lot of time with the staff, with the specific inspection team going through the basis for that and the validity for that. I think we've done a very good job and have a very credible basis for saying that that is a calibrated technique that we can use in places without a lot of reinforcement. We can't do this in a heavily reinforced area of the wall. But we have fairly clear path to do this. We can detect delamination very reliably.

MEMBER SHACK: And your 8,000 data points, how many of those are over the cracked area and how many are over in one cracked area?

MR. CAHILL: You saw the outline before that I drew. The comprehensive scan. We did comprehensive scanning pretty much in the entire containment, all 360 degrees of it. There's a few isolated and inaccessible areas we couldn't get to, but again, we shared that. It was a very big focus of the special inspection team was our extended condition to make sure we knew where we had delamination and where we did not. So we essentially scanned the entire containment using this technique.

CHAIRMAN SIEBER: So you operate this device, you get a readout and that readout tells you that there's an interface at a certain distance, is that what it is that you're looking at?

MR. CAHILL: It's not really calibrated to measure very good with distance, but it can tell you whether you have basically a delamination or a crack there in that same plane.

There's other techniques that we have that would be more precise in distances.

CHAIRMAN SIEBER: Let's same the delamination is 50 square feet, how does it know the difference between that and just the other side of the wall?

MR. CAHILL: I probably am not the right one to get into that, the detail, but we did calibrate that. If you look at the core bore mass we've taken, you will see the outline of the delamination. You'll see a large majority of our core bores were taken right inside that edge, right outside the edge. And you can clearly tell the difference between the two.

Rick, do you know any more about that?

CHAIRMAN SIEBER: These are questions we have to ask and you have to answer so we will have developed enough faith to believe that your method is reliable and viable and tells you meaningful information you can act on and perhaps perform a repair or do an analysis. If it doesn't give you distance, I'm not sure how you're going to do any kind of an analysis.

MR. CAHILL: It's calibrated only in a certain depth of distance. It basically can't detect -- it's basically not useful past about a 12-inch depth. So knowing that our plane had delamination, we were going after a targeted phenomenon in that plane.

CHAIRMAN SIEBER: You said it's useful only to about a 12-inch depth?

MR. CAHILL: The way it's calibrated and set up. I'm --

CHAIRMAN SIEBER: How thick is your containment?

MR. CAHILL: Forty-two inches.

CHAIRMAN SIEBER: So anything beyond 12 inches, you don't know anything about.

MR. CAHILL: You can set it up to basically more targeted for different areas the way it's set up. We calibrated it and did it comprehensively on containment for the delamination phenomenon we were trying to bound.

CHAIRMAN SIEBER: Now is this instrument given credit by any of the ACI, American Concrete Institute, or any national society or international society that endorses this as a way to attest to the integrity of concrete?

MR. CAHILL: I am not familiar with the level of endorsement it has.

CHAIRMAN SIEBER: Is the staff prepared to discuss these kinds of qualification details that we would have to have?

MR. LAKE: This is Lou Lake. Can anybody hear me?

CHAIRMAN SIEBER: Yes, sir.

MR. CAHILL: Yes.

MR. LAKE: This is Lou Lake. I was the lead inspector on the special inspection as well as the license renewal as stated previously. To answer your question, the special inspection team had a member, Dan Noss, from Oak Ridge Lab and he was very familiar and has presented this methodology of doing concrete inspections at a number of international seminars. He had attested to us that it was satisfactory in doing this inspection and determining the extent of the delamination.

MEMBER ABDEL-KHALIK: If there were another crack, let's say 20 inches deep, parallel to the one that you depict in this picture, would this technique be able to detect both?

MR. CAHILL: If you had cracks on top of cracks you say?

MEMBER ABDEL-KHALIK: No, cracks parallel to --

MEMBER SHACK: In a different region, if you had a crack at a different depth.

MR. CAHILL: My understanding of it, yes, you would be able to see that. You would see a difference in mobility factor. I mean you get very consistent results when you have solid concrete and when you don't you will get a change of mobility factor. The delamination was where it was at the depth that we were nominally looking it. It was very consistent.

A lot of other places we had results in the periphery of the delamination and so forth or in other places, we actually found some -- I guess some anomalies left over from original construction that were at different depths. We found that from laser scanning and actually did core bores to excavate those out and assess those, so we would see those things on the IR scans, but the only way to validate exactly what you've got is to go basically take a core bore. And we did that extensively. There's probably almost like 15 different places. We took core bores specifically just to investigate something we saw from an IR scannability fact, the number was not consistent with the solid concrete.

CHAIRMAN SIEBER: I would just ask the staff to provide the Subcommittee with technical documentation so we can make an independent assessment of the accuracy and the value of this instrument for doing the kinds of tests that you're describing.

MR. CAHILL: I sort of mentioned this already, but taking the concrete core bores, we also use boroscopic inspections. When you take a core and you're looking for a delamination somewhere in a plane, the core that you actually extract is usually somewhat damaged and it's not a very good correlation of what you found. So each one of those core bores, we actually went in boroscopically and did a visual to make sure we could see along the length of that core bore, exactly what we were seeing.

Again, I say these were used as a primary means as a prime standard to calibrate to make sure that we were getting valid readings from our IR readings. And also, we took a lot of core bores for various material testing.

MEMBER SHACK: Was the core bore intact the same way you do well logging?

MR. CAHILL: You take a core bore --

MEMBER SHACK: And examine the bore

cylinder.

MR. CAHILL: The bore cylinder you get out is not always -- sometimes you'll get, if you take a long bore cylinder, it will crack just from the physical shock of taking the core bore. So we never relied upon that. We relied upon actually going into the hole that was left in containment with a boroscope to be able to see exactly what the 360 circumference of the core we left, what there was in there. So looking for a crack that way.

The last thing, we took a lot of material testing out of the cores we've taken. We've retained a lot of those cores for future testing and trending.

MEMBER SHACK: Was the radar useful?

MR. CAHILL: The radar was primarily only useful, it's a very limited technique, and it was only useful for finding embedded objects. When we took a lot of these core bores there was a lot particularly outside of the repair area. We still have tendons energized. So there was a lot of physical safety aspects of taking a core in those areas.

So we used the GPR mostly for physically locating our tendons, as kind of a redundant technique. We use several techniques to make actually sure where we're taking a core. So many cores we took were fairly deep and long and even at an angle sometimes. You have to have certainty. It would be very catastrophic to drill into an energized tendon. That's primarily what GPR was used for.

CHAIRMAN SIEBER: In any of the core bores that you took, did you find any embedded objects that you did not expect to find, like pieces of wood?

MR. CAHILL: Not in the core bores. And you'll see in the later pictures, we did extensive amount of concrete removal in Bay 3-4 as part of the repair. And we found that there was large, extensive amount of different pieces of field fit like angle iron and so forth, really just put there that were not there for structural reason, but they were put there for mostly setting the tendons in place and things like that before they actual concrete pours. So a lot of those things are not on engineer drawings because they weren't engineer features.

So there's really nothing that we found that was from your perspective like big pieces of wood or things like that that would be a problem that would be unexpected. Those things were expected, but we didn't always know what we would find.

We used Performance Improvement International as our root cause lead. I'll refer to them as PII from here on. They applied their proprietary methodology to the effort that we went under for this investigation. It uses failure modes. So at the beginning of this we defined 75 potential failure modes. This is 75 different options that really anything that could be considered that could possibly have led to this event.

Of that 75 potential failure modes, we did conclusively refute 67 of them. That left eight that could not be conclusively refuted. Of those eight, they were combined to basically look at relative significance and assess for the root and contributing cause determination.

One of the notable discoveries very early on in this investigation though is that existing techniques we had that we used that many other utilities have used to actually make the opening for the steam generator placement, they continued to predict excessive margins to delamination. They did not show stresses being exceeded that would have predicted this delamination event that we had.

So very early on in this effort we realized that we needed to develop new finite element analysis tools to be able to go and basically model this phenomenon and be able to predict it with an engineering tool.

Those models progressively got more and more complex. When we started out, we realized very early on that we had to do a 360 degree global model. We could not do a symmetric and only cut it in half. But very early, we realized that just the standard finite element analysis techniques with displacements and stresses could not accurately model and predict this phenomenon, so we went to a visco-elastic non-linear model to be able to build this model that could actually model cracking and the propagation of that. So that led to basically two different models. We have a global overall model and we have a much more detailed sub-model which uses a much smaller mesh to get more fine resolution on localized areas to be able to mimic this behavior.

And really just having the condition assessment results behind us, knowing the extent that what we got for this delamination and the resultant pattern, that was really -- we needed to have that. We could not have built this model and had it calibrated without actual event data.

The overall conclusions though for our root cause was that our design was acceptable for normal emergency operations. There was nothing we found that jeopardized that fundamental basis. We did find that our construction was all done in accordance with our design, so there was no construction deficiencies that did not meet our design requirements.

We also confirmed, which the staff agreed with, with our special inspection team conclusion was the delamination occurred during the outage, during the opening of the steam generator placement opening.

As I mentioned before, we had to develop the state-of-the-art techniques to be able to analyze this response and to recreate within the reliability computer model.

MEMBER ABDEL-KHALIK: Where do you get constitutive relations for these visco-elastic models?

MR. CAHILL: Where do we what?

MEMBER ABDEL-KHALIK: Where do you get constitutive relations for these visco-elastic models?

MR. CAHILL: Constitutive relations? I --

MEMBER ABDEL-KHALIK: Right. Just essentially that relate the properties, the behavior of this material, the visco-elastic behavior.

MR. CAHILL: We use an ABACUS-based model that ABACUS is the vendor that built this model and with the testing we --

MEMBER ABDEL-KHALIK: ABACUS has a visco-elastic model?

MR. CAHILL: Yes, they do. This is a specialized application of it that has been basing this model. Their tool has been customized for Crystal River PII. PII has been the vendor to do that to look and be able to recreate this delamination with the specialized mode and using ABACUS as the underpinnings of that.

PII has been the vendor that's been performing that and like I said, they could not have done that without the data we have for the delamination and the pattern that had exhibited as well as the material test. And we took extensive material testing and a lot of fracture tests and took a lot of fracture energy tests and an extensive amount of tests which I have a laundry list of them which I can go through which some of them, I don't even fully grasp what you're getting out of them. But PII did those things to basically build this model.

I'm not real conversant at I guess the level of detail you probably want to know for how they built it.

MEMBER SHACK: But this is a specialized concrete model that they develop for you using the constitutive models within ABACUS and there's a bench primarily against your experience, not wider use for other reasons. This is really a customized --

MR. CAHILL: Exactly. It's a customized model of CR-3's containment and that is our prime standard.

MEMBER SHACK: Not the geometry. As Said -- in the constitutive model, in the concrete model, this is something that they've used widely?

MR. CAHILL: ABACUS has used this before. It's not something that has not been used in the past. I'm not familiar with I guess the detail of the question you're asking as how they map that to our --

MEMBER SHACK: Not a structural guy here.

MR. CAHILL: No. Sorry, I can't give you much more detail on it than that.

CHAIRMAN SIEBER: In your conclusions, the third one down says delamination occurred during the outage. Could you describe to me, first of all, the mechanism for the delamination? What caused the delamination to occur? And could you describe to me why you believe that it occurred during the outage?

MR. CAHILL: The mechanism was going through and looking through the stresses that were created for the actual opening of the SGR opening. I mean that's where -- those stresses did not exist when we had tension containment to start with.

CHAIRMAN SIEBER: What caused those stresses?

MR. CAHILL: That actual sequence and opening of the -- detensioning of those tendons, the 17 tendons that we detensioned, the horizontal tendons and vertical tendons that were detensioned in the opening of that SGR opening. That created a very significant change in the stress profile there which traditional analysis would have said was acceptable and met working stress requirements.

CHAIRMAN SIEBER: Don't you have procedures for tensioning and detensioning? Did you follow those procedures?

MR. CAHILL: The procedures are for the actual physical acts of it. We actually had to go and -- you don't have procedures that tell you how to detension significant amount of tendons. Containment is not designed, not intended for that. We had to do an engineering change, a formal engineering change to support that evolution for the steam generator replacement. So that was an analysis that Sargent and Lundy did for us to look at the actual structural aspects of detensioning those tendons to support the effort that we did to open up that containment opening.

CHAIRMAN SIEBER: So that analysis, since delamination did occur that analysis was faulty?

MR. CAHILL: Yes. It was not faulty, but it also was not --

CHAIRMAN SIEBER: You did the analysis so it wouldn't happen and then you went and did the activity and it did happen, so something goes to be wrong.

MR. CAHILL: It did not go down to that level of detail to be able to model this. Some of the things that propagate delamination are just some small existing cracks that exist with our design with our tendons. We have a very small -- we have a smaller amount of tendons compared to some other containments, so you have some nominal micro cracking that exists on top of the horizontal tendons to begin with.

Without having a refined niche, you don't model that localized behavior, so a typical element analysis like Sargent and Lundy did for us wasn't done to that level of detail. And even then when we did that level of detail, we still could not get I guess the propagation mechanism without going to a visco-elastic model to be able to get to a delamination phenomenon.

CHAIRMAN SIEBER: So there's at least one maneuver that you know that you can do that will cause delamination that you could not predict in the past.

MR. CAHILL: There's one --

CHAIRMAN SIEBER: This event occurred, even though you did an analysis. The analysis did not predict delamination, but delamination occurred. The only way you found it is because you disassembled the area to make the opening to change the steam generators. Otherwise, you wouldn't even have found it.

MR. CAHILL: Well, we did for the initial phases of opening, we have confirmation they did not exist beforehand. And we presented all this to the staff in the past why we had that level of confidence. So I really wasn't prepared to get into some of the details that you get with the root cause. The staff has concurred with that and did do a lot of investigative work with the evidence we had at the time to confirm delamination could not have been pre-existing.

CHAIRMAN SIEBER: I guess I have to be convinced before I can vote on your application.

MEMBER REMPE: Your response was that you had a lot of other cracks in the concrete. Does this impulse response method detect those other kinds of cracks, too?

MR. CAHILL: No, it's not really particularly well suited for that. It's well suited for going through and finding something that's I guess in the plane of the surface that you're going against. Some of these other cracks which we'll get into some details of what we found and what we've done about them and impulse response is not really very well suited to give you a crack basically in the same plane of the direction that you're taking the reading in.

MEMBER REMPE: So its orientation is not the size of the crack?

MR. CAHILL: Yes. The orientation has a big impact on the ability -- to be able to do -- we've been struggling with a good non-destructive evaluation technique to be able to accurately predict the crack that's in the same plane of the direction you're looking in. IR is very good for reliability predicting, detecting delaminations.

Let's go to the next slide.

MEMBER ABDEL-KHALIK: I guess I'm just trying to follow up on an earlier question. Of these 170 core bores, I guess you were able to see by just going with the boroscope and seeing what the crack is inside. Did any of these show a crack at a different depth?

MR. CAHILL: Not a delamination crack, no. No, not a delamination crack.

MEMBER ABDEL-KHALIK: Regardless of what you call it, did any of them show a 360 crack at any other depth?

MR. CAHILL: No, not something to that extent. There were some places we took localized core bores because we had like a void and containment just from original construction and a different bay outside of our repay bay, so we find things like that when we took some of these core bores. But nowhere else did we see another true delamination from taking a core bore. The cores that we took validated our IR scans showing the delamination. It saw something on the ability factor, we would go take a core and we would see about nine or ten inches. We'd see a 360 delamination crack. And depending on where you took those in the different areas of containment, as we detension containment further to help facilitate the repair, that delamination opened up as we took some of the pre-stress away from all those tendons. So it varied in width in some of those locations in Bay 3-4 where we took I guess probably most of our core bores.

To answer your question, that was pretty consistent. We saw the delamination and really nothing else. We never saw -- that would be a delamination if we saw 360.

MEMBER ABDEL-KHALIK: Right, that's what I'm trying to get to.

MR. CAHILL: No. We did not see anything other than delamination phenomena that we were looking for here. And that's why I made the point of drawing that picture on the very first slide. We have extensive, as I said in these presentations before, we've gone into very deep detail and some of my staff have been there to support exactly where each of the core bores was, what the extent of delamination was, in a lot more excruciating detail than I was planning to do here. But it confirmed, like I said, with the scans and cores through all six phases of containment. It confirmed that extended delamination was only in Bay 3-4 and was within that pattern that I showed you. That was a very simplistic version of it. I have a lot more detail. We actually brought in IR scans. With the mobility numbers is they varied across all containment we presented in our previous public presentations.

MEMBER ABDEL-KHALIK: You indicated that there were 75 potential failure modes and of those 67 failure modes were refuted?

MR. CAHILL: Yes.

MEMBER ABDEL-KHALIK: What was the basis for refuting those failure modes?

MR. CAHILL: Physical evidence or testing results. Like a failure mode could have been like we had an inadvertent building spray actuation many years ago. That could have possibly caused a slight vacuum being pulled on containment. That was something that was investigated thoroughly and the evidence was put in place to refute that that could not have been. And that was in the category of operational events. There's things like external events. Could a hurricane have done this? So those are the type of things. I mean some are very obviously unlikely failure modes, but they were all considered. That's the methodology PII proposes or does is lay out all these potential failures modes and you can't take them off the table until they've got something to refute them.

MEMBER ABDEL-KHALIK: I'm trying to understand the difference between the word mode and the word initiating event.

MR. CAHILL: It's probably somewhat synonymous for the sake of this discussion. Something that potentially could have caused this event. Really, no rock was left unturned looking for different things to put on that failure mode's list. So that was a significant amount of effort. The beginning was just to go through a lot of our operating history and the history of the containment to make sure that we had considered all the potential possible things that could have been out there.

You've got to recognize, when we first saw this, nobody had ever seen this before. It was a very unknown, there was not a lot of expertise to rely upon, so we cast a very wide net looking at what potentially could have been the cause of this.

Just on the summary for the root cause though, if the root cause was a combination primarily of inadequate detensioning scope and inadequate detensioning sequence, that caused us to exceed our tensive capacity in those areas and caused this delamination to occur. But there were several failure modes that were not refuted, so some of those were attributed as contributing causes. So there's multiple of those that contributed to delamination, but the root cause was described as the detensioning sequence and scope because if we had not done that, we would not have gotten into this event.

But some of those other contributing causes I mentioned are design. I touched on that before. Compared to some other similar pre-stress containment designs, we have a fewer number of tendons, so we tend to have a slightly higher stress concentration just because we have more force on each of those individual tendons.

MR. BARTON: Is that the reason you think you had the problem in other plants that have a similar containment that they had to cut a hole in containment to replace steam generators did not experience this?

MR. CAHILL: That is one of several. And other containments, other containments have done similar detensioning scope and sequence like we did. Others have a detension further and taken more of that pre-stress out. So we've looked at every single other steam generator replacement opening and tried to compare those. That was a lot that was put into building the failure, the potential failure modes. But another one key contributing cause was our aggregate. This is an issue the staff has discussed at length with us.

We use a Florida limestone-based aggregate. It is clearly not as strong as a northern granite-based aggregate. It met all of our design requirements though, that's a key thing that we looked at to make sure that we were not outside of our design basis.

MR. BARTON: Did you say the concrete is somewhat different than other containments with similar design?

MR. CAHILL: Yes. So those things added up to get -- basically, give us the higher potential for this to happen. But ultimately, it would not have happened and there was no design problem until we went through this specific detensioning scope and sequence, which we could not have predicted based on the tools as you mentioned.

CHAIRMAN SIEBER: Wasn't there some plant years and years ago that ended up with relaxation of these tendons that caused containment problems? I would have to look through my operating history records, but it seems to me I remember something like that. I don't remember it resulting in delaminations in concrete, but there are mechanisms where tendons can detension through --

MR. CAHILL: The creep phenomena and

things like that. That's why we keep testing them to make sure that we understand their --

CHAIRMAN SIEBER: And do you retension your containment tendons from time to time? Or do you check that?

MR. CAHILL: We check that as part of our normal program, our containment inspection program checks those tendons periodically on given intervals. We've not retensioned any of them. I'll talk about what we're doing at this outage.

CHAIRMAN SIEBER: You have actually checked the tensions as part of your surveillance program?

MR. CAHILL: As part of our surveillance program and you have, I guess, the time analysis as to how they're going to behave over time and you're checking to make sure they correlate with that. That was an extensive part of our investigation was looking at the results we had previously had to see if there was anything from those previous surveillance results that indicated something that we had a phenomenon going on that could have caused this delamination. That was also refuted.

CHAIRMAN SIEBER: Do you recall the periodicity of the checks you make on the tendon tension?

MR. CAHILL: So that I don't get the facts wrong, I'll let Rick Portman answer that because that is his program. He is the one that is accountable for making sure those periodicities and that surveillance program is met.

CHAIRMAN SIEBER: Before we even do that, do you take credit in your on-going life extension for the program you have to check the tension of tendons? That could be a part of the solution to this problem.

MR. CAHILL: Yes, that program is credit and license renewal credited. It's an existing ASME program.

CHAIRMAN SIEBER: Let me -- you can let your colleague speak in a little bit more detail about this.

MR. REYNOLDS: Crystal River Containment IW/IWF program manager. For our surveillance for the tendons, every five years we do a percentage of our tendons and test them for lift off of forces and we project those over the life of the plant. And our current projection is that they will be above the minimum requirements for the next 60 years.

CHAIRMAN SIEBER: What was your findings the last time you did this?

MR. REYNOLDS: Last time we did this was in 2007. And we had a few that were below the 95 percent requirements at the time. Since then we've also gone back and taken a look at our calculations that we use for that input and some of our creep values that we were using at the time, we have since changed and gone back and looked at everything that we've done in the past was above the 95 percent level.

CHAIRMAN SIEBER: Okay. You have a couple instances where you had to re-tension?

MR. REYNOLDS: Yes. We had a few that fell below the 95 percent and retensioned them up to the predicted values.

CHAIRMAN SIEBER: It's my recollection that Crystal River 3 is not unique among those that have this type of those tension concrete containment vessel. Are you familiar with other plants that are of similar design to yours? This is not a unique situation, right?

MR. REYNOLDS: I don't believe it is, no.

CHAIRMAN SIEBER: Okay. I don't know for sure, but I don't believe it is either.

MR. CAHILL: Anything else?

MEMBER SHACK: There was a statement made that you had fewer tendons than most plants. I don't know that it's unique, but you are somewhat different in design, apparently.

MR. CAHILL: Yes. There's a difference and that's one of the things we looked at is what made us different. We didn't realize that several other containments just have more tendons to disperse to individual forces.

MEMBER SHACK: Are there others who have as few as you?

MR. CAHILL: It's not -- I mean -- do you know the answer to that, Rick?

MR. PORTMANN: I believe we have less load factors as our tendons are actually physically larger, therefore we have less than others, larger wires.

MR. CAHILL: As far as raw numbers go, I'm not sure -- I can't answer that off my head. It's looking at basically how much you have in a given area. We saw our design was on the low end of that.

MEMBER ABDEL-KHALIK: Maybe we can ask the staff to answer that question when the time does.

MR. CAHILL: Going back to the root cause slide though, the one other one contributing cause I did mention was I mentioned that in the slide show in the graphics before. We didn't have any radial reinforcement in this area. It was not part of our original design, so that was also something that some other containments had some differing degrees of that and we saw that as well as the contributing cause. That was not a design problem for us until we went through this detension sequence.

So in summary, we did a pretty thorough and detailed root cause investigation. Recognized our containment was not designed for the scope of the detensioning that we did and going through that evolution, in the manner in which we did, was what caused the delamination.

I'm going to switch now and talk a little bit about more going forward in the repair phases. Just up there, an overview of six different phases. This plan was developed after a lot of exploration, like I mentioned before of various repair techniques. Most of those techniques would have been much less complex and a lot less time consuming.

We look at things like doing a grout injection of the repair to fill up the delamination. We looked at various anchorage methods, basically putting a different type of Hilti bolts or anchors or grouted anchors in to basically pull that delamination back together and structurally restore that by.

We looked at epoxy injection as an option.

Really, going through all those, we decided that none of those would have given us the confidence and the clear path to say that we have fully restored our design, design and licensing basis. So all those were rejected and we came up with a plan that I'll be talking about going forward.

So each of these things were driven by our Corrective Action Program. This was a formal root cause investigation we did in our Corrective Action Program, so all of these things were driven by the corrective actions coming out of the root cause that PII developed for us.

Our overall big picture work load shows five engineering phases. There are formal engineering products driving each part of that. So basically up there on the slide I have Phases 1 through 5. Each of those has an associated engineering change or EC in our language driving that.

The first three phases were documenting removal and mitigation. We did a stress relief cut. That was basically before we started any work. We actually made a cut in the containment to make sure the extent of our delamination, now that we had defined it, did not get worse or we did not create a new delamination.

Then we went through a very detailed detensioning sequence. We had to have PII use our new model to actually --

MEMBER ABDEL-KHALIK: So the yellow line that you have on this photograph, is this boundary determined through measurements? Or is it determined through modeling?

MR. CAHILL: Measurements. That boundary was dictated by our condition assessment which was the IR, the impulse response technique, as well as our core bores. So that was what determined what that boundary was and what the scope of our delamination was, those efforts.

MEMBER ABDEL-KHALIK: What would the model predict for the boundary of this region?

MR. CAHILL: As I said before, the model had to be largely built -- we needed something to calibrate it against and it was calibrated -- that was our prime standard, our benchmark for that model was that actual physical artifact we had left after this. So when you say what would it have predicted? It is set up to basically predict that.

MEMBER ABDEL-KHALIK: So the model is not an EPRI model that would have told you what the extent of delamination --

MR. CAHILL: There was nothing existing and we did go out and look when we realized that the existing tools were not adequate to predict this. There was nothing out there that was an off-the-shelf model or tool that could have accurately predicted this. And that was part of the initial phase of the investigation with PII was looking for other techniques that could have helped us with this.

We went through all the other vendors who had ever done these -- worked for steam generator replacement openings looking for other techniques that they may have used that we were not aware of and could not find anything going forward working through those, as well as with folks like EPRI. So that's why we built this model based on the ABACUS tool to be able to accurately model this.

MEMBER ABDEL-KHALIK: I'm just still trying to understand then what is the purpose of the model?

MR. CAHILL: The purpose of the model was one, to be able to replicate it, but we've used that model extensively to go through the second phase of this detensioning. When we made -- when we decided the scope of our work was going to be remove this delamination, we had to detension all the tendons pretty much in the repair area. That's a significant amount of tendons that had to be detensioned.

And knowing that detensioning those tendons is what caused this event in the first place, we would have been proceeding blindly unless we had an analysis technique to be able to predict what was going to happen next.

CHAIRMAN SIEBER: Would it not have been appropriate to detension the entire containment, do it in phases so as to balance the stresses in the concrete structure? Is that what you did?

MR. CAHILL: Detensioning is a significant devolution to a containment.

CHAIRMAN SIEBER: I understand that.

MR. CAHILL: In our analysis, we looked at the scope of that and came up with -- our experience has been every time we go further with delamination we wind up creating more problems. So that was something that was considered as a possible scope, that the sheer amount of that effort and the challenges that would have created with basically completely relaxing containment would have -- with where we were to start with which was the SGR opening, a delamination place, we elected not to go down that path.

CHAIRMAN SIEBER: So you made this cut to be the stress relief, detensioned in the area that you wanted to work, and on what do you rely since you created the new stress pattern, you probably don't know exactly except by analysis which means you don't know exactly, how do you know that the damage didn't spread?

MR. CAHILL: After we did detensioning, we did comprehensive further scanning to make sure and I'll be talking more about the scanning we're going to be doing to make sure we did not get delamination elsewhere. But we used this model to basically come up with a detensioning sequence. It was a very precise sequence and nowhere near a normal tendon tensioning sequence per the industry standards, precisely set up by PII using this model to make sure that we did not get a perpetuation of this delamination.

CHAIRMAN SIEBER: Detensioning is usually done sequentially and in stages. It takes a long time.

MR. CAHILL: It's usually done, optimized for moving platforms up and down a site of containment, it's optimized for the workers.

CHAIRMAN SIEBER: To minimize the stress.

MR. CAHILL: That was not the path we took because it was very inefficient what we did for detensioning as well as for what we're doing right now for re-tensioning is very inefficient as far as from a work point of view. But it's all done to make sure that we are staying within the bounds of what this tool predicts.

CHAIRMAN SIEBER: I don't think you have a choice.

MR. CAHILL: Exactly.

MEMBER SHACK: Just in the sequence, somehow I make the cut and then I detension, so my gut tells me I want to detension first before I cut. What would I exactly cut?

MR. CAHILL: The cut was really just an I cut within that outline that I showed you before, within the delamination area. It was basically to give a stress relief path when we took more of the stress out because there was still a lot of tendons fully tensioned going through that area.

So with the initial analysis we did, we realized that there was a potential for it to grow further and we did not want to give it that. As that stress was relieved by detensioning those tendons, we wanted it to be relieved through this cut. Sot it was a very simple evolution of just basically making an I saw cut in there and it worked very well. We saw that's where the stress relief came when we detensioned tendons further. So that was why that sequence was set up that way.

I'll cover some more details on this in subsequent slides. The next phase is the concrete placement, number four, and re-tensioning, number five. We've considered those our restoration phases. And those are the bases for our final engineering changes and our design basis restoration that the staff has been very -- has been interacting with us on how we get back to restore and say that we can do this. Because we're doing it via 50.59 approach.

CHAIRMAN SIEBER: Let me ask a question here. You made the opening which means you had to remove some tendons and rebar and all kinds of stuff. You replaced all that after you went through these maneuvers to try to limit the delamination and to remove it to the extent that you can. Now the rebar patterns and the tensioning cables, are they consistent with the design of the remainder of the containment in that these are all post-tensioned and not heavily rebarred to say here's a flat plate in an otherwise flexible membrane?

Did you rebuild it the way to its original condition or is there something new or extra or something missing in the latest -

MR. CAHILL: You'll see this in going forward that we considered this a significantly large repair. We changed a lot of the actual physical features in this, but one of the reasons again not detensioning the entire containment was to not take -- we had to very early on decide how far we were going to take this to set the starting parameters for the new repair design and as you'll see, we put a lot of rebar and reinforcement into the repair bay, but basically on that starting point, knowing the sequence we would go to restore it.

CHAIRMAN SIEBER: I saw the slides. That's why I asked the question. It looked like more rebar than I'm used to seeing in a post-tension containment under construction. So my question again is is the rebar design in other pictures in the section that you replaced different than the original design?

MR. CAHILL: Yes.

CHAIRMAN SIEBER: And if it's different, does it have different stress strength characteristics under, for example, seismic conditions, pressurized conditions? How does the redesign of that section affect the remaining sections?

MR. CAHILL: We've done several formal analyses and calculations.

CHAIRMAN SIEBER: Okay.

MR. CAHILL: We used another vendor, MPR, is one we relied on heavily to do analysis for that looking at -- really literally now we'll have a much stiffer Bay 3-4 because of the amount of reinforcement it has there with a significant amount of new concrete. So we did look on the effects of adjacent bays, on our liner. We have several formal engineering analyses and calculations that the staff has reviewed in detail. We've had a lot of interactions with Meena's civil staff on each of those individual changes and looking at the technical validity of each of those going back to what our original design basis was to make sure that it wasn't invalidated.

So yes, it is a big change from that perspective because the other bays don't have that level of reinforcement. But we did a lot of engineering work to support that.

CHAIRMAN SIEBER: The reason why I did look through the slides that come after this one, it seemed to me like the rebar design that I saw depicted in the slides was more like standard containment, as far as rebar density and spacing is concerned as opposed to my memory of what post-tension containments look like in their skeletal structure. Is that a correct impression?

MR. CAHILL: Yes. And a lot of that had was dictated by the design with a starting point where we were on the stresses that the design team was faced with with the amount of detensioning we did where you start from to get it back to the final pre-stress levels.

CHAIRMAN SIEBER: Now did you do an analysis that examined the whole containment, perhaps finite elements or otherwise with these two different methods of construction combined together to see how the containment would act as a whole?

MR. CAHILL: Yes. Both where PII has done for us and just looking at a re-tensioning sequence, but really, the design basis work that MPR has done for us has done that, has looked at from a finite only point of view. We have several formal calculations and analyses and as a part of our engineering change, those last two I mentioned about concrete placement, it has analyzed all that and we've been reviewing it with the staff to make sure that we still stay within our original stress strain characteristics for the original design basis. So that has been done.

CHAIRMAN SIEBER: You were able to do this all under 50.59?

MR. CAHILL: And we had a lot of discussions with the staff on that.

CHAIRMAN SIEBER: More than a two-page report.

MR. CAHILL: I also mentioned we were here on June 30th. We had a very long meeting with the staff just to lay out the approach and the strategy for that. And that's not -- we're not done yet, so there is always the chance that the staff -- that's an open question on the 50.59. We're still working through those.

CHAIRMAN SIEBER: Your responses answered some of my questions, but not all. I will have to do some homework on my own. Why don't you continue?

I think the members will see what I'm talking about when they look at these photographs that we have on the slide.

MR. CAHILL: As I mentioned, I made the comment before that a lot of this work had to be done to -- it had to be informed by the root cause and that's really the reason why. We needed to understand that phenomenon before we could make sure we had the design confidence to make sure we went forward with this.

The next slide kind of touches on what we've been talking about, but our overall conclusion was that this is a summary coming out of our design basis team that our containment design features that remain unchanged, we've done this via 50.59. I mean obviously some of the actual physical features have been altered, but we think we've been able to make a very sound case that we can do that under 50.59.

We maintain our original containment design basis. We still have a leak-tight structure to contain fission products in the design-basis loss-of-coolant accident and that's really done by an elastic response to the design basis loading preserved to protect the liner. The liner is the ultimate fission product barrier that this entire structure is designed to protect.

So all of our design loads and combinations are based on our accident and not local code requirements and we continue to apply the same load factors, provide safety margin. So we verified that all our stresses and strains stay within our design and licensing basis.

We sort of touched on this already, but our delamination repair was after the cut, we detensioned containment. We took 155 horizontal tendons and 64 vertical tendons, actually detensioned them and removed them from their sleeves. This detailed sequence analysis as I mentioned before that PII had to develop out of their model for us.

Pretty much all the tendons in the repair area of Bay 3-4 have been removed. There's still some on the right periphery and up by the ring girder that are still in their locations and as you can see in subsequent pictures, we did not remove those.

The delamination was fully removed. That was the initial charter of this. The initial charter of the concrete removal engineering change was to take down concrete enough to get to a nominal one foot level to remove all trades of the delamination. But as you'll see going forward, we wound up taking it to a significantly more extent than that in some certain areas.

When I say the delamination is fully removed, that's in our Bay 3-4, so that's elevation 157 up to 240 elevation. We wound up with different variations in the level of our concrete removal and I'll show you that in some pictures as we go forward.

And beyond that, we wound up also doing some excavations to repair some vertical cracks that we found in the course of this repair.

And then going forward to install the reinforcement, there this extensive new radial reinforcement. This is another area we've had extensive discussions with the staff on, on the scope of that design, but as I mentioned before, we did not have radial reinforcement in the original design and we put an extensive amount of that new radial reinforcement into places where the design called for it in that plane.

And as you'll see in the pictures we've added an extensive amount of horizontal and new vertical reinforcement.

MEMBER ABDEL-KHALIK: Now what confidence do you have that this additional detension has not created another delamination 10 or 12 inches deeper than the original one?

MR. CAHILL: As you can see here, we went down to the main, middle part of the containment. We've gone all the way down to the liners, so there's no place left to delaminate. And those other areas on the two sides of that you can see that that's about a nominal 24-inch excavation of concrete. So we've got pretty extensive access to it and I'll talk a little bit later about some of the vertical cracks that we found that we wound up excavating and refilling. It gave us an opportunity to go all the way down to the liner in some places.

We did not see any evidence of delamination. We have a high degree of confidence that delamination -- our design was sound and the repair we went through did not propagate it any further and make a new one. We did have one, I guess in the repair opening, we had I guess a secondary one and that was one of our reasons for driving to take just all the concrete off to make sure there was no doubt about that in that middle area which you can see we've gone all the way down to the liner.

One other thing I just want to point out, as you're looking at this picture, this is the back of our liner right here. So this is the liner plate. These are the stiffener bars that you see and those are the vertical stiffener bars that are reinforcement for the liner. You can see now this is the original SGR opening and you can see the weld where it was cut out. You can see we extensively went beyond the original steam generator placement opening in the extent of what we removed.

I point out the liner back to the subsequent discussions and I know this is obviously a very big license renewal question is the condition of your liner. One of the things that this repair afforded us was extensive opportunity to get access to the back side of our liner to be able to see the condition of it.

You'll notice that up in the top levels up to the ring girder, we did not remove concrete there to the same level of depth because of that existing reinforcement, there's extensive reinforcement of the ring girder, both down on the bottom by the equipment hatch. But nominally, we took down to three different depths. In the middle, we call that our full 42-inch depth. On those two side columns, you'll see -- we call that a 24-inch depth of excavation out of our original 42. And then on the sides here, where there is existing reinforcement also by the ring girder, we've taken it nominally to 1 foot to 15 inches, again, to make sure we removed all traces of delamination. But up in those locations you've got a significant amount of rebar that already exists there from the original design that would have made any more excavation challenging.

Our engineering change, the one on the

Phase 3 for the delamination removal dictated exactly how we left this. It has a very precise amount of the criteria for leaving in place the geometry so that when we come in and pour concrete into it later, it's going to be filled without any voids. There's also surface roughness. We have a new to old concrete interface here and there's some very precise requirements and QC checks on the surface condition to make sure we had a good bond between the new and old concrete.

This is just a picture to talk about some of our radial anchors. These are the actual radial anchors that I mentioned. This is an outer -- this is our new outer rebar mat. You can see it's outside of the plane of the horizontal and vertical tendons, but these radial anchors are hook-shaped bar connected to this outer rebar mat with that hook or grouted in a hole that's a bore about 20 inches deep so it's routed in there and there's substantial radial reinforcement. And they're extensive, as you can see the picture. They're quite closely spaced.

This is as we went through the phase of reinforcement installation, this is putting the inner layer of rebar mat. This is an area I mentioned in one of the pictures. We did not have any rebar, so as you mentioned before, there's a significant change to this as far as an outer rebar in there. So there's inner rebar mat as well as vertical cages that have been put inside the hoop and vertical plane, vertical tendon plane, excuse me.

CHAIRMAN SIEBER: And the vertical tendons you can see in this particular --

MR. CAHILL: Yes. This is our final picture. You can see some of the extensive amount of reinforcement that's been put in there. We've got about 52 tons of steel that has been put in this repair effort. You can see these are some of the vertical cages as well as there's an outer mat outside of that, so it's a much more congested, more highly reinforced. And that again was dictated by the design that was developed for the starting point where we left containment about doing the detensioning.

This next slide is a very important one to us. As you noted, this was a unique repair effort, not something that any other utilities have had much experience with. So one of the fundamental things that we put in place was a mock up. This is actually our mock-up wall that was built outside of our fence. This is a full-scale mock up and it basically mimicked every depth of excavation I mentioned before.

It's mimicked every reinforcement feature, every anchorage technique and we actually placed concrete fully in this model, put forms up there, fully placed the concrete, and then cut it open at the end to make sure that we validated that we were getting the results we expected.

I think that's a pretty unique thing showing the amount of rigor we put in to making sure we knew what we were leaving behind with this as far as the construction and design techniques. This was a challenging physical effort and we wanted to make sure we knew we had it right. That mock up is something that was very time consuming, but I think very important for us so going forward to have confidence in our repair.

So going forward at replacing the concrete, I'm not going to go into a lot of detail on that, but we wound up placing concrete in five-foot lifts. That is a small amount than the original construction was done. It was done in ten-foot lifts. A lot of that was dictated by the lessons that we learned on our mock up before we actually went up on the wall. We actually had an on-site batch plant to develop the engineering mix that we had designed. We used the same mix that was planned for the steam generator replacement opening which is optimized for our existing concrete already in the aggregate we have.

Again, the next phase of that was the retensioning sequence. That's in progress right now. We have to go retension those 155 and 64 vertical tendons. We have approximately touched 30 of those thus far.

CHAIRMAN SIEBER: Okay. I'd like to just stop just for a second. We have a question from a person on the bridge line. In order to do that we've got to rearrange the telephone system a little bit. After we do that, we'll see what the question is.

There are enough people on the bridge line so you'll have to drop somebody off in order to get enough volume and low enough impedance to get the question and then we'll connect it all together again.

I noticed the one picture, the back side of the containment liner, the liner doesn't look particularly smooth in that picture. Is that just an artifact of construction or --

MR. CAHILL: Yes.

CHAIRMAN SIEBER: Or an artifact from removal of all the concrete?

MR. CAHILL: You do have some stress

relief from moving the concrete and the tendons and we did see the liner move, but we had the same concern and looked into that and looked at our original --

CHAIRMAN SIEBER: Now has it changed during the life of the plant for -- did all the change to the liner surface occur during this deconstruction repair and reconstruction phase.

MR. CAHILL: You mean change in the surface, you mean just change in the general --

CHAIRMAN SIEBER: It doesn't look smooth. All the pictures I've seen it does not look very smooth compared to other containment liners that I've seen.

MR. CAHILL: I don't think you've ever had the chance to see this much of an extent to the back of the --

CHAIRMAN SIEBER: Nor have I ever had the opportunity to see much of the back of anybody's liner.

MR. CAHILL: But there was some stress relief from the repair effort. We saw that when we took the steam generator replacement opening, just the detensioning of the original scope of tendons caused some stress relief once we took the original liner out for the SGR Opening and we just saw some of that.

CHAIRMAN SIEBER: Are we set? Go ahead. We'll just take a few seconds to see if we can accommodate this question.

MR. BARTON: While we're taking this break, the question on -- you've had some areas of your liner where you've got bulges. Where this liner is exposed in this one photograph, on the inside of that liner in that area, are any of the bulges that you found in that area?

MR. CAHILL: Our bulges are dispersed and I'll be talking about that later, but they're dispersed pretty much all in different portions of containment. So yes, we had the opportunity of being on the back side of the liner where we could see them, particularly when you had up at the upper levels where you had to cut and you had the concrete still up against the portions of the liner. You could see actually, you could get behind them and see that there was a gap in some places between the liner and the concrete. So this gave us a good opportunity to --

MR. BARTON: Were you able to find anything in the concrete that would account for closing the bulge?

MR. CAHILL: Absolutely not. Obviously, we had that same concern and that's why we went after the bulges as aggressively as we did.

MR. BARTON: Seen at other plants whether that bulge is -- that a bulge -- all kinds of debris causing a bulge.

MR. CAHILL: I've got a couple of slides we're --

MR. BARTON: I note that later on.

MR. CAHILL: I can conclusively say no, we have found no corrosion or debris mechanism whatsoever that has been behind any of these bulges that accounts for those. And we went up to a pretty extensive effort to be able to account for those bulges to understand why they are there, what the cause was. It's not any mechanism such as that.

MEMBER SHACK: You did your structural analysis to verify your design basis behavior. Did you carry that to above internal pressure ratings above design basis so your ultimate strength was affected?

MR. CAHILL: Yes, we've done different looks at the analysis and we've got the factored loads that we have --

COURT REPORTER: Could you repeat that?

MR. CAHILL: I said we've had very detailed interactions with the staff and the special inspection team on the nature of that design. That's been a very key issue that they've been pursuing.

CHAIRMAN SIEBER: Is there anyone on the line?

MR. HOLIAN: Lou Lake, are you still on with Mark Franke? We had an issue earlier whether the region was on the line and they just could hear us and they couldn't speak. So Kent will check on the people that have come down. There wasn't somebody who was asking a question. It was NRC staff trying to tie in. So at our break we can see, but we can continue.

MR. CAHILL: All right, I mentioned retensioning that is in progress now. We are doing a very detailed sequence that's very inefficient, but it's using partial tensioning. We're actually -- each tendon we're going to touch twice. We're going to tension it half way, leave it, go on to some other tendons and then come back at a later point in the overall sequence and fully tension that last tendon.

Also of note as part of our overall design, the 80 remaining vertical tendons, these were not part of the 64 that I mentioned that were detensioned and removed. Those 80 other ones will also be reset to the original construction. So they'll be consistent with the 64 that we actually removed. So they will all be detensioned to the same original construction value, essentially reset.

And the last part of the repair and I'll be talking about this later in some subsequent slides is we plan to as an owner-elected structural integrity test, we plan to perform followed by an integrated leak rate test.

A little bit to discuss on the impacts on the containment liner. Our exposed containment liner reinforcement were very thoroughly examined in accordance with the Section XI Code requirements. And we did note and that's why we put the picture up there, that we've found minor indications. There's nicks and gouges, some welding arc strikes at the liner rebar. Each of those areas was evaluated in detail and repaired to restore the materials and surface conditions to meet the design requirements.

We did find a lot of those indications, some of them were from original construction. None of them were significant, but all those repaired. Some were created by actual repair effort, just the extensive amount of work as you can imagine removing concrete, you've got to be very careful not to damage the liner. And our construction team did a good job at that, but we did find some things that we had to go repair. But I can tell you with confidence we've gone over this inch by inch and our liner was in pristine condition before we placed concrete against it.

CHAIRMAN SIEBER: Did you find any due to corrosion or other aging effects?

MR. CAHILL: No, we did not and that's one of the things with the extensive amount of access we had to the back side of the liner, I think unprecedented compared to any other utility, we did not see anything along those lines.

CHAIRMAN SIEBER: Okay.

MR. CAHILL: I can say with confidence that we've restored the liner in much better shape than it was found in this area.

Another thing to note, I mentioned this before, is some impacts on the liner. We did note additional concrete cracking. As we went through the repair effort, we did find some vertical cracks. As I mentioned originally, our design was not to take this all the way down to the liner. We did see vertical cracks in Bay 3-4 as well as some horizontal ones above and below the opening. They were caused by residual stresses which after the fact we could very clearly understand why they were there, but we elected -- and that's one of the reasons that drove us to the decision in this area to take it all the way down to the liner.

These are some of the vertical cracks that I was just pointing out. They're actually highlighted in yellow. We had done that as part of mapping of those. And they are exacerbated by the actual hydroexcavation tends to wallow these out. They are tight, fairly hairline cracks, but hydroexcavation makes them look bigger. But each of those cracks were excavated and they were either completely refilled or restored to a geometry that when we did final placement that we validated with our mock up and we'd get it completely filled in.

So these cracks as they look now, they were completely repaired except there was some horizontal cracks and exist in these places over here that we just completely remove by taking all that remaining concrete out. There are some cracks that -- some hairline cracks that are in the areas edged by the buttresses that we wound up leaving in place because of existing reinforcement from a design perspective was already there to address the potential for concrete cracking.

Again, this is an issue that we've had extensive interactions with the staff on, on the nature of the cracking we found and what we've done on each one. But just this effort to go repair these vertical cracks that I just highlighted with the laser pointer, that was about a month and a half repair effort to make sure that we did the right thing with those --

MEMBER ABDEL-KHALIK: Now these vertical cracks are not exactly vertical, but yet the spacing seems to be roughly uniform between the cracks. Is there a mechanism that you have explored that would allow you to predict the spacing of these vertical cracks?

MR. CAHILL: I mean they generally run in vertical tendon alignments, but they're really driven by just the residual stresses as we detension containment. Basically, if you look at this we took typical tendons that were on top of this, took away that, and then took away all the hoop tendons and basically kind of opened up this bay. That's what created the vertical cracking. So we did go back and validate with analysis the cause of them and it was somewhat expected. We knew going into this repair effort we ran the risk of that.

It would have been a lot simpler for us physically to take that concrete and just completely remove it and start over. But would be very problematic because then we would have had to go to significantly more scope of detensioning because that concrete that's left there that you see was actually still structurally holding the weight of the ring girder as well as the ring. The only vertical tendons that were detensioned were in this bay and the one exactly opposite on the back side, Bay 6-1. The vertical tendons in the other four bays were still tensioned, so there's a significant amount of force still existing in this containment.

CHAIRMAN SIEBER: Now these are all vertical cracks.

MR. CAHILL: Yes.

CHAIRMAN SIEBER: And I would think that vertical cracks were like tension cracks. If you detension horizontal tendons, would that not cause the stresses to give you vertical cracks around the entire circumference of the containment?

MR. CAHILL: Yes, we did see some of those that were not just for releasing the stress, but just due to the release of the creep and the differential between the steel conduits and the steel that was left and in the concrete. The concrete had crept over 30 years of being in full tensioned containment and when we detension those tendons in those elevations where we removed those tendons going around, we did see some vertical cracks in areas outside of these areas and hairline cracks.

CHAIRMAN SIEBER: Obviously, I could see the terminus of the horizontal tendons and the vertical ones actually, in the areas where you're all the way down to the liner, so that's -- all that tension has been relieved and created a whole new stress set up in the remainder of the containment shelf and I would think there would be cracks everywhere.

Do you know whether there are or not and if you know whether there are or not, does it make a difference from the standpoint of structural integrity?

MR. CAHILL: We've looked and we've done extensive mapping of all the other bays and we do see in a certain elevation band which correlates with where we've done the retensioning, we see on surface indication we seen some evidence of hairline cracks. They're all less than seven mils. Most of them are pretty much very tightly clustered around five mil range. And our cause determination determined that it was based on the detensioning effort.

We have looked at those and incorporated those in our design. We are expecting them and have actually seen and heard those closing as we have gone through the retensioning right now. So structurally we have assumed that they all go through-wall, but --

CHAIRMAN SIEBER: I would think so, but I don't know if you have any other choice as far as the integrity of -- the gross integrity of the vessel itself. You're relying totally on the tendons, not on rebar, not on concrete, right?

MR. CAHILL: Our design assumes that we have contact between all those places where there could potentially be a vertical crack and we have monitoring in place which I'll talk about later to verify that they have closed, as we expected, and we have that context, so that you can transfer sheer across that plane.

CHAIRMAN SIEBER: Have they analyzed containment, those assumptions that the only members to carry the load are the horizontal and vertical tendons, horizontal meaning the hoops?

MR. CAHILL: Yes, we've not credited in our design coming out of this, we're not taking any credit for any tensive capacity of the concrete in those other bays. So that's -- the answer to your question is yes.

CHAIRMAN SIEBER: And are you crediting any rebar?

MR. CAHILL: Are we crediting any rebar?

CHAIRMAN SIEBER: Yes.

MR. CAHILL: Not in those other bays because we don't really have any structural rebar other than around the periphery.

CHAIRMAN SIEBER: Well, it looked like you had some rebar in the repair.

MR. CAHILL: The repair, yes.

CHAIRMAN SIEBER: That to me looks like a different design than what I recall the regular structural design of this type of containment.

MR. CAHILL: Yes.

CHAIRMAN SIEBER: So you've got probably a hard spot in a containment that's basically more flexible.

MR. CAHILL: And we had to do extensive analysis to make sure that that was accounted for.

CHAIRMAN SIEBER: Yes, the analysis for that because it had discontinuities would not be simple.

MR. CAHILL: Yes. And the repair efforts is because you start with that discontinuity --

CHAIRMAN SIEBER: I presume the staff has reviewed the analysis that we're discussing right now?

MR. CAHILL: I can say yes, because I know we had a lot of interactions with the civil staff.

CHAIRMAN SIEBER: We'll ask them when it's their turn.

MR. CAHILL: Next slide, Jeff. Just overall, the liner is very important to us. The liner is our fission product barrier and the ultimate design of this pre-stressed containment is to make sure we protect that liner.

Now we've looked at all design impacts on the liner due to the repairs and evaluated those in detail which I mentioned before includes normal calculations and analysis that have been reviewed in detail by the staff. The results of these are validated that there is no impact on the current design basis of the liner. All our original strain limits continue to be maintained.

Next one.

CHAIRMAN SIEBER: Looks like we're about halfway through.

MR. CAHILL: Right now I'm going to talk about the liner bulges. These liner bulges are not new. We've seen these before. They're something we extensively investigated over the course of this extended outage because we had the opportunity and saw them and we wanted to make sure. But we did not see any correlation between the delamination event and these liner bulges. We've seen these bulges. They occur between the vertical stiffeners. You saw those vertical stiffeners in that picture before. They're 18 inches apart. And we had the opportunity to go look at those in detail.

We've always monitored these bulges in the past and evaluated them per our formal IWE Program, but the evaluations of those has always been qualitative. So as part of this effort we went through a very extensive extended condition effort to understand the scope of these bulges, where they were and we went through basically two phases of that. One is in upper elevations we performed detailed laser scans above our 160 elevation which is our refuel floor. And that's a significant force in our containment, well over half that we can actually use laser scanning to get very detailed measurements.

We also at lower elevations where you've got interferences, you can't reliably get the comprehensive laser scanning. We did the detailed visuals as well as manual measurements of the existing bulges.

We did mention before you were concerned about what we found on some of those. In our extended condition we found the bulges are random and normally distributed in location of size, but we wound up doing a UT measurement on our most limiting bulges, the largest as well as some of the representative samples. We have done others in previous outages and we've never seen any loss of wall thicknesses on any of those bulges, but the ones that we did during this outage which were our largest ones, we did not see any indication of any mechanism, no corrosion mechanism, no loss of wall thickness, anything that would cause, I guess, a concern for what other, I guess, liners have been the source of OE in the industry.

MEMBER ABDEL-KHALIK: What is the cause of the bulges themselves?

MR. CAHILL: I'll get into that if you just give me a minute, in the next slide. We took hundreds of UT readings on the liner, the portion that we had exposed. That was done for the steam generator repair effort and it was also confirmed that we don't have any mechanism that's causing us to lose any thickness on the liner. So we confirmed, I think, conclusively for the bulges that there's no wall thinning or corrosion mechanism that's associated with those.

This next picture, this is a typical output we get from a laser scanning. Laser scanning uses an auto-CAD feature to allow dimensioning of the bulges in 3-D. So we can measure any distances between of those imaged items. And these are typical of the bulges we have.

You can see there's actually measurements placed up there on most of them. Most of them are nominally, when we see them, are about a half inch at their peak in between the stiffeners and that's the measure that we take because that's the largest one.

And you can see that they don't, I guess, travel beyond stiffeners and they really can't because the stiffeners embed in the concrete, but they also don't go beyond the weld, this weld line which is just the different plates of the liners that was constructed. That nominally arrests any propagation of those.

Next is just a picture looking up. This is our containment dome. So you can see with the large elevations laser scanning is a very valuable technique to be able to comprehensive go out and map these. And it is a very precise technique.

Truthfully, it's been my first exposure to it in a lot of detail. I'm really impressed with the vendor we're using and the ability we have to get engineering data out of it.

After we got that extended condition behind us, we realized that we needed to probably do some more robust engineering effort to understand what the technical basis for these being acceptable was. Like I said, they had been evaluated before by a qualified professional engineer, a civil engineer, as part of our program is having no impact, but we decided to do something more comprehensive because we realized the only true acceptance criteria we had was kind of an existing thumb rule of .72 inches as far as the bulge. That didn't really have much technical basis behind it. Other utilities have been using it, but when we wound up pulling the string to understand more about that, we did not really find anything behind that beyond an original construction tolerance.

So we actually chartered a finite element analysis. We used structural integrity for this, as well as doing an apparent cause investigation in the course of going through investigating this data that we had gotten from our scanning inspections to understand what could have caused it. So that effort that they did include the bulge growth that could have occurred due to past load history as well as permanent loads on containment.

The result that we got from that effort determined that a maximum acceptance criteria for bulge is 1.82 inches. That limiting component that dictates that is the stitch welds on the stiffeners. They are designed to release so that you don't have those welds tearing apart the liner if you had a design basis event and you had movement, but as part of our design basis, we cannot allow that to be something that the bulges could allow to happen. So that was the most limiting component in that evaluation.

A very, I guess, noteworthy thing coming out of that investigation apparent cause though was the finite element analysis was unable to identify any loading condition that could create and result in a bulge. You always had to have some initial, I guess, anomaly just start. If the liner was in the design radius for the initial curvature of construction, backed by concrete, the bulges could not reliably be created. So only if there was existing, I guess, inward deformation could that be created. So most of the notable bulges we had, the details -- you had to have probably something greater than a half inch deviation from initial construction requirements in order to basically get something that could propagate over the design load, I'm sorry, over the history in the design loads of containment to get to the existing condition we saw now.

We've accepted this assessment and final element analysis. It's a formal part of our design basis right now. We've accepted it as a formal calculation and incorporated into our design basis as an engineering change.

Also, moving forward, this extended condition is something we're going to be keeping an eye on for a while.

MR. BARTON: When you do the SIT it will all go away.

MR. CAHILL: No, actually, that's a question -- I guess everybody expected that would be the case, but we don't expect to see much change in these things from the SIT. Everybody's gut reaction was oh yeah, it will just flatten out. They will not based on those pressures. That's something we had structural integrity to look at in than we do the model.

MEMBER ABDEL-KHALIK: So were these bulges observed from Day 1 or did they become more pronounced after the event you referred to where vacuum was created in the containment?

MR. CAHILL: And looking around the industry, other similar containments, I've seen examples of these. We know that they've been around. We have documented records of them in our program in various discrete locations from before that even. So they're not anything that is, I guess, a new phenomenon.

CHAIRMAN SIEBER: But these are unique to tension containments, right?

MR. CAHILL: That I do not know. I --

CHAIRMAN SIEBER: Where they're uniformly vertical?

MR. BARTON: I don't remember. I don't remember the other bulges, whether they were this type of containment or not.

CHAIRMAN SIEBER: Sub-atmospherics have bulges in different places because of pull away from the produced pressures.

MR. CAHILL: That's one of the things when we did the analysis was look at obviously the effects of being in tension containment for 30 years, you're going to have some creep and that does account for some of the bulge growth.

CHAIRMAN SIEBER: I'm sort of guessing, but I'm curious as to what the reason is because it tells you, once you know the mechanism, you're better able to make an analysis as to where it's going to go.

MR. CAHILL: The only mechanism we could find that there had to be some deviation from the usual curvature to start. There was no design or any event or anything like that we could find that would cause them to just --

CHAIRMAN SIEBER: How thick is the liner?

MR. CAHILL: Three eighths of an inch.

CHAIRMAN SIEBER: Pretty stiff?

MR. CAHILL: Yes.

CHAIRMAN SIEBER: Okay.

MR. CAHILL: This extended condition is documented in our IWE Program and we'll be tracking the most limiting bulges going forward. We'll do manual bulge measurements and as we continue to track make sure that we understand the response of those.

I guess something notable, the acceptance criteria is important to us because it gives us some allowable margin. As you can see up there the one most limiting bulge we have is at a 1.33 measurements. We only have four bulges that are even greater than an inch. Most, like I mentioned before, nominally that we see are much smaller dimensions, so we're very closely going to monitor those four ones because they are most limiting conditions.

But in summary, all the bulges that we have are within our acceptance criteria and we're going to continue to monitor those with our program with some augmented inspections which I'll discuss later going forward. We did just to note from that, the reason it says manual measurement up there on that dome bowl is we originally had a laser scan measurement. We went up and did a manual measurement just because it's a slightly higher level position than the laser scan and that's why we went up to do that.

Any other questions on the bulges?

This goes into my discussion on close repair testing. This is just a summary slide just talking about what I mentioned before. We plan to do an integrated leak rate test. This is required for, I guess, two main drivers out of ASME Section XI. Obviously, we had always planned on doing one because we removed and replaced the liner for the original steam generator placement opening, so we planned to do an integrated leak rate test before the delamination for that reason. But also the required pressure test per the code for the repaired concrete, the ILRT will be credited for that.

As I mentioned before, we also plan to do an elective Structural Integrity Test. Structural Integrity Test is normally something that's only done once in the life of a plant as part of construction. As we are characterizing this as repair, a Structural Integrity Test is not required, but we do intend to do one. So we're doing it electively, although we will do it fully in accordance with ASME Section III, the subsection which drives this which is CC 6000. We elected to do that just to make sure that there was no question that we were doing it to some different standard. So we're doing it per the original requirements. And that will be done at 63 pounds which is 1.15 of our peak design pressure.

The SIT will be done first, followed by the IRLT just because you need to have the IRLT second to verify leakage of containment before you can declare it operable.

This slide is going to be busy going through. This is the things that we're doing for pre-start up. All these things that I'm going to go through here are all driven and formally contained in our formal engineering change or EC that I mentioned before. The first section is just things that are driven by Section XI as part of repair/replacement.

We're going to be detailed VT1 exams of the new concrete surfaces. That includes all the new concrete in Bay 3-4, as well as all the other repairs, so every time we refill the core bore, any place we put a hoist or a scaffolding anchor bolt, those need to be done as far as Section XI requirements. And those inspections will be done prior to, during, and after the ILRT.

We'll also be doing detailed visual exams of the liner, the opening repaired areas. So the steam generator replacement original cut, the weld repairs we've done and any other repairs as well as on the inside containment is part of the structural integrity test. We are mounting taut wire straining gauge -- strain gauges to get the measurements we need for the SIT, so that also has an impact on the liner and those need to be inspected. And those inspections will be done prior to and after the ILRT.

We'll also be doing detailed visual exams of VT1s of the tendons, the tendon anchorage areas for any manipulated tendons. We'll be doing that after retensioning and then as mentioned, the Section XI drives the ILRT as part of a required test.

MR. BARTON: I don't see anything on your bullets there, but there was an issue with leaching on the walls in the tendon access gallery. And you guys were going to go in and look at that and do some core bores and try to figure out what the cause of the leaking. Did you do that?

MR. CAHILL: Actually, we had the opportunity. We decided to go after some groundwater leakage in our decay heat vault which is the lowest level in our Aux. Building, so in conjunction with that we went after the tendon gallery and so forth. We did do a pretty comprehensive effort. We actually did some repairs for the decay heat vault, but that was -- we might have seen a gap in the construction joint that accounted for a lot of that groundwater leakage.

So we confirmed that we don't have any -- there's basically no iron deposits in any of the water leakage and the core bores we did, we actually got a chance to get one of our one-time inspections done, inspecting that rebar both in the decay heat vault and tendon gallery and found no damage mechanism whatsoever going on. The rebar was actually in pristine condition.

All the sampling we did on the effluent groundwater that was coming in, I mean there's a lot of different details, chloride tests and things like that. They all came completely favorable. So those are a good thing to get behind us, not something we originally planned to do until we got close to the period of extended operations, but we do have that confirmed. But we're going to be doing some more efforts on that just to mitigate that groundwater leakage that we're seeing.

The next section down, these are some of the requirements that I guess we're doing the SIT per Section III, so that requires us per CC 6000. We'll be doing visual exams in the accessible portions of the containment. So that includes concrete and the liner. That has to be done prior to and after the SIT.

One of the main things you do during SIT though is you do detailed crack mapping. We'll be doing that prior to, during, and after the SIT. By that, I mean you're required to -- these three areas of 40 square feet to actually map out and do detailed crack mapping during those periods. We've selected five areas including one on the dome. All those areas for us are greater than 60 square feet, so we've gone a little above and beyond what the crack mapping requirements is just because we had different areas of interest and we wanted to make sure we were doing a detailed look at that.

CHAIRMAN SIEBER: That's all on the outside of containment?

MR. CAHILL: That's all on the outside of containment, yes.

And also just as part of an SIT, we do displacements and as I mentioned, we have taut wires that will be running all through the inside of containment between the liner and our internal structures like our D Ring up to the dome and so forth as all monitoring pressures and temperatures. Those will be monitored prior to, throughout and after the SIT to help dictate the success of that SIT.

This next slide is also things that we're doing pre-start up. And this is stuff that is contained formally in our engineering changes, but these are all augmented, owner-elected activities. So we'll be doing laser scanning of our liner bulges going forward. We'll be doing that prior to and after the tendon retensioning. As we finish our tendon retensioning, we'll do that. We'll also do it again after the pressure tests, just to verify that they did not change as we discussed earlier.

We'll be doing liner bulge measurements of our most limiting ones prior to and after the tendon retensioning, after the pressure tests. We're doing vertical crack width measurements. These are the cracks that you mentioned before outside Bay 3-4 that we've seen. We've already done those prior to retensioning. We'll be doing those after retensioning as well as after the pressure tests.

We'll be doing a general VT3 visual exam outside of all concrete containment surfaces, outside of the areas affected by the containment repair. That's normally something that we do one time period, but this gives us a baseline going forward, just so in future outages and inspections, we understood exactly where we left it with this outage.

We also have over 80 embedded stream gauges throughout containment, primarily in Bay 3-4, but several in other bays. We'll be monitoring those prior to, throughout, and after retensioning through the completion of the pressure tests as a source of data.

Our laser scan data will also be giving us storing displacements. We're doing that as efforts storing our tendon retension. Another method of evaluation we have is acoustic sensors. We have acoustic sensors mounted all around exterior containment. We'll be monitoring those during tendon retensioning. Those listed and are calibrated for concrete cracking, so if we were to create another delamination or any potential incipient cracking that could cause a delamination, these acoustic monitors are optimized in locations where we would see the peak stresses to be listening for that and to give us an indication that we might need to do something different.

And then lastly, we plan on doing a lot of time after the retensioning to go do impulse response testing, IR scans of the containment concrete. We'll be doing that in targeted high-stress areas so it won't be a comprehensive, but the areas if there was any problem based on our analysis that we have used to design a separate going forward. We're going to be doing IR scans there to make sure nothing happened.

And these last two bullets, these are things that are driven out of Corrective Action Program. Coming out of the root cause, we had two things that we needed to do. They're not quite finalized yet, but the first one is for areas outside Bay 3-4. We will continue to have a scope of impulse response mapping in that area going forward both the test and as well as future outages, we'll go take a look at that to make sure nothing else has happened.

And then also inside Bay 3-4 with the amount of reinforcement you saw there, IR scanning is not a very valid technique to use just with amount of reinforcement. You can't get a valid mobility number with all those steel interferences. So inside Bay 3-4 we're going to be using the extensive amount of existing strain gauges that we've installed there and come up with a monitoring program to credit and keep an eye to make sure that those interfaces between the new and old concrete are behaving as expected.

This next slide moves into things we plan on doing after start up, so post-start up. Again, first section is dictated in our engineering change, the Section XI requirements.

MEMBER ABDEL-KHALIK: If there is new delamination in Bay 3-4, after this is all repaired, how would you detect that?

MR. CAHILL: We would detect that with the strain gauges. We've had extensive interactions with the staff on how we would be able to detect any of that. The delamination with the extensive amount of reinforcement as now in Bay 3-4 is highly unlikely.

We have strain gauges both in the radial and different directions that would detect any movement that would give you delamination and they are strategically dispersed throughout that opening. So that would be our mechanism for monitoring and assuring ourselves that we have not had anything. And if we had a delamination, like I mentioned before, the acoustic monitors would be able to pick it up and that's how we would give ourselves that confirmation.

The amount of reinforcement we'd put in there, we can't use really IR reliably in Bay 3-4 any more so that's why we came up with other mechanisms to assure ourselves that there is no delamination.

So going post-start up, we'll be doing a BT3 inspection of all the surfaces affected by the repair replacement activities. Also, the augmented tendon exams and testing of those that were affected by the repair replacement, we'll be doing those after we have a one-year requirement to do those following, so we'll be doing some tendon testing one year out for start up. That four percent scope is above our normal five-year requirement, so we'll have two populations that overlap in our next refueling outage, the four percent augmented and then our normal five percent, two percent that Rick mentioned before that we would normally be doing.

And then other owner augmented type of inspections, as I mentioned before the vertical cracks. We plan to go look at those vertical cracks one year after in conjunction with the other inspections. We'll be looking at that to see if those continue to stay closed as we expected they would. We'll also be doing liner bulge measurements of those most limiting locations. Also, we have that plan for doing it in the next three refuels after completion of this replacement.

And these are very similar to what I mentioned before, these last two are Corrective Action Program driven actions to monitor the concrete in Bay 3-4. We have the strain gauges as well as come up with a program for periodically monitoring outside Bay 3-4, using an NDE technique such as impulse response.

This next slide is just talking about some things that -- a discussion topic driven by NEI 94-01. This is the industry guideline for implementing performance-based option of 10 CFR 50, Annex J testing. That guidance section 9.2.3, the extended test interval states that you can extend your Type A testing to a frequency of at least once per ten years if you have an acceptable performance history.

Crystal River previously established an acceptable performance history of our integrated leak rate test and already extended that ten-year interval. So that fostered some discussion out of 9.2.4 which is the containment repairs and modifications. It mentions that repairs and modifications affect leakage integrity and it will require a leak rate test, a Type A test or local leakage rate testing prior to return of the containment to operation.

So as I mentioned before, we are planning to do an integrated leak rate test, but based on our work being classified as repair, we do not intend on changing our performance-based interval. We expect to have a valid performance history with our integrated leak rate test due to the quality of our liner. So we are maintaining our current interval and that is our plan going forward, assuming a successful performance of the test that I just laid out.

CHAIRMAN SIEBER: Because that's what the words say. There's a tremendous amount of modification being done and I think I'll let the staff decide on what's adequate or not. I could go either way on it.

After you're testing the design concept, you're also testing construction of it and the design concept is there, because these things have been built before, even though your repairs are a little on the unique side and a single test ought to prove construction integrity, but I still think there's some question considering the extensiveness of the repairs as to whether you've got to go to the review team a little more. I'll let the staff decide.

MR. CAHILL: This next slide is just to specifically respond to items in the open items for license renewal. We were specifically requested on how our experience with this overall containment repair is going to be incorporated in our programs and also whether plant-specific program is necessary to manage the aging.

I mentioned before that the changes to our program were the ones driven by the ASME Section XI repair and replacement, so we talked about those changes before that we are going to be doing and we'll also be doing several augmented owner-elected inspections of things going forward which were from those previous slides I selected. Most notably, the additional ones that we're talking about are the vertical crack inspections that we'll look at at the one-year point and we'll reassess continuing that at that one-year point depending on the results and the liner bulges.

So in overall summary, we're not -- those are the things that were used by, driven by the repair replacement code as well as the augmented ones that we've done to change our program, but we did not conclude coming out of this repair effort that we needed to develop a plant-specific containment aging program. Most of the issues we saw we did not see an aging mechanism associated with them and that was the basis for our conclusion.

CHAIRMAN SIEBER: So the real basis for not having a plant-specific containment aging program is that this was a one-time event under unique circumstances or caused by an aging mechanism?

MR. CAHILL: Yes. And we've done several things within our existing programs to augment those as well as utilize the aspects of the existing programs, monitor this for the period of extended operation.

CHAIRMAN SIEBER: Thank you.

MR. CAHILL: With that, I was going to turn it over to Chris to talk about some of the other open items.

CHAIRMAN SIEBER: In the interest of time, I think that what you have now is a bunch of open items that most of which deal with extensions brought about by Rev. 2 and the GALL which is issue 3 of GALL.

MR. MALLNER: That's correct.

CHAIRMAN SIEBER: Why don't we skip those and go to the -- I think there's maybe two that really aren't related to that.

MR. MALLNER: Okay, let's skip to the next slide which has to do with submerged power cables. The question was that we received from the staff was whether or not we needed to do inspections of manholes that were then driven based on rain storms, hurricanes, etcetera. For Crystal River 3 there are four manholes within the scope of license renewal. Of them one is by the intake structure and has a sump pump. There's one on top of the berm that's located inside the hot machine shop that's completely enclosed and not exposed to weather. And that leaves two manholes of interest.

Those manholes are located on the berm. They're well above the water table and we've looked in these manholes recently and we found a couple of inches of water, the last time we inspected these manholes and the amount of water was more than two feet below the latest cable tray in that manhole.

We look at these manholes on a one-year

frequency and it's really based on the design of the manholes. As you can see at the inset, the top of the manholes are one and a half to two feet above the berm there and there's a plug that fits into the top that has a seal on it to prevent water intrusion. And we believe the annual inspections are adequate and you don't need to do any additional inspections.

Also, we've looked at the area -- Crystal River receives about 50 inches of rainfall a year and because of that, like I said, we've done inspections recently. We have found very little water inside the manholes, so we don't believe we need to do any inspections that are event driven.

CHAIRMAN SIEBER: The water table is pretty close to the surface.

MR. MALLNER: But the water table -- okay, to give you some idea of where everything is, where that manhole is located is at about elevation 114.

CHAIRMAN SIEBER: Okay.

MR. MALLNER: And the groundwater table is approximately at elevation 90.

CHAIRMAN SIEBER: All right.

MR. MALLNER: And the bottom of the manhole is at about elevation 105. So the bottom of the manhole is about 15 feet above the water table.

CHAIRMAN SIEBER: Thank you.

MR. MALLNER: So that's why I don't believe we need to do event-driven inspections.

MR. BARTON: So long-term, you go to an annual --

MR. MALLNER: Yes, we do annual inspections, that's correct.

Okay, we can skip the next slide. This open item here is related to a further evaluation recommended item that's in the Standard Review Plan that's associated with non-regenerative heat exchangers. And the issue was in the Standard Review Plan whether or not it's required to do any current inspections of non-regenerative heat exchangers. For Crystal River, the heat exchanger in question would be the letdown coolers and as you can see by that inset, those letdown coolers are not amenable to any current inspections. Those two form an Archimedes spiral inside there and there's many tubes and it's going to be extremely difficult to try to do any current inspection.

So what we did, we went back and looked at the operating history of these coolers and we noted that we had leakage from these coolers early in plant experience and we revised our design because they were caused by flow-induced vibration. We lowered flow rate. We've changed the heat exchanger design and we hadn't had any leakage in these coolers since 1991.

Based on that, we believe that our design issue has been resolved and that cracking due to cyclic load is not applicable aging effect for Crystal River letdown coolers. However, we still agree with the further evaluation recommended item that SCC could be possible and we've included these letdown coolers within our one-time inspection program and we'll do as part -- they will be part of our inspection population for one-time inspection program. And similar to other items that are in the GALL that are susceptible to SCC, we will have the water chemistry program be applicable and be a part of our one-time inspection program population. We've provided this response to the staff for their review and it's currently under review.

The next open item is in regards to the NUREG/CR-6260 locations. We were asked the generic RAI that's been sent out to the current applicants on whether or not the locations that we've selected for our 6260 environmentally-assisted fatigue evaluations are bounding for Crystal River. We did another review which we've provided to the staff and we reviewed our locations on a component by component basis and on a material basis. As part of that review, we considered bounding environmental penalty factors and also as part of that review we did a qualitative evaluation of risk significance which was related to the original GSI 190 resolution for environmentally-assisted fatigue.

Based on our review, we've concluded that the evaluations we performed are bounding for environmentally-assisted fatigue and again we provided our response to the staff and are waiting on review.

CHAIRMAN SIEBER: We'll see what the staff says.

MR. MALLNER: Yes. We have two confirmatory items. The first confirmatory item is related to a compressed air monitoring program. The original license renewal application did not include a compressed air monitoring program. Crystal River assumed that downstream, the dryers, that we had a dry air environment and we had no aging effects and our interactions with the staff, they asked us questions related to how do we guarantee that the environment will continue through the period of extended operation.

We made the decision to provide the staff the compressed air monitoring program consistent with Revision 2 of the GALL in order to alleviate their concerns about the potential of those lines containing moist air in the future. So we provided them with a new program consistent with Revision 2 of the GALL to alleviate their concerns.

The second confirmatory item has to do with the leak before break analysis TLAA evaluation we had in the application. The original CLB analysis only performed a qualitative evaluation of the cast material and did a specific evaluation for transients. When we did our license renewal evaluation, we determined that there was enough new information to drive us to do a qualitative evaluation of thermal aging. However, we did not consider that portion of the TLAA to be -- that portion of the analysis to be a TLAA and we had originally resolved this TLAA using Method I, that the original analysis was acceptable for 60 years.

The staff disagreed and during a teleconference we agreed to call the thermal aging portion of that analysis, TLAA, and therefore we've now resolved the analysis using method II which is we've projected the analysis for 60 years. And we've provided that to the staff and that's currently under review.

That concludes that portion of the discussion and I'll turn to --

CHAIRMAN SIEBER: Let me sum up what you plan to talk about next. You're going to do steam generator replacement, reactor vessel head replacement and power uprate and in some respects those enhance your ability to operate beyond the 40-year license life but they're external to the review of the license renewal and we wish you success in all of those endeavors. You'll get your power uprates greater than five percent which I think it will be. We'll be back to talk.

MR. WILSON: We'll be back.

CHAIRMAN SIEBER: To talk. And if any of the members have any questions --

MEMBER SHACK: Just a quick question on the head. What's your head temperature?

MR. CAHILL: Lower head -- I can't give you the exact number. It's like lower than Davis-Besse, but compared to other --

MEMBER SHACK: It can't be too much lower though. Your hotleg is 604.

CHAIRMAN SIEBER: Yes, but it's usually a degree or two --

MR. CAHILL: It's not much.

CHAIRMAN SIEBER: Depending on how much circulation you have. Any other questions?

MR. BARTON: Yes, I've got one on the switchyard. I haven't seen this before. Since your plant is located right on the Gulf of Mexico, you've got the salt spray question on insulators, that issue. And I noticed that you said the way you get around that or solve that problem is a silicone coating that presents salt spray from adhering and it's good for ten years. What did you do to qualify that? Because that's the first time I've seen somebody apply silicone coating to insulators to get around this salt spray, salt deposits on their insulators.

MR. MALLNER: We're going to have Mike Heath, the supervisor of license renewal address that.

MR. HEATH: That's really not uncommon. We used it in Brunswick and Crystal River. That's the standard product for that purpose.

MR. CAHILL: We've had very good extensive operating history with it. I'm not familiar with the qualifications we've done on it, but it's something that has worked very well for us.

MR. BARTON: I just want everybody to know for ten years, this is the first time I've seen anybody doing this.

MR. HEATH: We inspect it every four years.

MR. BARTON: I had some other stuff, but for the sake of time we can move on. I do have one other one. On your socket welds, ASME Section XI, your socket weld commitment, you agree to perform volumetric exam of ten percent of the socket welds per interval and you're going to do one third of those that you would do at an interval prior to license extension here. How many welds are we inspecting? I don't know what your total population of socket welds is. Are we talking about one or two welds or something that's meaningful.

MR. MALLNER: The population is approximately 60 socket welds, so 10 percent would be 6 per interval which would mean two per period. So we intend to do at least two prior to the period of extended operation which would be the equivalent of three and one third percent of an interval. So we'll have two done.

MR. BARTON: Is the staff happy with that? I just think that's a small sampling.

MR. MALLNER: I'll leave that for the staff to --

MR. BARTON: So that's what I'm going to do. That's it.

CHAIRMAN SIEBER: Okay. I think it's time for a break, even though we were 15 minutes late. I'd like to resume our meeting with staff presentation at 4 o'clock.

(Whereupon, the above-entitled matter went off the record at 3:43 p.m. and resumed at 3:59 p.m.)

MR. HOLIAN: This is Brian Holian, Director, Office of License Renewal. I'd just like do brief introductions and then turn it over to the NRC staff. From left to right and let me first check on the region, we do have Lou Lake, the Senior Reactor Inspector and Mark Franke, the Branch Chief for Region II on line.

MR. LAKE: This is Lou Lake.

MR. HOLIAN: And Mark?

MR. FRANKE: Mark Franke here.

MR. HOLIAN: Good, you're coming through loud and clear. And you can hear this discussion?

MR. FRANKE: Yes.

MR. HOLIAN: Good. All right, from left to right across the front of the room is Meena Khanna, our Branch Chief from the Division of Engineering. To her left is Farhad Farzam, Senior Structural Engineer, Division of Engineering. Then we have Abdul Sheikh, he's one of mine.

(Laughter.)

Senior Structural Engineer. We have Rob Kuntz, the Senior Project Manager and Dr. Allen Hiser, senior level in Division of License Renewal.

I wanted to comment briefly on kind of the three Branch Chiefs that have been involved. Raj Auluck is also here, Division of License Renewal Branch Chief on Structural and Electrical. Between Meena and the Branch Chief Mark Franke in the region and Raj, you've got three different organizations and divisions in NRC that have been, one, looking at the restart applications of containment and of course, the Division of License Renewals are not the open items on what testing is appropriate as we head in towards the period of extended operation.

So there has been coordination of all of that. It's not in silos. They look at each other's request for additional information. They kind of peer check each other and go from there, so that coordination has occurred.

There have been two public meetings at headquarters. There was one initially after the initial delamination event and that was in December of

2009. And then there was a follow-up meeting that the applicant referred to where a lot of the technical information behind the repair costs of root cause and repair was done in a public meeting here in the Commission hearing room in June of 2010.

With that, I thought the staff, we do have some open questions on the testing. It does get down to some of the issues regarding what the applicant has proposed for start-up testing and immediate testing in that initial time, how much of that would be extended long before the period of extended operation and in the period of extended operation. That's kind of a summary of where the staff's open items are.

I thought we'd start though with Meena Khanna just addressing a few of the open comments that she took notes on from her staff and then we can briefly go over some of the other open items. And then I'll also go into a deeper discussion on the containment, if that's appropriate.

CHAIRMAN SIEBER: Okay, thank you very much. Appreciate it.

MS. KHANNA: Thank you, Brian. I just wanted to also add with respect to the containment delamination issue, as you know, we've been supporting Region II. We support the special inspection team as well as IP50001 steam generator replacement. We also have three independent contractors that we brought on board as well, very skilled, very highly technical folks that assist us with the review as well. So I just wanted to mention that as well.

First of all, I think you guys have raised a few questions, so we wanted to address those very quickly. On the tendon configuration, Farhad, if you want to address that, you guys had a question with respect to --

MR. FARZAM: I took the note that you had a question about tendon configuration.

CHAIRMAN SIEBER: Yes.

MR. FARZAM: Let me just explain what the containment configuration is. It's a six buttress and the tendons are 163 wires, 7 millimeter diameter.

CHAIRMAN SIEBER: Right.

MR. FARZAM: So it's kind of equivalent to 170 wire quarter inch diameter.

CHAIRMAN SIEBER: Right.

MR. FARZAM: So obviously the horizontals go 120 degrees, every other buttress and verticals go from the ring girder all the way to the tendon gallery.

CHAIRMAN SIEBER: Right.

MR. FARZAM: On the domes are three families of 60 degrees.

CHAIRMAN SIEBER: Right.

MR. FARZAM: So that's really the configuration of the tendons. Now I noticed that you had a question about the repair. I think it's important to know what the design basis of this containment was originally. The post-tensioning that applied to this containment was enough to counteract 1.5p, p being the design basis accident. And however, the design basis allowed 212 psi. When the repair was done, that 212 was neglected and it was zero tension. That's why you see the rebar in the Bay 3-4.

CHAIRMAN SIEBER: Okay.

MR. FARZAM: And the other thing is you need to make sure is when you open up the containment when you detension locally and you open up the hole, you have a redistribution of stresses to surrounding stresses. So when you retension the containment, you will not get all the prestress that you had originally. So that's another factor that you see rebar in Bay 3-4.

CHAIRMAN SIEBER: Okay.

MR. FARZAM: I hope this helps the -- go ahead and you can ask a question.

CHAIRMAN SIEBER: Well, it helps my understanding and it's consistent with my conception of it. But it is not an easy problem from a structural and analytical viewpoint. I think it's very difficult because you end up with two different types of containment wall with different properties as I understand it.

MR. FARZAM: That's correct.

CHAIRMAN SIEBER: And it's not clear without really detailed analysis that you can -- a global nondetailed analysis won't tell you everything you need to know about stress and strain and particularly on the boundaries of the repair.

MR. FARZAM: Well, let me go into a little bit more detail on that.

CHAIRMAN SIEBER: Okay.

MR. FARZAM: The ANSYS model, the structural analysis design basis calculations are based on computer program ANSYS.

CHAIRMAN SIEBER: Okay.

MR. FARZAM: And what the licensee has done is -- this particular calculation computer model it tracks the loading as it happens. In other words, the baseline is containment, nothing has happened to it.

CHAIRMAN SIEBER: Right.

MR. FARZAM: As they detension 10 vertical and 17 hoop containment deflected, and then after they remove concrete containment deflected and redistributed, so the entire history has been captured in that analysis.

CHAIRMAN SIEBER: Right, okay.

MR. FARZAM: And staff requested parametric studies on modulus of elasticity of concrete, new and old, to capture the sensitivity on stress distribution of containment.

CHAIRMAN SIEBER: Okay.

MS. KHANNA: Thank you. Thanks, Farhad.

CHAIRMAN SIEBER: So the detailed analysis has been done and is confirmed what you actually found in the -- after this evolution has been completed.

MR. FARZAM: That's correct. I mean the model even included the liner, liner plate in the model, because liner plate takes load as you detension and retension and we requested another analysis without the liner in the model to understand if the liner is not there, what would be the stress distribution to concrete.

CHAIRMAN SIEBER: The liner would seem to me, not having done the calculation, does contribute not substantially, but a significant portion to the overall strength of the containment.

MR. FARZAM: Right, I mean liner if you -- based on a design basis. It's a leak-type area.

CHAIRMAN SIEBER: That's right.

MR. FARZAM: And as far as being a strength element or not, that's why we requested to have two different analyses. One is Licensing -- what they did is they include the liner in order to track the load.

CHAIRMAN SIEBER: Right.

MR. FARZAM: Because that's the physics of the problem. The liner is there. And we requested another analysis without the liner to understand what the stress distribution is, basically an envelope of both.

CHAIRMAN SIEBER: Yes, but the liner itself is not -- is more than just a membrane.

MR. FARZAM: Absolutely, and the ultimate strength of the container, the liner will go into tension and it will contribute to the structural integrity, yes.

CHAIRMAN SIEBER: But the liner by itself would be totally inadequate.

MR. FARZAM: Absolutely.

CHAIRMAN SIEBER: Without the remaining structure.

MR. FARZAM: Yes.

MS. KHANNA: Thank you. With that, Ali, are you on the phone as well? Ali?

MR. REZAI: Yes, I am here.

MS. KHANNA: Okay, great. Ali, if you don't mind addressing the question that the ACRS members had with respect to the incident response and your review of that to detect the delamination to properly detect the delamination that Licensing had done?

MR. REZAI: Yes, I have been asked to evaluate the licensee's technique that has been used to detect delamination created during detension and they propose a technique called impulse response method and this method has been used in other industry to detect delamination in piles and columns and it's useful for thick structure similar to a containment building.

And so the licensee proposed this method and did calibration. They basically did the studies on this method under containment and first calibrated the system, as well as did some trial testing and after that they performed testing on the structure.

Basically, this system is done qualitatively and provides qualitative answers. That means the system basically tells you what area is delaminated and what area is not delaminated, meaning that the data is taken at every foot by foot. Basically, the structure is divided into grids of one foot by one foot and at every foot they collect the data and the system basically provides mobility value. Mobility value is a range of numbers that indicates, for instance, from zero to .4, if the range is below .4 or the mobility number is below .4 indicates no delamination of that section. If it's in between the .4 and some other number, indicates it's inconclusive. And if it's above some number indicates a delamination.

So the error on this system basically in a foot's range, so the licensee collected the data and then took a core sample at locations that there was a boundary between non-delaminated and delaminated values of impulse response. And the core result verified their findings. And that was basically my analysis of their determination of extent of delamination.

MEMBER ABDEL-KHALIK: Can this technique detect more than one discontinuity?

MR. REZAI: Are you indicating like --

MEMBER ABDEL-KHALIK: Parallel discontinuities?

MR. REZAI: Are you talking about a multiple delamination at different depths?

MEMBER ABDEL-KHALIK: Right.

MR. REZAI: That's a little bit difficult to determine multiple delaminations at different depths. The reason for that is the way it's calibrated you get some sort of a depth so the system becomes very sensitive to depth initial depths of the structure that you are given. So if there are different delaminations, it can detect, but it's kind of in a gray side.

MEMBER ABDEL-KHALIK: How can it? I mean don't you essentially just give an acoustic wave going through and it's reflected at the first discontinuity?

MR. REZAI: No, this is not as a normal acoustic application. Basically, what it does is you hit the hammer and you vibrate the structure and the structure, when the vibration goes and comes back, basically it doesn't go and comes back. The whole structure vibrates.

In other words, it's a little difficult to explain, but it's not the sound wave that goes and hits delamination and comes back. It's the structural response to that hammer impulse. And the mobility value is basically the particle at the sensor, the vibration of the particle at the sensor, divided by this pulse that you impinge on the material.

So the way it's determined, the delamination or affects the structure is how the vibration of that structure, in other words, if the structure is not delaminated the whole structure, the whole entire solid part vibrates. The structure and the mobility value becomes higher and if the structure delaminated, then the part of the structure vibrates and that's the mobility value. I hope I was able to explain.

CHAIRMAN SIEBER: Sort of like ringing the Liberty Bell without being able to see it.

MS. KHANNA: Okay, if you guys have any further questions on that we can get back to you. Thank you.

And George Thomas, if you could just discuss the ABACUS question that will be great.

MR. HOLIAN: George Thomas is also a member of the Special Inspection Team.

MR. THOMAS: I just want to clarify the question of ABACUS. The ABACUS model was not used by the licensee from a design basis calculation. One of the outcomes of the root cause investigation was that they determined that standard industry analysis tools was a linear elastic method where incapable of predicting delamination.

As part of the root cause investigation, the licensee put on the computer simulation for which they have to use more refined models capable of predicting delamination. So have let the fracture base nonlinear model using ABACUS to go there. And the model was informed using forensic data collected during this delamination.

MS. KHANNA: Great, thanks. And finally, you had requested whether the staff was evaluating a review of the liner. And we are conducting a liner evaluation. As I indicated, we are supporting the region. They've got the lead on this inspection procedure, 50001, which containment liner is part of the review. We are currently reviewing that. It's still under review. We have not made any conclusions and the reasons, as Lou will address later, will be documented in their inspection report. Okay?

I'll turn it back over to Rob.

MR. KUNTZ: Okay, before we get started with the prepared material, there was one other outstanding question with whether the staff found the applicant's approach for socket weld and inspections prior to PEO, whether staff had found that acceptable and why.

Dr. Hiser will address that question.

DR. HISER: This is Allen Hiser, License Renewal. The applicant is doing 2 before the extended period of operation, but they're also 10 percent within each 10-year period, so they will ultimately end up doing somewhere on the order of 14 out of the 60 socket welds which is beyond the guidance and recommendations that are in the GALL report.

So the fact that they're doing a periodic program is why we find the three and one third percent or four PEO to be acceptable.

MR. BARTON: I just thought that two was an awful small --

DR. HISER: It's 2 early, but then 12 coming through.

MR. BARTON: Gotcha, the operating period.

MR. KUNTZ: Okay. I guess we can start with the prepared material now.

Like we discussed, my name is Rob Kuntz. I'm the project manager for the Crystal River Unit 3 license renewal project. I'll try not to belabor points that were made by the applicant and get through the presentation material as quickly as possible here.

This is just an overview of our presentation material. So let's move on to the next slide. The application came in on December 16th. As Brian mentioned, we've delayed the schedule twice actually because of the delamination issue, until we have a better understanding of where they were before we came to ACRS with our findings.

And like, I believe, the applicant mentioned, the operating license expires in 2016. So this is just a summary of the inspections and audits that have been conducted. You can see the scoping and screening audits were done back in 2009, as well as the initial Region II inspection and we did a follow up inspection in October of 2010. This gives the time frame of the special inspection conducted in response to the delamination.

The SER open items was issued December 14th. The next several slides are just mentioning each of the open and confirmatory items that we'll discuss in greater detail later in the presentation, so I'll go ahead and plow through these next couple of slides.

Section 2, the section described here the staff found that the applicant had done a fairly thorough job scoping the screening. There were a few RAIs primarily related to clarifying the renewal drawings, system attendant function and fire protection. So that's just the initial discussion. At this point I'll turn it over to Lou Lake. We'll talk about the regional inspections as well as the SIT.

Lou, are you on? Lou, are you still there?

MR. LAKE: Hello, yes. I'm sorry. I had it on mute for a while. I apologize. Can everybody hear me well?

CHAIRMAN SIEBER: Yes.

MR. LAKE: Okay, I'd like to apologize for not being there. Unfortunately, the ice and the way Atlanta treats ice storms I can't get out so accept my apology.

My presentation is basically in two parts. The first part is going to discuss -- is going to be focused on license renewal inspections and then it will be followed by a brief discussion on the containment delamination and associated issues.

Inspection Manual Chapter 2516 provides the policy and the guidance for review and inspection activities associated with license renewal inspection programs whereby the NRC staff verifies the accuracy of the licensee's Aging Management Program associated with its request for license renewal under 10 CFR 50 Part 54.

Inspections are conducted in accordance with NRC Inspection Procedure 71002 to verify the applicant's license renewal program including support activities are implemented consistent with the requirement of CFR Part 54.

A site-specific inspection plan was prepared and the inspection was scheduled to support NRR's review of the application. The inspection was conducted by a five-member team that consisted of inspectors with experience in mechanical engineering, electrical engineering, structural engineering, and system and component testing and examinations.

Next slide, please.

The objective of these inspections are focused on Aging Management Programs. Confirmed that existing Aging Management Programs are working well and to examine the applicant's plans for establishing new Aging Management Program or enhancing existing ones.

The initial team inspection was two weeks in length and was conducted between July and August of 2009. It consisted of a review of 100 percent of the applicant's 40 Aging Management Programs. We interviewed personnel, examined records of past tests, surveillances, operating experience, and corrective action from existing Aging Management Programs.

We examined implementation plans for new and expanded Aging Management Programs. We verified inclusion of future tasks into established site test tracking systems and inspected the material condition of the plant by conducting plant walk-downs to verify that equipment is being adequately maintained.

The inspection was completed on August 14, 2009 and the results of this inspection is documented in the section of the report issued September 28, 2009.

Next slide, please.

As required by the initial inspection, a follow-up inspection was conducted to further review five Aging Management Programs that were not able to be fully reviewed during the initial inspection due to insufficient information and opened the request for additional information.

Review of the steam generator monitoring program, the carbon under monitoring program, the one time inspection program and the internal surface and miscellaneous piping and ducting component program was conducted, including the new neutron absorbing program for fuel pool A containing carborundum and fuel pool B containing boral. We verified inclusion of future tests into established site test tracking systems. We inspected the material condition of the plant by walkdowns including the inside of the containment and a walkdown of the spent fuel pool A and B.

The inspection was completed on October 6, 2010 and the result of this inspection is documented in an inspection report issued on November 10, 2010.

Are there any questions so far?

Next slide, please.

The inspection team concluded that the existing programs credited to license renewal are functioning well, that the implementation of both new and existing Aging Management Programs provide reasonable assurance that the intended functions of plant systems, structures, and components related to these programs will be maintained through the period of extended operation.

The documentation supporting the application was in an auditable and retrievable form and new Aging Management Programs are as described in the license renewal application and in responses to request for additional information.

Inspections of plant equipment conducted during walkdowns found no significant adverse conditions and it appears plant equipment was being adequately maintained.

The applicant had established sufficient implementation plans that were incorporated in the plant action request system to track the committed future actions to license renewal and to ensure that they are completed.

Licensee's Aging Management Program will be subject to additional NRC inspections in accordance with Inspection Procedure 71003 prior to the extended period of operation.

Next slide, please.

The position of the containment building. As has been discussed previously by the applicant, a delamination in a containment concrete wall formed in September of 2009. To assess the circumstances associated with the discovery of the delamination, the Region II Administrator issued a special inspection charter in October of 2009. The inspection began on October 13, 2009 and was completed on September 2, 2010. The results of the inspection is documented in an inspection report issued on October 12, 2010.

The special inspection was conducted prior to the completion of the applicant's planned corrective actions. Corrective actions and repairs are subject to an on-going inspection in accordance with NRC inspection procedure 50001.

As previously mentioned, the root cause was determined to be the scope and sequence of the detensioning conducted in support of making the steam generator opening and was limited to the area between buttress 3 and 4. The delamination has been removed and the containment wall has been restored.

Final repair activities are in process of being completed.

Vertical cracks were observed when the containment was further detensioned in preparation for delamination removal and repair activities. Some cracks were removed and those cracks that were less than 10 mils were left as-is. The applicant plans to monitor those cracks left as-is during retensioning, during the SIT pressure test, and plan is to inspect them one year after post-maintenance pressure test.

Also, in accordance with requirements of 10 CFR 50.55a and ASME Section XI, the applicant plans to examine the containment surface at a frequency of every five years thereafter.

Continued monitoring of these vertical cracks is currently an open issue that will be discussed later as part of items, open item number 3.5-1.

Next slide, please.

Containment liner bulges have been identified by the licensee and observed by NRC inspectors. These bulges are located in between the liner stiffeners and are independent of the delamination formed in the concrete portion of the concrete wall.

Review of examination records and interviews of plant staff indicate that these bulges were initially identified earlier in plant operation and evaluated to be acceptable for plant operation. Monitoring beyond 10 CFR 50.55a regulatory requirements is currently an open item and will be further discussed in the presentation of Open Item 3.5-1.

Cracking in the containment dome concrete in 1970 prior to initial plant operation, a delamination was also identified and repaired. The delamination was in the form of a circle covering a significant portion of the dome. During the activities associated with determining the extent of the current delamination, Crystal River conducted IR scans of a sample of the dome surface and identified evidence of subsurface cracks in a localized area. It was determined that this cracking was not associated with the current delamination and that it was associated with the repair conducted on the delamination found in the 1970s.

As a result, essentially 100 percent of the containment dome surface was examined by scanning with IR and core bores were taken in suspect areas. This investigation determined that the cracks identified during this outage were localized along the edge of the repair area and were not related to the delamination recently identified.

NRC is in process of conducting inspections of the scheduled licensee's post-maintenance inspections and testing and will conduct additional license renewal inspections prior to the period of extended operation in accordance with IP 71003.

CHAIRMAN SIEBER: Now is there operating experience for this type of containment with events or damage similar to that which Crystal River 3 has observed and analyzed and is repairing at other plants with this type of containment?

MR. SHEIKH: Not that I know of. This is Abdul Sheikh. Not that I'm aware of.

CHAIRMAN SIEBER: Well, this is certainly a lesson to learn for those plants who do have this type of containment.

MR. BARTON: What caused delamination in the dome?

CHAIRMAN SIEBER: That's unrelated to this steam generator replacement.

MR. BARTON: I understand that.

CHAIRMAN SIEBER: It's not clear to me. On the other hand, that was dispositioned some time ago. And it has passed the integrated leak rate test.

MR. LAKE: It also passed the structural integrity test and the integrated leak rate test.

CHAIRMAN SIEBER: Right.

MR. FARZAM: This is Farhad Farzam. I just want to make a clarification. The 1976 dome delamination was during construction.

CHAIRMAN SIEBER: Right. And other types of containments other than post-tension containments have cracks in the concrete structure. It's that the other types of containments with rebar-type structure for the strength and integrity of the containment is perhaps better understood because it's a more common construction technique. This is relatively unique in construction practice, so that draws interest to issues that occur there. But I would hope that the industry promulgates the knowledge of this particular event to others so that we don't find other units of similar construction having incidents which are costly and cause a lot of downtime for the plant.

MS. KHANNA: And we also have an action item to pursue this as a generic. We're looking into either issuing an information notice or something as well as soon as we get done with our review, we do have that's an Action Item, we can definitely do that. Okay? And we did talk to NEI. NEI's been involved. They've got a data base of all the steam generator replacement plans as well, so they're tracking that as well.

MEMBER ABDEL-KHALIK: Could someone --

CHAIRMAN SIEBER: Sorry to interrupt the presentation on the inspection process. You may continue, sir.

MEMBER ABDEL-KHALIK: Well, can I just ask if someone could physically explain why would the original detensioning cause delamination while the subsequent detensioning would cause vertical cracks?

MR. FARZAM: Okay, you're talking about during steam generator replacement?

MEMBER ABDEL-KHALIK: Yes.

MR. FARZAM: Okay, you're talking about wall delamination?

MEMBER ABDEL-KHALIK: Right. Why did the original cause delamination while the subsequent detensioning cause vertical cracks physically?

MR. FARZAM: I think the subsequent detensioning was the 155 hoop tendons and 64 -- and 155 went around the perimeter. It's 360 degrees detensioning. The original prior to steam generator opening, it was local. In other words, it was not 360 degrees.

So the phenomenon that went on prior to steam generator opening is different of what went on when you opened up the relaxed 360 degree and the -- as I recall, I guess Slide 61 of the public meeting that the licensee had, the finite element analysis that they replicated the vertical cracks showed that because of the creep concrete, when the concrete was relaxed, the steel responded immediately and created tension, membrane tension in the wall and as it was discussed, there is no particular rebar within the depth of the containment wall. It's just outside.

And that particular tensile stress overloaded the concrete and created the vertical cracks.

MEMBER ABDEL-KHALIK: Okay, thank you.

CHAIRMAN SIEBER: Okay, I think the region can continue.

MR. LAKE: Okay. Thank you. I'm on Slide 15 now. We talk about Containment Building restart milestones and we have identified the following milestones at Crystal River and that's retensioning of the tendons which is currently in progress and it's being monitored during inspections in accordance with inspection procedure 50001. It's being implemented in stages with completion scheduled some time in March.

Also, a structural integrity test is planned after retensioning, followed by an integrated leak rate test and the inspectors will review these activities to verify the results are consistent with the licensee's assessment of containment operability and assumptions used in their design calculations.

Also, there are some remaining technical issues on vertical cracks and containment liner bulges that are being currently viewed by NRC staff. With that, I'd like to thank you and I'll turn over the rest of the presentation to Rob Kuntz.

CHAIRMAN SIEBER: Thank you very much,

appreciate it.

MR. KUNTZ: Thanks, Lou. Next is the -- we'll go through the format of the SER. Section 3 is the Aging Management Review. Section 3.0 discussed the staff's review of Aging Management Programs and 3.1 through 3.6 are a discussion of the staff's review of AMRs.

Just a summary of the Aging Management Program you heard Lou describe 40 earlier. One has been added since it is related to the tendon stamped to monitor the aging of the tendons in containment. So that was just added December 8th, so that's why there's 41 and Lou only looked at 40 during the inspections.

So we'll start with the open items. I thought I'd leave the containment after the other ones, so we get through these and get the containment one.

I lumped the one-time inspection selection leaching as a similar item. That's for the components inspected, how many, and how they would decide the components to be inspected. The applicant responded to this RAI December 29, so staff still is in the process of reviewing that response.

Similar with the cracking due to SSC and cyclic loading. We received that response the end of December and the staff is still reviewing that.

And structures monitoring and masonry wall program were similar to the previous ones that we just received a response to these and we're in the process of reviewing. So I'm going to go over Buried Piping and Tanks Inspection Program. The staff submitted to the applicant as an RAI similar to other applicants based on industry operating experience. The applicant's response stated that the cathodic protection is available for most of the buried piping except for a small portion of the condensate system and all the nuclear service in decay heat seawater system and proposed augmented inspection for those pipes of those components.

The applicant also stated the coatings and backfill quality are acceptable based on plant specification and has been validated by inspection results. The applicant proposed alternate inspection methodology, remote field transfer coupling for buried concrete piping. That response came in December 8th and the staff is still finalizing its review.

CHAIRMAN SIEBER: How reliable is the licensee's cathodic protection program? Does it meet the 90 percent criteria?

MR. LANE: Bill Holston, can you answer that, please? How reliable is the applicant's cathodic protection?

MR. HOLSTON: Yes, my name is Bill Holston, Division of License Renewal. And the applicant in 2004 did an evaluation of their cathodic protection program and found some gaps. They've corrected those gaps and put long-term corrective actions in place and from GALL AMP perspective we look at a minimum of the five years prior to the period of extended operation having 90 percent availability which they will achieve.

CHAIRMAN SIEBER: Thank you.

MR. KUNTZ: Moving on to the next slide, inaccessible medium-voltage cables. The applicant discussed this one also. They provided a response that include to the staff's request which asked how they would manage end scope cables that potentially could be submerged and they increased the scope of the program to include cables below four kilovolts and as the applicant discussed, they didn't mention in their cover what they'd do in an event-driven response, heavy rains. So we're still waiting a response from the applicant.

And now we get on to the containment open item, Open Item 3.5-2. The background of the staff's perspective, there was a large area of concrete that had been removed and replaced compared to other steam generator replacements. All the vertical tendons had been either reinstalled or retensioned. One hundred fifty-five of the 282 hoop tendons will be reinstalled or retensioned. The applicant has installed monitoring sensors to track the condition of the two types of concrete and the applicant plans to perform an SIT as mentioned and ILRT.

The applicant is performing containment concrete in post-retensioning rework. As a repair replacement activity pursuant to 10 CFR 50.55a, ISI requirements, and ASME Code Section XI, Subsection IWL

Staff notes that the code is the minimum standard and the unique nature of the repair may require the applicant to consider inspection requirements more than what was prescribed in the code or potentially --

CHAIRMAN SIEBER: The unit is still shut down?

MR. KUNTZ: Correct.

CHAIRMAN SIEBER: When do you expect restart?

MR. KUNTZ: March?

PARTICIPANT: First quarter of this year.

CHAIRMAN SIEBER: Thank you.

MEMBER REMPE: Can I ask for some clarification. You said that you did detect some cracking in the dome, but it was repaired in 1976, but it isn't related at all to this repair, but is that an indicator that repaired concrete cracks?

MR. SHEIKH: No. Those cracks are the ones, the cracks they found were as a result of the repair found on the dome.

MEMBER REMPE: So the repair was well done is what you're saying?

MR. SHEIKH: It was well done. Because they added some reinforcement which helps that, you know, because they cut the containment at that very location. And when they cut it it was a potential of a crack and that is in the -- there was some delamination detected. But that was -- the situation was analyzed and those cracks can be resisted by the additional reinforcement provided in that area during that repair. That's my understanding.

MR. KUNTZ: Next slide. In its review, the staff identified the need for additional information related to the containment on the inspection methods and frequency for the containment concrete. The frequency of the planned integrated leak rate test, how the applicant will monitor the bulges that are left in service. There is surveillance and inspection requirements for the pre-stressed tendons, how the effects of the through thickness vertical cracks will be monitored, and also additional information on the applicant's TLA on the pre-stressing tendons.

The applicant -- the staff received responses to these requests on or after December 8th of this year for 2010, so we're still in the process of reviewing those responses and the staff is considering the need for additional information related to the dome cracks, so that's still a possibility.

MEMBER ABDEL-KHALIK: So I guess the explanation that I received earlier about why the vertical cracks versus delamination pertains to the fact that your -- in the subsequent detensioning, it was done in a sort of broader azimuthal distribution and that's why you got the vertical cracks.

So what makes you sure that the extent of the vertical cracks is only within that area that was opened up?

MR. FARZAM: It's not -- this is Farhad

Farzam.

MEMBER ABDEL-KHALIK: So these cracks extend 360 degrees.

MR. FARZAM: Outside Bay 3-4, there are also vertical cracks.

MEMBER ABDEL-KHALIK: And those are throughwall cracks?

MR. FARZAM: The licensee has done core bores to identify if they're going through the thickness. I believe one of the core bores showed that it's about 12 inches or so. Their analysis is assuming its through thickness.

MEMBER ABDEL-KHALIK: Thank you.

MR. BARTON: But they're saying when they retension those are going to close up?

MR. FARZAM: That's the open question that we are reviewing at this point. For sheer transfer, obviously, you need -- you have a clamping force and you have to -- that clamping force needs to give you that sheer transfer across the crack, yes. I mean that's the main system that you have. You don't have any rebar going through the cracks. It's just post-tensioning --

MR. BARTON: So how are you going to know whether that happens or not? Or doesn't it matter?

MR. FARZAM: Well, the basic assumption is that you have sheer transfer because you have contact and through the thickness on a crack. So that's another issue that we're reviewing right now about the monitoring of the vertical cracks after its retension, the containment is retensioned. That's the critical point to confirm that what you have assumed in your analytical work is physically happening. That's an open item at this point the staff is reviewing.

MR. BARTON: Good luck in proving that one.

MS. KHANNA: I just want to note that --

MEMBER ABDEL-KHALIK: With respect to what you said, so the assumption is that sheet transfer is by friction between these two interfaces?

MR. FARZAM: That is correct because there's no other element across the crack.

MS. KHANNA: I just wanted to reiterate as well, but as Lou had indicated this was an issue that we're looking at from the current operating term as well as we're bringing it, yes, correct. We're looking at it.

MR. FARZAM: Just to give you a little bit more detail, the critical load combinations, obviously, is 1.25 pressure plus OBE and 1.OP times pressure plus SSE. And since the containment is being retensioned, the pre-stressing force that you have give you the clamping force for that particular, for those particular load combinations. As far as the design basis OP and SSE, it's not as high as other plants.

MR. KUNTZ: Ready to move on? That's it for the containment presentation.

Next is the one confirmatory item from the SER Section 3. The RAI originally proposed no aging effect in the dry air environment for compressed air components. Staff noted that this was inconsistent with the GALL report. Through a series of RAIs, the applicant added the Compressed Air Monitoring Program. Staff just needs to confirm that that program as described by the applicant is consistent with the GALL.

Moving on to SER Section 4, this is a section detailing the one plant specific TLAA has to do with bedrock in solution. There's one open at one. Confirmatory Item Section 4 and also the open item 3.5-1 also refers to Section 4-5 which is the TLAA pre-stressed and tendons.

One open item has to do with the

environmentally-assisted fatigue. The staff asked the applicant if the analysis presented in the LRA was bounding for components not necessarily discussed in NUREG/CR-6260.

Any questions on that open item? That response came back also on December 29th, so the staff is in the process of reviewing that.

The final item is confirmatory item Section 4. The applicant also described this. The original LRA did not consider CASS components and leak-before-break analysis is the TLAA of that. That's why that was and the applicant is going to amend the LRA to address this.

That ends the prepared slides from the staff. I'm going to turn it back over to Brian for any closing comments.

MR. HOLIAN: Brian Holian. We knew that the containment issue is the primary issue today for closing out this SER. Related to the non-containment open items, they're very similar to NRC's recent license renewal applications in our final close out. We expect to be able to work through those items over the next several months and schedule a final SER.

The containment open items are still up in the air. It's appeared to me that applicant is clearly focused on getting the containment operable, the root cause took a long time. Even the retensioning, when you look at it. The fact that we're having to take that long kind of shows the extent of the problem and the issue that was caused. So it's a touchy issue. I'm glad you got a focus of that today.

The region has monitoring with Division of Engineering help on the restart aspects here. They'll be taking a look at those vertical cracks and make sure that they close up according to the model.

We've heard a little bit more today on doing a one-year check of that. That's where license renewal has come in with these open items and RAIs. Okay, we see that plan, but you've got six years before the extended period and we'd like to see a plan for some additional checks in that time and some commitments for what we'll do in the extended period. We have kind of a relatively weaker aggregate in the delamination in the dome early on with some cracking that you've now just recently identified, most probably due to the original construction. But we'll probably ask different questions to verify that and continue to check the dome.

Aspects on what they plan to do as a check and make sure they have a robust Aging Management Program, we're still left open. We'll take our time with that and inform the Committee if we have a tough time closing those open items. You'll see us extend as needed.

CHAIRMAN SIEBER: Is that it?

MR. HOLIAN: That's it.

CHAIRMAN SIEBER: Okay. I guess my comment at this point in time is that I consider that the applicant has done a pretty good job in analyzing and responding to the very adverse condition that is difficult to understand, difficult to analyze, and I see the applicant putting attention to detail and to coming up with the adequate solution that will restore the containment to an operable condition.

Like the staff, I still have some questions that I believe will be resolved and the process will come to completion on this. I also understand that the bulk of the open items is due to the GALL transition from Rev. 1 to Rev. 2 and will ultimately be closed.

And so I do appreciate the applicant's presentation and the analysis that they have done and their explanations in this meeting because I feel I have a much better understanding than I did even at noon today.

I also appreciate and understand that the work that staff has done and I think even though this is probably the 65th or 66th application that's been reviewed that the staff has continued to do excellent work and I think that you're right on the money as far as tracking the issues that you are and understanding the issues that are resolved in a satisfactory way. And so I actually can offer congratulations to both the applicant and the staff to having proceeded at least this far, but we are not to the end of the quest. And there's still work to be done.

What I'd like to do is take a few minutes just to ask our members if they have any comments and also our consultant and former member John Barton who has done extensive review on this.

John, I'd like to start with you. Do you have any additional questions, comments?

MR. BARTON: I think you covered it pretty well, Jack. I was impressed with the applicant's presentation. I think this is a tough subject and I think that they were well prepared and could answer all of our questions basically. That's all I can say. The proof is going to be in the pudding as to how they come through with thing, but I think they did a good job explaining what they got and what they found and how they intend to recover.

CHAIRMAN SIEBER: Well, it's almost like the movie "The Wizard of Oz" and we are standing outside the castle seeing what's going to be inside.

Perhaps I could go around the room and ask if anybody, any of the members have questions or comments?

MEMBER SHACK: No additional ones. Again, I thought it was a good presentation today. I have a much better understanding of the problem than I did when I started. I think there's still work to be done, still questions to be addressed, but things seem to be moving forward.

Learning more about reinforced concrete, between this and the Shield Building, I'm an old steel man, so this is all new to me.

CHAIRMAN SIEBER: Well, three more license renewals, I might be able to repair my driveway.

(Laughter.)

Joy?

MEMBER REMPE: I don't have any comments other than to also add my thanks to the applicant and the staff for their presentations. I don't have any questions.

CHAIRMAN SIEBER: Said?

MEMBER ABDEL-KHALIK: I do appreciate the presentation by both staff and the applicant, but I must admit that I'm left with more questions than what I started out with. And therefore I'm just wondering if it would be appropriate for this Subcommittee to devote a meeting to a detailed review of the analyses performed to support the work related to the delamination root cause and the subsequent repair work.

CHAIRMAN SIEBER: I would not object to that. And we have not gone into the details neither here nor is it available in the documents that we read. And they are difficult to understand.

MEMBER ABDEL-KHALIK: I guess this is something that we need to discuss, whether it would be appropriate --

MEMBER SHACK: It would be good to have a consultant.

MEMBER ABDEL-KHALIK: Right, but even for the Committee itself to, the Subcommittee itself to spend a full meeting reviewing all these analyses.

CHAIRMAN SIEBER: We could perhaps discuss that at the Full Committee meeting this week and see what the members would want to do.

MEMBER ABDEL-KHALIK: Sure.

MEMBER SHACK: Thank you.

CHAIRMAN SIEBER: Thank you. Sanjoy?

MEMBER BANERJEE: I just came in, but is this coming up in front of the Full Committee?

CHAIRMAN SIEBER: Not in the near future.

MEMBER BANERJEE: So the discussion would be just sort of decide whether we wanted to take a look at this?

CHAIRMAN SIEBER: If we had additional discussions on the containment analyses and the repair process that would be in addition to our ordinary process of doing the license renewal that it is a unique analysis that took a lot of skill by a lot of people to perform it and understand it and find it acceptable and we are not at that point yet. So there are still questions to be asked. I would not oppose an additional meeting on that.

MEMBER ABDEL-KHALIK: Would the staff and the applicant be able to support such a meeting?

MR. HOLIAN: This is Brian Holian, License Renewal. The answer is yes. We would and the applicant would have to.

(Laughter.)

They have done a lot of work with NRR

staff, but even we realized going into this, I think a Full Committee scheduled in June, they've got a lot to do here to -- on this retensioning. I think the March start up, now if it all goes according to plan, it will validate the model and the results will be good. Any other perturbation to that or any other perturbation to coming to agreement with the staff on some of these open items through the Aging Management Program already kind of makes us at risk for making an April SER final SER date to get to -- end of April. So that has to extend anyway, but even if that schedule did stay and we would fit a Subcommittee meeting in, I think that would be appropriate.

CHAIRMAN SIEBER: We will take that into consideration, I'm sure, when we decide whether we need an additional meeting or not because it is important to everyone that's involved.

Okay, with those comments, I want to thank everybody that's here who have made presentations and contributed to the work effort in this regard. I can tell you that I am leaving this room with a much better feel than I had when you started at 1:30 this afternoon. So I thank you all for that.

If there are no other additional comments, this meeting is adjourned.

(Whereupon, at 5:03 p.m., the meeting was concluded.)


CR-3 LICENSE RENEWAL
APPLICATION

AGENDA

- Site Description
- License Renewal
- Open and Confirmatory Items
- Major Upgrades

Site Description

- CR-3 is a Babcock and Wilcox NSSS Plant
- Gilbert Associates was the A/E
- Operating License Approved December 3, 1976
- Licensed for 2609 MWt (912 Mwe)
- Key Features
  - Pressurized Water Reactor
  - Large Dry Containment
  - Once-Through Steam Generators
  - Gulf of Mexico Ultimate Heat Sink
    - Helper Cooling Towers on Discharge Canal

License Renewal

- CR-3 License Renewal Application is the fourth Progress Energy application
- Core Corporate team developed all applications
- License Renewal staff involved in industry working groups
  - Chaired Mechanical and Electrical Working Groups
  - Involved with NUREG-1801 revisions
- Site involved in IPA development
  - Reviewed all Aging Management Programs

License Renewal Application Development

- Scoping and Screening
  - Consistent with 10 CFR 54 and NEI 95-10
  - Sources included Equipment Database, design basis documents, plant procedures, FSAR, and docketed correspondence
- Aging Management Reviews
  - Consistent with 10 CFR 54 and NEI 95-10
  - Plant operating experience utilized
  - Consistency with GALL a priority

GALL Consistency

- Application was based on NUREG-1801 Rev. 1
- Aging evaluations are 82% consistent with GALL (standard notes A through D)
- 41 aging management programs
- 17 programs are consistent with GALL
- 22 programs have exceptions or enhancements
- 2 plant specific programs

Time-Limited Aging Analyses

- Reactor Vessel Neutron Embrittlement
- Metal Fatigue
- Environmental Qualification of Electrical Equipment
- Concrete Containment Tendon Prestress
- Containment Liner Plate, Metal Containments, and Penetrations Fatigue
- Plant-specific TLAA
  - Bedrock Dissolution from Groundwater

Commitment Management

- CR-3 has made 30 License Renewal commitments
- Tracked by Progress Energy’s commitment tracking process
- Implementation Plan is developed for each commitment

Open and Confirmatory Items

- OI-3.5-1: Containment Delamination
  - Root Cause
  - Delamination repair
  - Impacts on the liner
  - Liner bulges
  - Pre-startup and post-startup inspections
    - NEI 94-01 Test Intervals

Containment Delamination Root Cause

SGR Opening Dimensions

@ Liner
23' 6" x 24' 9"

@ Concrete Opening
25' 0" x 27" 0"

Yellow line denotes boundary of delamination

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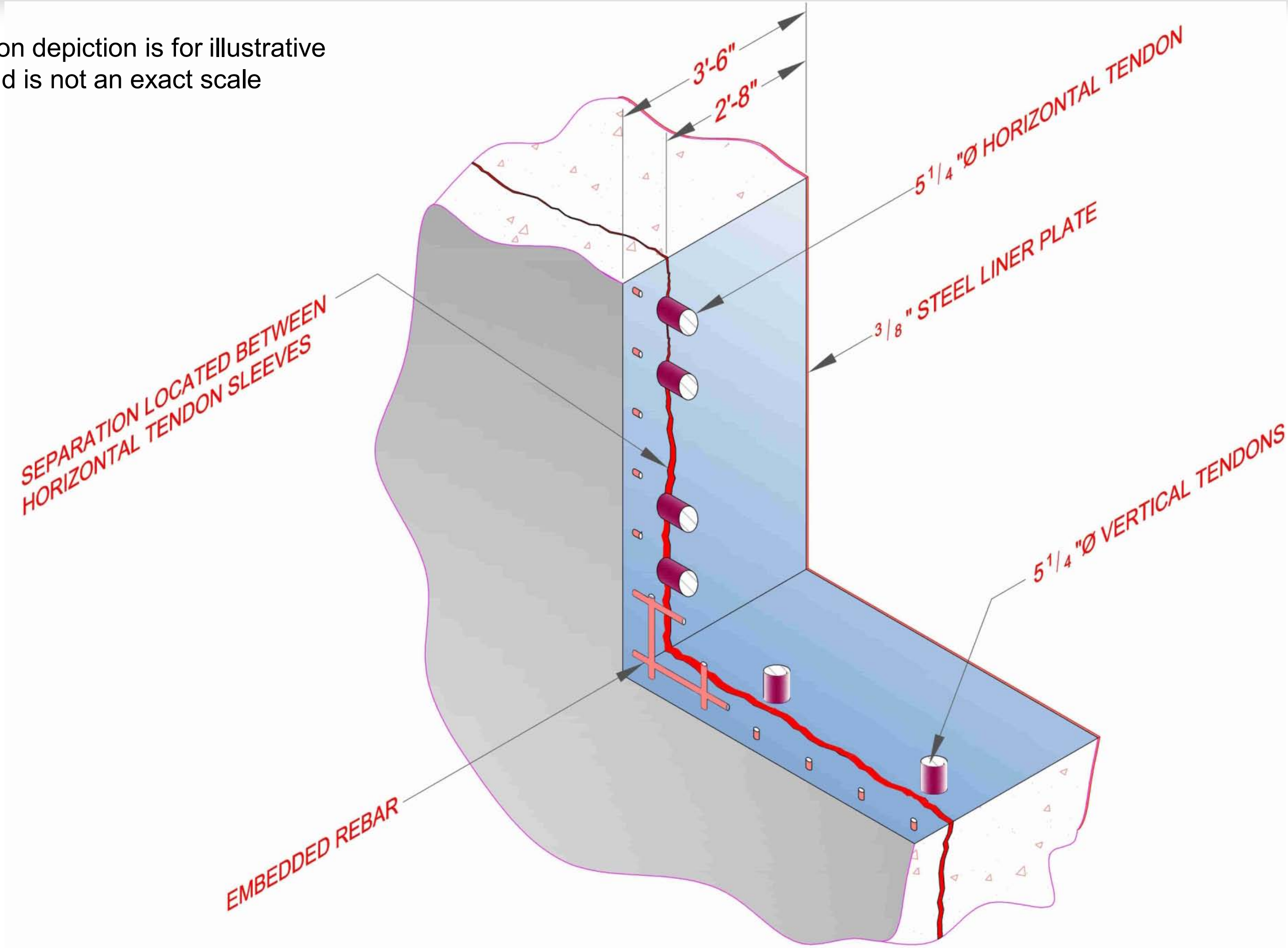
Containment Delamination Root Cause

- Problem Statement: “While creating an opening in the containment building wall to support the steam generator replacement project, a gap in the concrete was discovered. The gap is in close proximity to horizontal tendons. This gap was not anticipated and based on industry operating experience, other similar projects have not encountered the same condition.”

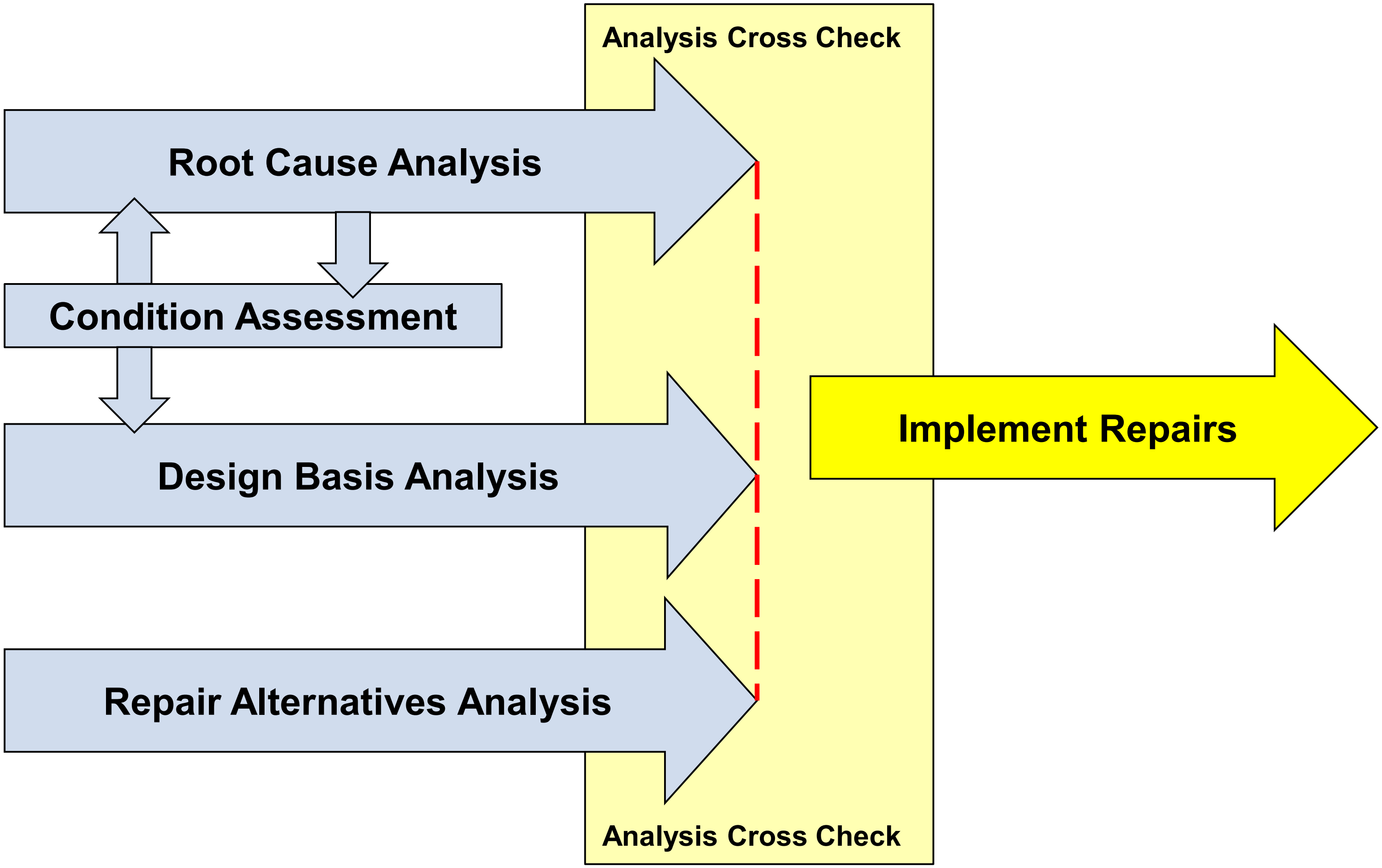
- Comprehensive Team Commissioned
  - Progress Energy personnel - expertise across fleet
  - Industry utility peers
  - External industry expertise
  - Laboratory and Testing Expertise

SGR Opening Sequence & Identification of Delamination

Note - Tendon depiction is for illustrative purposes and is not an exact scale



Containment Delamination Root Cause - Strategy



Containment Delamination Root Cause

- Initial Focus on Condition Assessment

- Non-Destructive Testing (NDT) of Containment Surfaces
  - Use of Impulse Response (IR) Method - over 8,000 IR data points
  - Ground Penetrating Radar (GPR)
  - Comprehensive on all accessible areas

- Concrete Core Bores
  - Over 170 core bores performed
  - Ranged from 1” to 8” diameter, 6” to 32” long
  - Validated IR data, along with boroscopic inspections
  - Laboratory testing

Containment Delamination Root Cause

- 75 potential Failure Modes (FM) investigated
  - 67 FM's refuted
  - Remaining 8 FM's combined for Root Cause Analysis to determine their significance
- Existing Industry Analysis Techniques Predicted Acceptable Margin to Delamination at CR3
- Investigation Required Development of New Finite Element Analysis Tools
  - Progressively increasing complexity
  - 360^{o} global containment model
  - Visco-elastic / non-linear model
  - Model includes individual tendons, rebar, liner, etc.
  - Sub-models (1" mesh) provide higher resolution of localized behavior

Root Cause Analysis
Summary

- Conclusions
  - Design acceptable for Normal and Emergency Operations
  - Construction was in accordance with design
  - Delamination occurred during the outage
  - New state-of-the-art analytical methods had to be created to analyze containment response

Root Cause Analysis
Summary

- Root cause
  - De-tensioning scope and sequence resulted in redistribution of stresses that exceeded tensile capacity
    - Could not have been predicted based on existing information and models at that time
    - Multiple pre-existing conditions contributed to the delamination (design, materials, etc)

Containment Repair Phases

Phase
1. Stress Relief Cut
2. De-Tensioning
3. Delamination Removal
4. Concrete Placement
5. Re-Tensioning
6. Post Repair Testing

Design Basis & Repair
FSAR Structural Design Parameters

- Containment Design Features Remain Unchanged
  - Approach done via 10 CFR 50.59

- Containment Design Basis Maintained
  - Leak-tight structure to contain fission products in design basis Loss of Coolant Accident
  - Elastic response to design basis loading preserved to protect liner
  - Design loads and combinations based on operating, accident and applicable code requirements
  - Load factors applied to provide safety margin

Delamination Repair

- Detension Containment to facilitate delamination removal
  - 155 horizontal and 64 vertical tendons
  - Detailed sequence analysis
  - Tendons in repair area of Bay 3-4 removed
- Delamination fully removed
  - Bay 3-4: Elevation 157'-10" to 240'
  - Variations in depth of concrete removal
  - Vertical crack removal
- Install reinforcement
  - New radial reinforcement
  - Additional horizontal and new vertical reinforcement

Delamination Removal
Hydro-Excavation Completed

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Radial Anchor Installation
For Concrete Placement Below 176’

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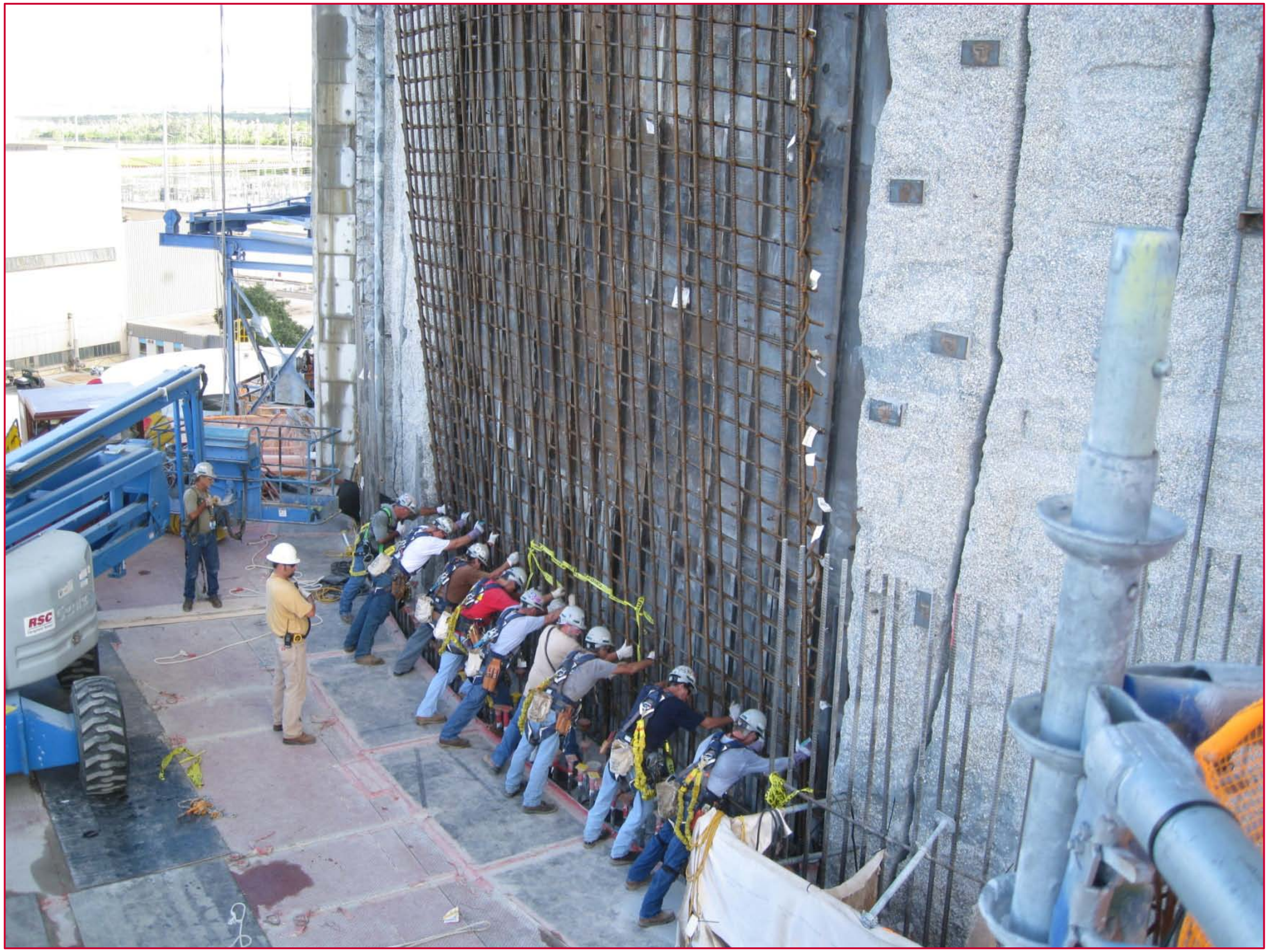
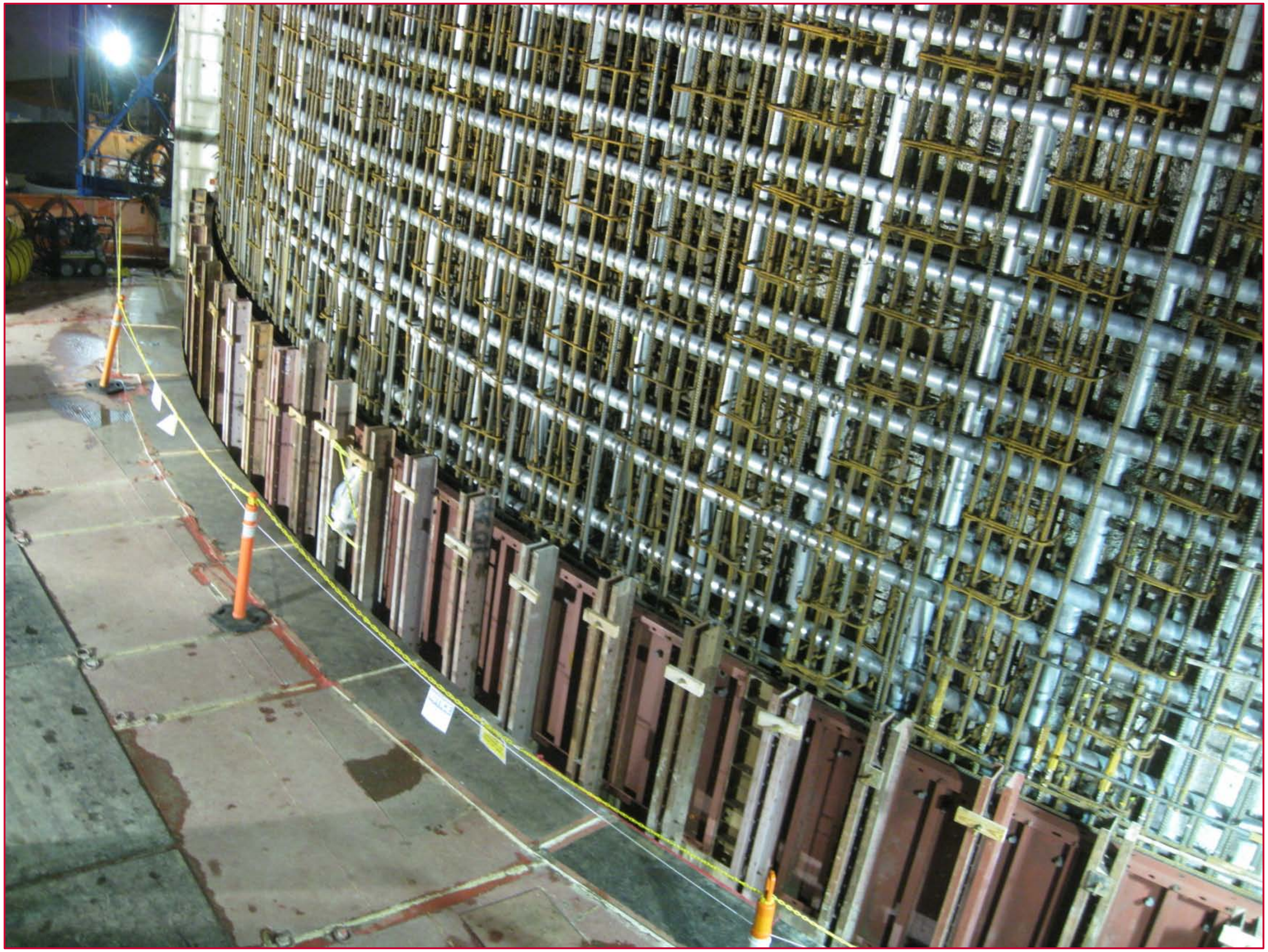
Reinforcement Installation

Inner layer of Rebar Mat in Fully Excavated Area



Final Reinforcement Installation



Mock-up Testing – Reinforcement Installation

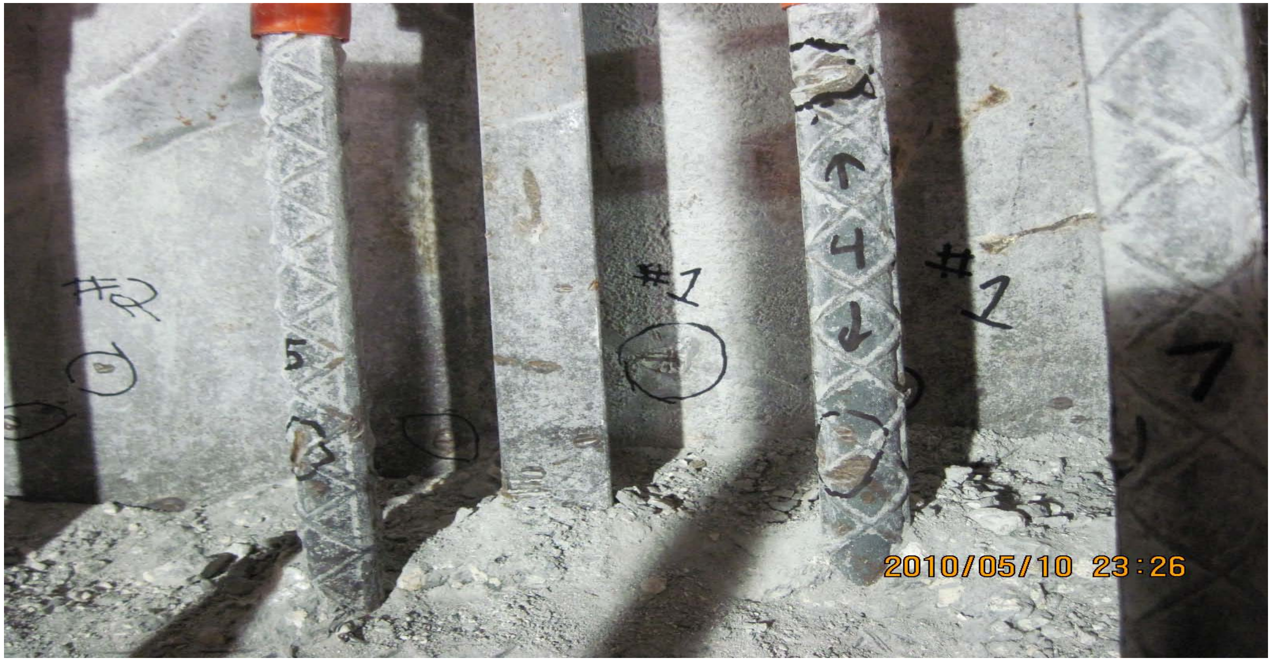
Delamination Repair

- Place concrete – 5 foot lifts
  - On site batch plant
- Retensioning
  - 155 horizontal & 64 vertical tendons
  - Detailed sequence using partial (2 step) tensioning
  - 80 remaining vertical tendons reset to original construction value
- Owner-elected SIT / ILRT

Impacts on the Containment Liner

- Exposed containment liner and concrete reinforcement were thoroughly examined in accordance with Code

- Minor indications noted during these examinations
  - Some from repair effort; some original construction
  - All assessed and repaired



Impacts on the Containment Liner

- Additional concrete cracking was also noted.
- All areas were evaluated and/or repaired to restore the materials and surface conditions to meet the design requirements.

Impacts on the Containment Liner

- Design impacts on the Containment liner due to the repair have been evaluated.

- The results of the calculations show that there is no impact on the current design basis of the Containment liner.

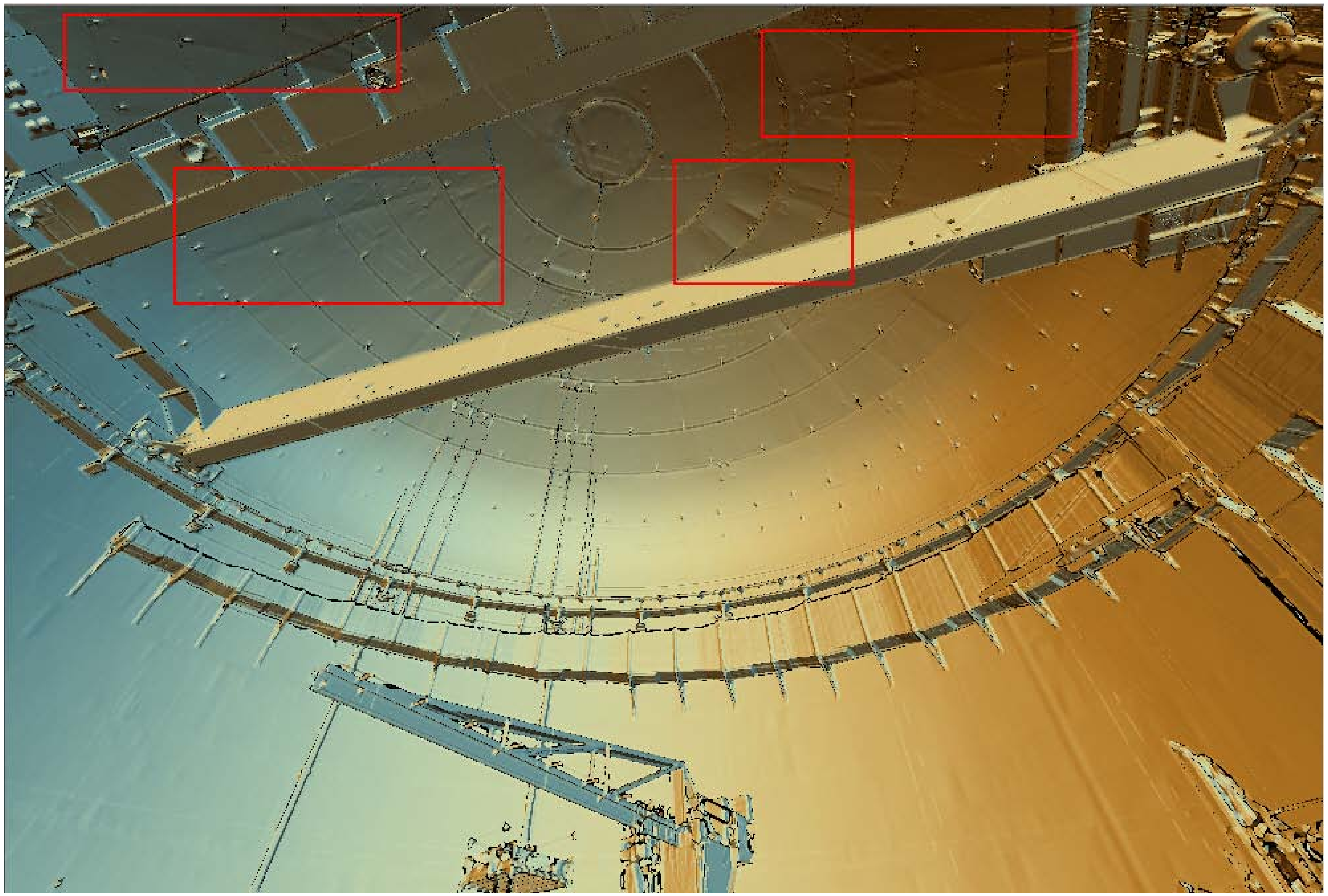
Containment Liner Bulges

- Observed between vertical stiffeners (18” apart)
  - Bulges had always been monitored & evaluated per IWE Program – qualitatively
- Extent of condition bounded by laser scanning and visual inspections
- UT measurements have confirmed no generalized corrosion or liner wall thinning

Laser scan


CSA
x = 777.927
y = 21.958
z = 2013.294
depth = 153.425
0. 2
0. 47
0. 49
0. 55
0. 46
View mode

Dome Bulges



Containment Liner Bulges

- Finite Element Analysis completed
  - Verified no impact and conformance to liner design requirements
  - FEA established allowable bulge size: 1.82”
  - No loading condition would create / result in a bulge
  - Construction tolerances
- Have tracked most limiting bulges
  - Dome bulge 1.312” +/- .125” (manual measurement)
- All bulges are within acceptance criteria
- Continue monitoring per ASME XI IWE Program

Post Repair Testing - *Pressure Tests*

- Integrated Leak Rate Test (ILRT) required per ASME XI code
  - For removing / replacing liner in SGR opening
  - Pressure test for repaired concrete

- Plan to perform an elective Structural Integrity Test (SIT)
  - Normally a one-time initial construction structural test
  - Test intent: measures structural integrity and deformation at 1.15 peak design pressure (63.3 psig)
  - SIT will be followed by ILRT

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Pre- startup Monitoring and Inspections

- ASME Section XI – Repair/Replacement Required
  - Detailed visual examination of new concrete surfaces
  - Detailed visual examination of the liner repairs
  - Detailed visual examination of tendons and anchorage areas (for manipulated tendons)
  - Containment pressure test (ILRT) for liner and concrete

- ASME Section III – SIT Scope
  - Visual examination of accessible portions of containment (including concrete and liner).
  - Mapping of surface cracks
  - Displacements, temperatures, and pressures

Pre- startup Monitoring and Inspections (cont.)

- Owner Elected – Augmented
  - Laser scanning (of liner bulges)
  - Liner bulge measurements
  - Vertical crack width measurements
  - General visual examination of all accessible concrete surfaces (outside repair areas)
  - Embedded strain gauges and thermocouples
  - Laser scanning (building displacements)
  - Acoustic sensor monitoring
  - Impulse response testing
  - Periodically monitor containment concrete condition outside Bay 3-4 to ensure no unexpected changes via NDE methods
  - Monitoring condition in Bay 3-4 via installed containment sensors

Post-startup Monitoring and Inspections

- ASME Section XI – Repair/Replacement Required
  - General visual examination of new concrete surfaces
  - Augmented Tendon examination and testing of tendons affected by the repair/replacement activities
- Owner Elected – Augmented
  - Vertical crack width measurement
  - Liner bulge measurements
  - Periodically monitor containment concrete condition outside Bay 3-4 to ensure there are no unexpected changes via NDE methods
  - Monitoring concrete condition inside Bay 3-4 via installed containment sensors

Pre-Startup and Post-Startup Inspections

- Test Intervals per NEI 94-01
  - CR-3 is committed to 1995 Rev. 0 of NEI 94-01
  - Section 9.2.3 “Extended Test Intervals”
    - Allows Type A (ILRT) testing to be extended to once every 10 years based on two consecutive successful Type A tests
  - CR-3 previously established acceptable Type A history and extended this interval to once every 10 years
  - Section 9.2.4 “Containment Repairs and Modifications”
    - Requires Type A test when repairs could affect leakage integrity
    - Does not require re-establishment of acceptable test history to apply Type A extended test intervals for “repairs” to Containment
  - CR-3 maintaining test interval

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OI-3.5-1: Containment Delamination

- Open Item requested how our experience will be incorporated into the ASME Section XI, Subsection IWE and IWL programs
  - Also whether a plant-specific program is necessary to manage aging of the containment
- Changes to the CR-3 IWE/IWL Program
  - Those required by the ASME Section XI repair/replacement requirements contained in Articles IWL -2000 and IWL-4000
- Additional augmented Owner-elected inspections include:
  - Vertical crack width inspection – assure crack widths remain the same or reduce in size
  - Liner bulge heights and wall thickness measurements
- CR-3 not developing plant-specific containment aging program

Open and Confirmatory Items

- OI-3.0.3.1.9-1: One-Time Inspection Sampling
  - Sampling methodology consistent with NUREG-1801,Rev. 2
- OI-3.0.3.2.10-1: Selective Leaching of Materials Sampling
  - Sampling methodology consistent with NUREG-1801,Rev. 2
- OI-3.0.3.1.10-1: Buried Piping and Tanks Aging Management
  - Inspection activities reconciled with NUREG-1801, Rev. 2

Open and Confirmatory Items

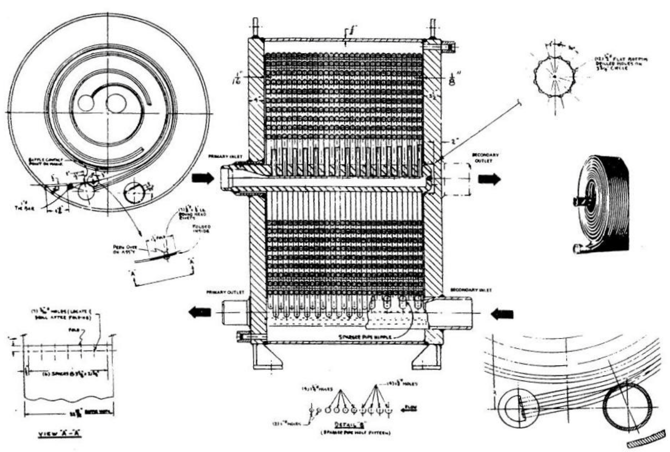
- OI-3.0.3.1.19-1: Submerged Power Cables
  - Concerned with event driven manhole inspections
  - One manhole has a sump pump
  - One manhole is located in the Hot Machine Shop
  - Two are located on the berm
    - Manholes are sealed
    - Located well above the water table
    - Annual inspections find little water accumulation
    - Annual Inspection frequency to be informed by operating experience

Open and Confirmatory Items

- OI-3.0.3.2.13-1: Masonry Wall Program inspection frequency
  - Inspection frequency changed to five years
- OI-3.0.3.2.14-1: Structures Monitoring Program quantitative acceptance criteria
  - Acceptance criteria per ACI 349.3R
  - A baseline inspection will be performed prior to the period of extended operation

Open Item OI-3.3.2.2.4.1-1

- OI-3.3.2.2.4.1-1: Cracking due to stress corrosion cracking and cyclic loading
  - One-time Inspections vs. Eddy Current Testing
    - Cracking due to cyclic loading (associated with high cycle fatigue)
      - Not applicable to the letdown coolers
    - Cracking due to SCC can be detected by inspections performed by One-time Inspection AMP



Open Item OI-4.3.3-1

- OI-4.3.3-1: Environmentally-Assisted Fatigue Analysis
  - Bounding of NUREG/CR-6260 Locations
    - Review performed by material and component
    - Bounding F_{en} considered
    - Qualitative Assessment of Risk Significance
  - EAF evaluations performed are bounding

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Confirmatory Items

- CI-3.0.3.1.11-1: Compressed Air Monitoring Program GALL Report Consistency
  - Compressed Air Monitoring Program added
  - Program based on NUREG-1801, Rev. 2
  - Staff is evaluating determination of consistency

- CI-4.3.4.2-1: Thermal Aging of Cast Austenitic Stainless Steel (CASS)
  - Disposition for the CASS RCP casings and nozzles under 10 CFR 54.21(c)(1)(ii)

Recent and Ongoing Major Projects

- Reactor Vessel Head Replacement
  - Head inspections identified cracking of Alloy 600 nozzle due to PWSCC
  - Head replaced in 2003
  - Alloy 690 selected due to it’s superior resistance to PWSCC
  - Replacement Head project included cable replacement and other operational improvements

Recent and Ongoing Major Projects

- Steam Generator Replacement
  - Decision based on
    - Alloy 600 mitigation
    - Tube plugging limits
  - Steam generators replaced in current outage
  - New generators use Alloy 690 tubes
  - Replacement project included FW riser and RCS piping replacement

Recent and Ongoing Major Projects

- Power Uprates
  - Measurement Uncertainty Recapture (2007)
  - Secondary plant thermal efficiency improvements (2009)
  - Full Extended Power Uprate – licensed change to rated thermal power scheduled for Refuel 17 (2012)
  - Significant modification scope in 2009 through 2012

Major Power Uprate Modifications

- Primary plant changes scheduled for next outage
  - Cross-tie of low pressure injection trains
    - Improve core flood line break performance
    - Enhance boron precipitation mitigation
  - Enhanced primary-to-secondary heat transfer capability
    - Larger, safety-related ADVs with alternate low pressure control value
  - Increased Emergency Feedwater and High Pressure Safety Injection flow

Major Power Uprate Modifications

- Secondary plant new equipment
  - High and low pressure turbine
  - Electrical generator including exciter, partial bus and bus duct cooling
  - Replaced, upgraded or added several secondary heat exchangers
  - Replaced/upgraded secondary pumps, motors and/or rotating elements

Questions

Questions?

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Advisory Committee on Reactor Safeguards (ACRS) License Renewal Subcommittee

Crystal River Unit 3 Nuclear Generating Plant (CR-3)

Safety Evaluation Report (SER) with Open Items

January 12, 2011

Rob Kuntz, Project Manager
Office of Nuclear Reactor Regulation

Presentation Outline

- Overview of CR-3 License Renewal Review
- SER Section 2, Scoping and Screening review
- Region II License Renewal Inspections
- SER Section 3, Aging Management Programs and Aging Management Review Results
- SER Section 4, Time-Limited Aging Analyses (TLAAs)

Overview of LRA

- License Renewal Application (LRA) Submitted December 16, 2008
  - Applicant: Florida Power Corporation
  - Facility Operating License DPR-72 expires December 3, 2016
- Approximately 35 miles southwest of Ocala Florida in Crystal River Florida
- CR-3 is a B&W two loop PWR

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Protecting People and the Environment

Audits and Inspections

- Scoping and Screening Methodology Audit
  - June 23-26, 2009
- Aging Management Program (AMP) Audits
  - July 13-17, 2009
- Region II Inspection
  - 2 weeks in July/August 2009
  - 1 week follow-up in October 2010
  - Special Inspection in response to containment delamination October 2009-September 2010

Overview of SER

- Safety Evaluation Report (SER) with Open Items issued December 14, 2010
- SER contains 9 Open Items (OIs) and 2 Confirmatory Items (CIs):
  - Component selection for the One-Time Inspection Program (OI-3.0.3.1.9-1)
  - Component selection for the Selective Leaching of Materials Program (OI-3.0.3.2.10-1)

Overview of SER (cont.)

- SER contains 9 Open Items (OIs) (cont.)
  - Inspection frequency for the Masonry Wall Program (OI-3.0.3.2.13-1)
  - Quantitative inspection criteria for the Structures Monitoring Program (OI-3.0.3.2.14-1)
  - Cracking due to stress-corrosion cracking and cyclic loading in stainless steel non-regenerative heat exchanger components (OI-3.3.2.2.4.1-1)
  - Environmentally assisted fatigue analysis locations (OI-4.3.3-1)

Overview of SER (cont.)

- SER contains 9 Open Items (OIs) (cont.)
  - Aging management of buried and underground piping and tanks (OI-3.0.3.1.10-1)
  - Aging management of potentially submerged power cables (OI-3.0.3.1.19-1)
  - Aging management of the containment (OI-3.5-1)
- SER contains 2 Confirmatory Items (CIs)
  - Compressed Air Monitoring Program consistency with the GALL Report (CI-3.0.3.1.11-1).
  - Classification of thermal aging of CASS RCP casing and nozzles (CI-4.3.4.2-1)

SER Section 2 Summary

- Structures and Components Subject to Aging Management Review
  - Section 2.1, Scoping and Screening Methodology
    - Methodology is consistent with requirements of 10 CFR 54.4 and 54.21
  - Section 2.2, Plant-Level Scoping Results
    - Systems and structures within the scope of license renewal are appropriately identified in accordance with 10 CFR 54.4
  - Sections 2.3, 2.4, 2.5 Scoping and Screening Results
    - SSCs within the scope of license renewal are appropriately identified in accordance with 10 CFR 54.4(a), and those subject to an AMR in accordance with 10 CFR 54.21(a)(1)

Regional Inspection -
License Renewal Inspections Program Implementation

- License renewal chapter - MC 2516

- License renewal inspection procedure - IP 71002

Regional Inspection - License Renewal Inspections Program Implementation

- Objective

- First Team Inspection
  - Examine records
  - Examine implementation plans
  - Verify material condition of plant was adequately maintained

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Regional Inspection - License Renewal Inspections Program Implementation

- Follow-Up Inspection
  - Reviewed 5 AMPS Open from Initial Inspection
  - Conducted plant walk-downs

Regional Inspection - License Renewal Inspections Program Implementation

- Inspections concluded
  - existing programs credited for license renewal are functioning well.
  - Applicant had established AMP implementation plans
  - Region II will follow up during a future IP 71003 inspection

Regional Inspection -
License Renewal Inspections
Program Implementation

- Condition of Containment Building
  - Special Inspection
  - Delamination - Cause, extent and repair
  - Vertical Cracks

Regional Inspection

- Condition of Containment Building (Cont'd)
  - Liner Bulges
  - Cracks in Containment Dome

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Regional Inspection

- Containment Building Restart Milestones
  - Successful Retensioning
  - Successful Structural Integrity Test
  - Successful Integrated Leak Rate Test

Section 3: Aging Management Review

- Section 3.0 – Aging Management Programs
- Section 3.1 – Reactor Vessel & Internals
- Section 3.2 – Engineered Safety Features
- Section 3.3 – Auxiliary Systems
- Section 3.4 – Steam and Power Conversion System
- Section 3.5 – Containments, Structures and Component Supports
- Section 3.6 – Electrical and Instrumentation and Controls System

SER Section 3

3.0.3 – Aging Management Programs

- 41 Aging Management Programs (AMPs) presented by applicant and evaluated in the SER

	Consistent with GALL	Consistent with exception	Consistent with enhancement	Consistent with exception & enhancement
Existing (27)	10	4	8	5
New (12)	7	5		

The LRA also included 2 plant specific AMPs

SER Section 3 Open Items

- One-Time Inspection Program, OI-3.0.3.1.9-1 and Selective Leaching of Materials Program, OI-3.0.3.2.10-1
  - Both items relate to the components inspected by the One-Time Inspection and Selective Leaching of Materials Programs
  - The staff is reviewing the applicant’s response
- Cracking due to SCC and Cyclic Loading OI-3.3.2.2.4.1-1
  - Inspection techniques for non-regenerative heat exchangers exposed to treated water
  - The staff is reviewing the applicant’s response

SER Section 3 Open Item

- Structures Monitoring Program, OI-3.0.3.2.14-1
  - Acceptance criteria for the Structures Monitoring Program inspections
  - The staff is reviewing the applicant's response
- Masonry Wall Program, OI-3.0.3.2.13-1
  - The inspection interval for components within the scope of the Masonry Wall Program
  - The staff is reviewing the applicant's response

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SER Section 3 Open Item

- Buried Piping and Tanks Inspection Program (OI-3.0.3.1.10-1)
  - Staff submitted buried pipe RAI to applicant
  - Overview of response
    - Cathodic protection available except for small portion of condensate system and all of nuclear service and decay heat seawater system, augmented inspection proposed
    - Coatings and backfill quality are acceptable based on plant specific specifications, validated by inspection results
    - Alternative inspection methodology proposed for buried concrete piping
  - Staff finalizing review

SER Section 3 Open Item

- Inaccessible Medium-Voltage Cables Not Subject to 10 CFR 50.49 Environmental Qualification Requirements Program, OI-3.0.3.1.19-1
  - The applicant’s proposed aging management for potentially submerged cables did not include information related to event driven actions
  - The staff is awaiting additional information from the applicant

SER Section 3 Open Item

- Containment Aging Management, OI-3.5-1
  - During the Fall 2009 outage a delamination was discovered in the containment concrete
  - Applicant is in the process of completing testing, analysis, and repairs to the containment
  - Applicant is performing containment concrete and post-tensioning rework as a repair/replacement activity pursuant to the 10 CFR 50.55a inservice inspection program in accordance with ASME Code Section XI, Subsection IWL
  - CR-3 containment rework is extensive and unique and the need for additional commitments is being evaluated

SER Section 3 Open Item

- Containment Aging Management, OI-3.5-1 (cont.)
  - The staff has open questions related to the aging management of the CR-3 containment structure:
    - Concrete inspection methods and frequency
    - Integrated leak rate test frequency
    - Monitoring bulges in the liner plate
    - Prestressing tendons surveillance and inspection
    - Monitoring of the through thickness vertical cracks in the concrete containment shell during the period of extended operation
    - Prestressing Tendon TLAA
  - The staff is reviewing the applicant’s response to these items

SER Section 3 Confirmatory Item

- Compressed Air Monitoring Program, CI-3.0.3.1.11-1
  - Staff requested additional information on aging management of compressed air system components
  - In November 2010 the applicant added the Compressed Air Monitoring Program
  - Staff needs to confirm that the applicant’s program is consistent with the GALL Report

SER Section 4: Time-Limited Aging Analyses

- Section 4.1 – Identification of Time-Limited Aging Analyses
- Section 4.2 – Reactor Vessel Neutron Embrittlement
- Section 4.3 – Metal Fatigue
- Section 4.4 – Environmental Qualification of Electrical Equipment
- Section 4.5 – Concrete Containment Tendon Prestress
- Section 4.6 – Containment Liner Plate, Metal Containments, and Penetrations Fatigue Analysis
- Section 4.7 – Other Plant-Specific time-Limited Aging Analylses

SER Section 4 Open Item

- Environmentally-Assisted Fatigue Analysis, OI-4.3.3-1
  - The staff questioned whether the locations in the LRA considered locations beyond those identified in NUREG/CR-6260 and if the locations considered are bounding for the plant
  - The staff is reviewing the applicant’s response

SER Section 4 Confirmatory Item

- Thermal Aging of CASS RCP Components, CI-4.3.4.2-1 (TLAA of Leak-Before-Break Analysis of RCS Loop piping)
  - The original LBB analysis used fracture toughness of ferritic material to analyze CASS RCP components due to limited CASS data in the 1980’s.
  - The applicant updated analysis.
  - The applicant did not consider thermal aging of CASS as a TLAA in LRA. The staff did not agree.
  - During a recent teleconference with the staff, the applicant to disposition as a TLAA in accordance with 10 CFR 54.21(c)(1)(ii)