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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)

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PLANT LICENSE RENEWAL SUBCOMMITTEE

DAVIS-BESSE NUCLEAR POWER STATION

+ + + + +

WEDNESDAY

SEPTEMBER 23, 2015

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ROCKVILLE, MARYLAND

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The Subcommittee met at the Nuclear Regulatory Commission, Two White Flint North, Room T2B1, 11545 Rockville Pike, at 8:30 a.m., Harold B. Ray, Chairman, presiding.

COMMITTEE MEMBERS:

HAROLD B. RAY, Chairman of the Subcommittee

RONALD G. BALLINGER, Member

MICHAEL L. CORRADINI, Member

DANA A. POWERS, Member

STEPHEN P. SCHULTZ, Member

GORDON R. SKILLMAN, Member

ACRS CONSULTANT:

WILLIAM SHACK

DESIGNATED FEDERAL OFFICIAL:

KENT L. HOWARD, SR.

ALSO PRESENT:

DENNIS BLAKELY, FirstEnergy Nuclear Operating Company

BRIAN BOLES, FirstEnergy Nuclear Operating Company

KEN BYRD, FirstEnergy Nuclear Operating Company

PHYLLIS CLARK, NRR

CHONG CHIU, Performance Improvement International

CLIFF CUSTER, FirstEnergy Nuclear Operating Company

YOIRA DIAZ-SANABRIA, NRR/DLR

STEVE DORT, FirstEnergy Nuclear Operating Company

TRENT HENLINE, FirstEnergy Nuclear Operating Company

THOMAS HENRY, FirstEnergy Nuclear Operating

Company

LARRY HINKLE, FirstEnergy Nuclear Operating Company

JON HOOK, FirstEnergy Nuclear Operating Company

BENNY JOSE, NRC, Region III

KEVIN KAMPS, Beyond Nuclear

MICHAEL KEEGAN, Don=t Waste Michigan

MARVIN LEWIS

JANE MARSHALL, NRR

CHRIS MILLER, NRR

DENNIS MOREY, NRR

JIM NEURAUTER, NRC, Region III

RICK PLASSE, NRR

GEORGE THOMAS, NRR

BRIAN WITTICK, NRR

*Present via telephone

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

(8:30 a.m.)

CHAIRMAN RAY: Good morning. This meeting will now come to order.

I'm Harold Ray, Chairman of the Davis-Besse Plant License Renewal Subcommittee.

The Subcommittee will review the License Renewal Application for the Davis-Besse Nuclear Power Station.

ACRS Members in attendance are Dana Powers, Gordon Skillman, Michael Corradini, Ron Ballinger and Steve Schultz.

Our ACRS consultant today and former Member and Chairman, Bill Shack is also in attendance.

Ken Howard of the ACRS staff is the designated Federal Official for this meeting.

Principle milestones for this License Renewal Application will be summarized by others, but let me begin with the following.

The licensee submitted a License Renewal Application a little over five years ago in August 2010.

This Subcommittee met to review the application two years later in September 2012.

From then until now, no ACRS meetings have been held, although several were scheduled in 2013 and 2015.

The NRC staff Safety Evaluation Report, which is vital input to our review process, was issued in September 2013, one year after our Subcommittee meeting and two years prior to today.

That would be plenty of time for us to get prepared for today except that the extensive Supplement 1 to the Safety Evaluation Report became available to us only one month ago in August 2015.

Given this background and our objective to fully prepare for the next meeting to be with the full Committee, at which a letter is expected in accordance with 10 CFR 52.25, today's meeting agenda has provided for flexibility to pursue questions that may involve emergent issues.

I'd expect we will also extend the normal recess periods in order to review where we are at that point and make any adjustments in the remaining agenda items.

This may also cause participants to be asked to return to the table.

And then, finally, there is some proprietary material in the record which, if it's the subject of discussion and the licensee wishes to have a closed discussion to protect proprietary information, they should let me know and we'll arrange for that.

Finally, I want to acknowledge that this is a License Renewal Application for which 10 CFR 54.30(b) applies. It specifically complies with the current license basis, it's not a part of the license renewal scope.

That said, there are matters which are both a part of the current license basis which are not the subject of this review but which to need to be understood in some detail in order to evaluate the Aging Management Programs which do apply to the period of extended operation.

Therefore, there may be questions which appear to address compliance for the current licensing basis, but that's not our intent.

Today, we will hear presentations from the Division of License Renewal, from Region III and from FirstEnergy Nuclear Operating Company regarding the License Renewal Application.

The Subcommittee will gather information, analyze relevant issues and facts and formulate proposed positions and actions as appropriate for deliberation by the full Committee.

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

We've not received written comments or requests for time to make oral statements from members of the public regarding today's meeting. And, except for anything that is deemed proprietary and causes us to have a closed meeting, the entire meeting is expected to be open to public attendance.

There is a phone bridge line on which callers have already called in.

To preclude interruption of the meeting, the phone will be placed on listen in mode during the presentations and Subcommittee discussion. The bridge line will be opened for any public comment prior to the end of today's meeting.

A transcript of the meeting is being kept and will be made available as stated in the Federal Register Notice. Therefore, I request that participants in this meeting use the microphones located throughout the meeting room when addressing the Subcommittee.

The participants are requested to please identify themselves and speak with sufficient clarity and volume so that they may be readily heard.

Those of us at the table have microphones which need to be actuated by turning them on and off as the occasion requires. If people remind me to do, I will then remind everybody else to do it. It's something that doesn't come naturally.

Also, I'll ask that people silence any mobile devices in the room as we proceed.

We'll now proceed with the meeting. I call on Chris Miller to make any comments on behalf of the staff.

MR. MILLER: Thank you, Mr. Chairman.

My name's Chris Miller. I'm the Director of the Division of License Renewal and we look forward to the discussion with you on this License Renewal Application.

The management team seated with me include Yoira Diaz. We have Brian Wittick and Dennis Morey.

And, also in the audience, we have from Region III Jim Neurauter who is -- he led the shield building laminar cracking inspections.

We also have on the phone from Region III Benny Jose who led the 71002 inspection.

The staff's presentation on the Davis-Besse Safety Evaluation Report will be conducted by our Safety Project Manager, Rick Plasse. And, he will be joined in the presentation by structural engineer, Dr. George Thomas and Safety Project Manager, Phyllis Clark, is also with us.

CHAIRMAN RAY: Chris, the folks from Region III that are on the phone, are they on the bridge line or have we got a separate line for them?

MR. MILLER: They're on the bridge.

CHAIRMAN RAY: They're on the bridge line? I see. All right, thank you.

MR. MILLER: And, I assume, did we -- we made a check with them? Yes? Okay.

We also have with us in the audience a large group of staff members. And, during the presentation, staff members who will add comments will introduce themselves at that time.

As you mentioned, you met with the ACRS Subcommittee on September 19, 2012 in which we discussed the SER with open items that was issued in July of 2012.

In the SER with open items, the staff identified four open items related to shield building cracks, operating experience, pressure temperature limits and upper shelf energy.

Since 2012, the staff worked in closing the open items. The three year's delay mostly occurred due to challenges in closing the shield building cracking issues.

We agreed with ACRS that it was prudent to have a second ACRS Subcommittee meeting due to the delays in between the issuance of the SER with open items and the final SER.

The resolution for the open items are discussed and are documented in the final SER and Supplement 1 issued September 2015 and August of 2015 respectively.

During his presentation, Rick Plasse will provide an overview and background of the staff Safety Review of Davis-Besse License Renewal Application and will go into more details on the resolution on of the open items I mentioned.

At this time, I'd like to turn the presentation over to FirstEnergy and site Vice President, Brian Boles, to introduce his team and commence their presentation.

MR. BOLES: Thank you and good morning.

My name is Brian Boles. I'm the site Vice President at Davis-Besse. We're pleased to have the opportunity to meet with this committee today.

We have a brief agenda where I'll cover introductions of my team. We'll cover some background material of the Davis-Besse plant, the License Renewal Application description.

We'll go into a discussion about our shield building, containment vessel inspections and then a summary and closing remarks.

With that, I'd like to introduce my team. To my left is Ken Byrd. He is the Director of Engineering at Davis-Besse.

And, seated to his left is Cliff Custer, our Fleet Project Manager for License Renewal.

And, to his left is Steve Dort, our Site Project Coordinator for License Renewal.

Over to my right, we have members of our License Renewal Core Team and then we have a fairly large contingent of our Aging Management Program owners and subject matter experts that are seating in the room also.

With that, I would like to turn it over to Ken Byrd who will discuss the background of Davis-Besse and get into our presentation.

MR. BYRD: Okay, Davis-Besse, our site, we're on the Southwestern shore of Lake Erie in Ottawa County. We're between 20 to 30 miles east of Toledo, Ohio. The site's about 954 acres, a substantial portion of it, 733 acres, is leased to the government for a wildlife refuge and the remaining 221 acres is for our site facilities.

Next slide, please?

So, our design, we're a pressurized water reactor. Babcock & Wilcox design, a raised-loop design. The only reason I mention the raised-loop is we are the only one of the Babcock & Wilcox plants that has the raised-loop and, with that, design, is the generators are raised relative to the reactor. Now, the intent of that design was to promote natural circulation.

Bechtel was the construction management and our facility operating license will expire April 22, 2017.

Next slide, please?

So, I'll briefly talk about some of the

recent equipment improvements we've made. I tried to keep this slide simple.

But, we have made a lot of improvements over the last approximately, just within the last year, we've completed digital electrohydraulic control that improves reliability, reduces single point vulnerabilities, replaced containment and station vent monitors.

We've replaced our turbine plant cooling water heat exchangers, improved the heat transfer by doing that.

We've modified our switch yard. We've added three new breakers, a new offsite line and that significantly improves our offsite power reliability.

We've replaced our reactor coolant pump seal piping with flexible hoses to prevent any type of leakage in the elbows.

We replaced the main generator rectifier, voltage regulator.

We've replaced just within our last outage about a thousand feet of service water piping, part of a long term project to replace all of our piping that's less than six inches.

And, recently, we replaced a station

air compressor.

So, a lot of improvements we've made.

The ones I was going to focus on, though, are the ones which are on the slide, reactor head. The center picture in the slide is our reactor head which was replaced. That picture was back in 2011, the fall of 2011.

The significant improvement with that new head is the control rod drive mechanisms are alloy 690, so that does replace the alloy 600 that we previously had in the existing head.

Then we replaced steam generators. We replaced that in our spring outage, our most recent outage in the spring of 2015.

The new steam generators are substantially similar to what we had. The big difference is our tubes are now alloy 690 tubes.

The picture you see there on the left is our steam generator. That's a once through steam generator design being lifted up over the d-ring into place in Davis-Besse.

We did -- we tried to keep the design as similar as we could to the original steam generators. We did take advantage of some of the operating experience that we were aware of from the

ANO, Three Mile Island as well as Oconee to make some improvements.

CHAIRMAN RAY: Now, the thought was increased heat transfer is any power up rate involved or anticipated?

MR. BYRD: No, there's no up rate anticipated. These steam generators are very similar with regards to heat transfer with what we originally had.

Then, the final improvement on the left hand side is our new emergency feedwater facility which we're in the process of implementing.

So, we are building this emergency feedwater system in response to two initiatives. One is the National Fire Protection Association 805. The other is our FLEX which -- so, what this facility will provide for us, it's going to be our Phase I for our FLEX and it also will be our response to 805 in allowing us to improve our core damage frequency.

So, what we're going to have, we'll have a 290,000 gallon protected tank. We'll have an automatically initiated diesel-driven emergency feedwater pump.

What you're looking at right there is

the lower level or the basement of the facility where the pump will reside down in that area. And just off to the left, that's where we'll have the 290,000 gallon tank.

The entire thing is designed seismically. It'll be all missile protected, so it'll be fully protected from environmental and seismic conditions.

So, what this gets us is it provides us our Phase I for FLEX. It substantially improves our core damage frequency for fire protection and that also provides a very significant improvement in just our long line of core damage frequency. A very significant project that's underway right now.

Okay, next slide, please?

This part, I'll turn it over to Cliff to talk about some of the details of our License Renewal Application.

MR. CUSTER: Good morning. My name is Cliff Custer. I'm the Project Manager for License Renewal.

So, the Davis-Besse License Renewal Application was developed to NUREG-1801, or GALL Rev. 1. However, it was reviewed to GALL Rev. 2.

It was developed by a team of AREVA,

FENOC core team and site preview and concurrence was provided for all the AMPs, TLAAs and documents in the application.

There was an industry peer review prior to its submittal in August of 2010.

The application consists of 44 Aging Management Programs, 13 of which are new, 6 are plant specific, 31 are existing and 4 are plant specific. And, it also consists of 55 license renewal commitments.

Next slide, please?

CHAIRMAN RAY: When the commitments are all completed, will then all the AMPs comply with Rev. 2 GALL?

MR. CUSTER: There are -- to the largest majority will comply with GALL Rev. 2. The AMPs will comply with GALL Rev. 2. The AMR tables, as they were built to GALL Rev. 1, some of the numbers were -- it was difficult to change some of those numbers. So the AMPs will comply to GALL Rev. 2, with exceptions, of course, which we'll talk about here shortly.

CHAIRMAN RAY: Okay. Well, it was a little hard to follow in the material we got as to whether the initial submittal which, of course, is based on Rev. 1, was entirely updated or whether only pieces of it were to reflect Rev. 2.

But, you're saying, as far as AMPs go, they all will comply with Rev. 2?

MR. CUSTER: Yes, the AMPs comply with GALL Rev. 2 and, along with that is, several of the ISGs that came along through the years, as we'll talk about shortly.

CHAIRMAN RAY: Yes.

MR. CUSTER: Next slide, please?

So, as far as open items on the first or final SER, there were four open items. They were addressed and closed in that Safety Evaluation Report September 2013.

With respect to -- there was an open item with respect to operating experience. We developed the process to align with the ISG-2011-05 for ongoing review of operating experience.

The second open item was on reactor vessel neutron embrittlement. We provided equivalent margins analysis for the reactor vessel shell weld regions.

The third open item was with respect to pressure temperature limits. We revised the application to include future limit curves consistent with 10 CFR Part 50 Appendix G.

And, then, of course, the final open item was the shield building, which we will discuss at length later in this presentation.

Next slide, please?

With respect to the review period, the time line, the NRC audit and inspection period was through the years 2011. There was an extended review period due to the waste management decision and the shield building evaluation.

There was interim staff guidances, all nine of them, through ISG-2013-01 have been addressed.

Our last annual update was submitted in June of 2015. Our final Environmental Impact Statement was issued in June of 2015, this year. And, our Supplemental SER was, of course, issued here in August.

Next slide?

MEMBER SKILLMAN: Cliff, before you change, I understand the delay due to the shield building evaluation. I didn't understand the delay based on waste management decisions. Could you explain that, please?

MR. CUSTER: Yes, the waste management

decision held in abeyance, approval of License Renewal Applications through the year 2014.

MEMBER SKILLMAN: Got you, now I understand. Thank you.

MR. CUSTER: Now, at this time, I'll turn the presentation back over to Ken.

MR. BYRD: Okay, for the next part of our presentation, we'll be discussing the shield building.

At this point, I'd like to ask our Design Engineering Manager, Jon Hook, to come up front because he'll be providing a significant part of this presentation.

I'll go ahead and get started just with the overview of what we're going to talk about.

We're going to provide a time line, first of all, just because of the shield building activities. Obviously, we discussed parts of this in some length at our last Subcommittee meeting, but quite a few things have occurred since that time frame.

We're going to provide a background, very briefly, of the earlier parts of this investigation. Then we'll describe in somewhat more detail the more recent actions we have taken in response to the more newly identified crack propagation issues.

And then, we'll provide a basis for concluding the conditions acceptable with continued monitoring.

Next slide, please, Steve?

Okay, for our shield building time line, we identified back in October of 2011 when we were performing our head replacement, we identified laminar cracking, completed our first root cause in May of 2012 and we'll provide some very brief discussion of that root cause as we move through this presentation.

In August 2012, we completed condition monitoring, identified no issues.

And then, in October of 2012, we did complete an exterior coating of the entire shield building. That was done as a preventative action from our first root cause.

And then, in our condition monitoring in August of 2013, we did identify some crack propagation and we'll describe that crack propagation.

And, finally, in June of 2014, we did complete a second root cause regarding the new phenomena we'd encountered in crack propagation.

So, at this point, I'm going to turn it over to Jon Hook and let him walk through the next series of slides.

MR. HOOK: Okay, thank you, Ken.

Good morning. As Ken said, my name is Jon Hook. I'm the Design Engineering Manager at Davis-Besse.

Next slide, please?

And, I'll provide overview of the shield building, the investigation and the actions we have taken in response to the laminar cracking.

The shield building is a freestanding reinforced concrete structure with 30-inch thick walls. The shield building shares the same foundation as the containment vessel which is an independent structure.

There's a four and a half foot annular space between the shield building and the containment vessel.

The shield building is designed to provide biological shielding, provide environmental protection for the containment vessel and provides an extra barrier for defense against controlled releases during an accident condition.

Next slide, please?

When we installed the access opening in the shield building as part of our reactor head replacement project in 2011, a laminar crack was discovered. The crack was located along the left side of the construction opening at the bottom left corner and along the upper left side.

The crack was located at the interface between the shoulder area and the outer mat of the shield building reinforcing steel.

Next slide, please?

Now, I'll describe what I mean by a shoulder area.

This is the typical sketch of a shoulder. The shoulder and the shield building, the shield building has eight flutes and 16 built up shoulders, or flute shoulders.

These shoulders project 18 inches out from the shield building and these shoulders serve no structural purposes and they're only there for architectural purposes.

This sketch shows the configuration of the crack identified in the shoulder area at the construction opening.

All observed cracks were near the outer

reinforcing mat and all the cracks were very tight, usually less than 0.01 inches, which is about the thickness of three sheets of paper.

Next slide, please?

MEMBER SKILLMAN: Jon, let me ask a question. So, this was discovered in 2011?

MR. HOOK: Correct.

MEMBER SKILLMAN: If this building was cut back in 2002 --

MR. HOOK: Correct.

MEMBER SKILLMAN: -- was there any evidence of cracking observed --

MR. HOOK: No.

MEMBER SKILLMAN: -- at the first head replacement event?

MR. HOOK: No, there was not. That was in the original construction opening. And, the original construction opening was between the shoulder areas and this opening was a little bit different location and on the left side of that construction opening was part -- located part in the shoulder area. And, that's where the cracks are located.

MR. BYRD: I would suggest, Jon, if you move forward, if we could just jump forward to slide 17, we have a picture that would explain that --

MR. HOOK: Okay.

MR. BYRD: -- and help out.

MEMBER SKILLMAN: Well, let's march through the slides and then catch it on --

MR. HOOK: Okay, that's fine.

MR. BYRD: It'll be very clear when we get to that slide.

MEMBER SKILLMAN: All right, thank you. You've answered my question.

MR. HOOK: Okay.

MEMBER SKILLMAN: Thank you.

MR. HOOK: Next slide, please?

The extent investigation was performed using nondestructive impulse --

CHAIRMAN RAY: I'm sorry, I need to interrupt you. It takes a while to think of the question.

I don't recall seeing, and I couldn't discern from you've seen so far, the vertical -- the horizontal extent, of course, is shown of the crack, but the vertical extent is a question. Is there anything that'll show us --

MR. HOOK: Yes.

CHAIRMAN RAY: -- that footprint?

MR. HOOK: Yes, yes, and I think in two slides.

CHAIRMAN RAY: All right.

MR. HOOK: Okay. Okay.

So, the extent of investigation was performed using nondestructive impulse response testing to investigate the extent of the crack.

We confirmed these impulse response readings by taking core bores to confirm the presence of cracking and also to confirm areas of no cracking.

We have very good correlation between the impulse response reading and the core bores.

MEMBER CORRADINI: Just so I understand the difference, so impulse responses is another way of saying you tap it?

MR. HOOK: Yes. You set up an impulse, hit it hard with a hammer, as the picture shows and then --

MEMBER CORRADINI: But, not too hard?

MR. HOOK: You have to hit it pretty hard. But, you're not going to break the concrete.

MR. SHACK: You've got to make some noise.

MEMBER CORRADINI: But, what I guess I'm -- I wanted to get to the -- you said then you did a core bore and the core bore was -- what was the diameter of the core bore?

MR. HOOK: Well, they range from two to four inches in diameter.

MEMBER CORRADINI: Okay. And, you saw good correlation between that?

MR. HOOK: Correct.

MEMBER CORRADINI: So then, you mapped out where you thought the cracks were based on the impulse response or the core bore?

MR. HOOK: Well, we did the impulse response first and we had a region where we had laminar cracking and we confirmed that by putting a core bore close to the edge to confirm, yes, I really do have a crack here and then I put another core bore where I believe I have solid concrete and I confirmed I had solid concrete. So, it confirmed the boundary of the impulse response test.

MEMBER CORRADINI: And, where was the impulse response test done? How far up vertical?

MR. HOOK: Well, we end up doing the whole building.

MEMBER CORRADINI: Okay.

MR. HOOK: So, we did approximately 100 core bores to verify cracking and non-cracking and we did over 60,000 individual impulse response readings, which covers the entire accessible area of the outside of the shield building.

MEMBER CORRADINI: Okay, thank you.

MR. HOOK: Okay. Next slide, please?

CHAIRMAN RAY: And by entire area, we include the roof, do we?

MR. HOOK: No, no, only the walls. We were only doing the walls.

CHAIRMAN RAY: Okay, that -- at some point, I need to have some discussion over the risk to the containment building of spalling. This is probably not the right place to discuss it, but that is something I want to pursue.

MR. HOOK: Well, if you want to go back two slides, maybe I can address that right now. That one right there.

So, this picture shows the shoulder area and where the crack is located is between the interface between the shoulder and the main rebar.

CHAIRMAN RAY: But, I'm talking about the roof.

MR. HOOK: Well, I can get into the

root cause. The root cause was associated with the stress concentrations of the shoulder. That was the big difference. And, because of that, it's confined to the shoulder areas and also areas or high density and those are not evident or they're not applicable to the roof area.

CHAIRMAN RAY: Well, okay.

MR. SHACK: But, you get some cracking in the dome that you sealed up.

CHAIRMAN RAY: Push the button.

MR. HOOK: I'm not aware we had cracking in the dome other than just normal wear and tear.

MR. SHACK: Well, it was leakage, you know, you were getting. That at least was one of the candidate mechanisms.

MEMBER BALLINGER: If they interface between the dome region and the vertical region, right?

MR. BYRD: The cracking that you may be thinking of was in our parapet which we have on the top of the building. There was cracking in that area that was repaired. Is that what your think of possibly?

MR. SHACK: That's probably it.

MR. BYRD: And the parapet did have cracking that was -- there was some repairs made in that area, but that's really, and, Jon, you can confirm, that's not a structural portion, that's --

MR. HOOK: Correct.

MR. BYRD: -- extending up at the top of the wall and you can walk around the top of the building inside the parapet.

CHAIRMAN RAY: Well, just to finalize my point, I think perhaps we'll return to it again, as I understand it then, what you did on the vertical walls was not done on the roof because the root cause indicated that the cracking was due to or associated only with the shoulders and, of course, they don't exist on the roof?

MR. HOOK: Correct. The shoulder areas and areas of high rebar density, and so, those two items are not found on the roof.

CHAIRMAN RAY: Well, all right. My interest still is in the potential for spalling of concrete due to cracking impinging on the containment and affecting it as a consequence of that. And, I'm going --

MEMBER CORRADINI: Interior spalling is what you're --

CHAIRMAN RAY: Yes, of course.

MR. HOOK: Oh, interior?

CHAIRMAN RAY: Yes.

MR. HOOK: Everything here is associated with the outside.

CHAIRMAN RAY: I understand that.

MR. HOOK: Yes, we did pretty like extensive investigation. That laminar cracking is only applicable on the outside mat rebar. There is no laminar cracking on the inside mat rebar.

CHAIRMAN RAY: Okay. And that's because of the root cause or because we did --

MR. HOOK: We did extensive investigation. So, around the construction opening, we did a 360 degree inspection around the construction opening and the crack was only located on the outside mat rebar.

We also did several core bores that were very deep to determine if we had laminar cracking on the inside face rebar and all those core bores showed that we had no cracking on the inside. All the cracks are associated with rebar located on the outer mat.

CHAIRMAN RAY: Okay.

MEMBER BALLINGER: But, to be clear

again, the no cracking issue -- it's an assumption that there's no cracking related to the roof because no inspections were made?

MR. HOOK: That is correct. We did not do impulse response reading of the roof nor did we do core bores on the roof.

MEMBER BALLINGER: So, I understand the issue of the geometry here, but you say also, you saw cracking in areas where there was a lot of high rebar density?

MR. HOOK: High rebar density, that is correct.

MEMBER BALLINGER: Is that rebar density in any way similar to what you might find on the roof?

MR. HOOK: No, no, it's not.

MEMBER BALLINGER: Okay.

MR. HOOK: So, the rebar density was a lot of rebar spaced very, very close together and for stress. On the roof, we don't have that high stress so rebar are further apart.

MR. BYRD: And, just to follow, we did do some core bores in other structures just to validate that we weren't seeing similar kinds of cracking. We did some on the auxiliary building which also has actually fairly high rebar density in some areas and we did not identify cracking in other structures.

MR. SHACK: But, you would have fairly high rebar density at that junction between the roof and the wall. I mean that's where the bending stresses are in the shell.

MR. HOOK: Right. That's the top 20 feet and that's where we see some cracking and we'll get to the IR map and it'll show that area.

But, on this slide, what I wanted to point out is the shoulder reinforcing and you'll see that the shoulder reinforcing is anchored into the wall, so that should take care of your concern with any spalling.

So, want to move ahead to the core bore, please? Okay, thank you.

So, this picture shows a typical core bore in the shield building. Core bores were used to investigate the crack condition. Core bores varied in diameter from two to four inches and in depth from eight to 28 inches deep. That was dependent upon the test to be performed or the items needed to be verified.

So, core bores were used to validate

the IR data to determine the crack depth, determine the crack width and also for laboratory samples.

On the right is a picture of a crack and a crack comparator. This crack measures 0.005, again, the cracks are very tight.

Next slide, please?

So, this will probably answer a lot of your questions, this map here.

So, this is an impulse response layout map of the exterior portions of the shield building. The magenta areas are portions of the building where the impulse response testing indicate we have laminar cracks.

So, some areas I want to point out are the majority of laminar cracks is confined to the shoulder areas. Also, at the top 20 feet of the shield building and then two smaller areas by the main seam line penetrations.

MEMBER CORRADINI: Where is that? Can you point to where you're talking about?

MR. HOOK: Like right there, that's one seam line penetration and that's the other main seam line penetration.

MEMBER CORRADINI: Oh, I see, okay.

MR. HOOK: Those are the two main seam

line penetrations.

MEMBER SKILLMAN: Hey, Jon, in this image, what is zero? Is zero polar north?

MR. HOOK: Yes. Zero is polar -- and I have identified two red circles there. The one on the left is zero, that is due north and on the other one is 180 degrees and that's due south.

MEMBER SKILLMAN: Okay, thank you, Jon.

MR. SHACK: In your acceptance criterion, you have sort of criteria for the aerial fraction that you can tolerate without losing structural capacity. What's the current area fraction that you've used up here?

MR. HOOK: That -- we have broken the shield building into several different regions and the top region, the -- I believe it's -- we assumed 70 percent, but we analyzed for a 100.

The next region is I think it's 50 percent and we analyzed for 75. And then the next region was zero, we analyzed for 20.

MR. SHACK: But, what's the current fraction that's been -- I'm sort of interested in the margin.

MR. HOOK: Right.

MR. SHACK: How much is actually

cracked now in terms of those regions where you were allowed to have 70, what do you have now? Thirty-five? Twenty? Fifty?

MR. HOOK: I don't know. Mr. Henry, do you have those values? I want to make sure I get them right.

MR. HENRY: Thomas Henry, Design Engineering and Structures Monitoring and Shield Building Aging Management Program Monitoring.

It's one of those values, Jon, that was --

CHAIRMAN RAY: Wait, I've got a feeling the microphone isn't on.

MR. HENRY: Thomas Henry, Design Engineering and Structures Monitoring and Shield Building Monitoring Aging Management Program Owner.

As far as the current state of cracking, the percentages that we analyzed in our calculation roughly corresponded to the extent of cracking that we did see. So, as far as those percentages, I will give you the exact numbers in a moment once I look them up.

But, we did analyze roughly the as-found condition for extent of cracking.

MR. SHACK: Right. But then you had --

there's the table in one of the response to the RAIs --

MR. HENRY: Correct.

MR. SHACK: -- which I assume set a limit to how much cracking you would have and then you'd have to go back and redo the analysis, basically, or be new action levels.

MR. HENRY: Correct.

MR. SHACK: And how close are you to those action levels from the current cracking state?

MR. HENRY: Well, the table values that you're referencing corresponded I want to say within about five percent of the as-found condition in 2012.

MR. SHACK: Oh, so you're within five percent of those, the numbers?

MR. HENRY: Well, if I may clarify? Since then, we've conducted the additional analysis to provide ourselves margin.

MR. HOOK: I think I can answer that a little bit now that I know what you're going for.

MR. SHACK: Driving at?

MR. HOOK: Yes, yes, yes.

So, the shield building is a heavily

reinforced concrete structure. We do have significant margin in that shield building.

So, for the structural analysis, we assumed cracking 360 degrees around the parameter and the maximum interaction for that is 0.76 of the allowable. So, that has a significant margin as well.

Then, we also did some scoping studies in our Seismic Response Analysis. And, for those scoping studies, the analysis showed that we can accommodate also significant crack propagation before we have to reanalyze that to even gain more margin.

And those assumptions that we used was an addition 100 feet of cracking from what we have right now.

So, whatever we have right now in different layers, we analyzed it for another 100 feet and our analyses are bounded by that.

MR. SHACK: Another 100 feet? What do you mean by that?

MR. HOOK: Yes, right.

MR. SHACK: I mean, I've got Region I, II, III and IV.

MR. HOOK: Right.

MR. SHACK: And I see allowable limits and all I'm looking for is the corresponding numbers.

MR. HOOK: Okay, so what region do you have up there?

MR. SHACK: Well, I have Region II is 70 percent, Region III is 20 percent, Region I is zero percent, Region IV is zero percent.

MR. HOOK: So, in our scoping study that we did, Region I is the roof, so we didn't analyze that because nothing up there.

Region II, the scoping study analyzed 100 percent cracking in that region.

MR. SHACK: And you have now what value?

MR. HOOK: Seventy percent.

MR. SHACK: Okay. So, this is the acceptance criteria, so you're right at the acceptance criteria now?

MR. HOOK: That's what we evaluated, correct. And then --

MR. SHACK: This sounds like it's the future. The acceptance criteria for core bore inspections will be a maximum crack length with the 0.013 inches and maximum circumferential laminar crack planer limits in percent, rounded to the nearest whole number identified by region as follows.

So, that sounds like --

MR. HOOK: So, that analysis was the first analysis we had knowing that at that time the crack was passive. So, that's what we set our design basis and anything beyond that then was something that needed to be entered in our Corrective Action Program and then we evaluated that.

But, that was the starting point or the base inspection that we had in 2012 when we established where we were with the crack knowing that is was passive, we evaluated the as-found condition. That was our benchmark or base. And anything beyond that, then when did future inspections and we found laminar cracking, that was a condition report and we evaluated that.

Since that time, since Tom indicated, though, we went out into the future to see how much more cracking that we could have instead of analyzing it each time the crack grew a foot, a foot, a foot, let's go maximize it and that's where I talked about where the -- let's just start with assuming let's get a 100 extra feet and what does that show? And with an additional 100 feet, we're still bounded before we have to do additional analysis.

MEMBER BALLINGER: Okay, so let me carry that on. I think what we're saying is, is if you've got -- you have an as-found condition of X which you thought was passive?

MR. HOOK: Correct.

MEMBER BALLINGER: It turned out not to be passive?

MR. HOOK: Correct.

MEMBER BALLINGER: Now, you have to estimate the growth rate?

MR. HOOK: Correct.

MEMBER BALLINGER: So, the increase in surface area, and then compare that surface area, estimated surface area, at say at the end of license extension, with the amount of margin which you have?

MR. HOOK: Yes.

MEMBER BALLINGER: And, if it's good, then you're okay?

MR. HOOK: Correct.

MEMBER BALLINGER: And, I guess one

question that I'd like to see an answer is, concrete is sort of not like metal, it's even worse.

MR. HOOK: It's not homogeneous, you're right.

MEMBER BALLINGER: It's not homogeneous. What's the uncertainty on the estimate?

MR. HOOK: Well, that's why we have Aging Management Program, that's why we do inspections to confirm what our assumptions are in that calculation.

MEMBER BALLINGER: Yes, but there has to be some reasonable argument that says there's a very good chance that by the end of license extension, we will not have reduced our margin to zero. So, where is --

MR. BYRD: What we can do, we're going to go through and I think when Jon gets into the cracking portion of this --

But, as we move forward into the cracking portion, we'll talk about what we've identified and add some more -- we are prepared to discuss that and, I think we do have an answer to what you're asking.

But I think what we want to do first is talk about what we've identified because we have looked at the crack rate and part of the problem that I think is getting confusing here is we did analyze this originally, as Jon was saying, based on the condition we had.

We subsequently evaluated an additional margin, but even that margin isn't an absolute limit because that's just point, we have to go back and reanalyze.

So, right now, but we're comfortable with that because we have looked at the crack propagation rate and we have some other investigation we've done and we'll get into that. And, that's where we are right now.

MEMBER BALLINGER: Including the uncertainty?

MR. BYRD: We can discuss that as well.

MR. SHACK: While you've got this figure up, the other, you know, you've got your 23 bores, three of which are at the leading edge, can you point out to me on this figure roughly where those bores are?

MR. BYRD: No, but we have a backup slide that shows them precisely.

MR. SHACK: Okay, could you do that?

MR. HOOK: I'll let Tom explain that.

MR. BYRD: Do we have that slide, please?

CHAIRMAN RAY: I assume you'll provide that slide to the Committee?

MR. BYRD: We will. It actually highlights all of the ones where these 23 bores are.

MEMBER SKILLMAN: While we're digging, let me ask this question. Will the predictive nature of this process be captured in the new AMP for the shield building?

MR. HOOK: Every time we go do an inspection and if there's any changes that we see, we identify that in our Corrective Action Program. And then, we'll evaluate the effects of that and also the impact it has on our AMP program.

So, there is an acknowledgment that we'll have to revise our AMP program to make sure that we capture the leading edge of these cracks.

MEMBER SKILLMAN: Thank you.

MR. SHACK: Just to follow up on Dick's comment. I mean the table that's in the License Renewal thing now is the one that you say is out of date basically because you've essentially hit those limits? When you analyzed them to as-found and now it's propagated, so you're basically there already?

But, your argument is that that's just now covered in the Corrective Action Program? You don't need to go back and revise that table in the License Renewal Amendment?

MR. HENRY: The table provides -- Thomas Henry, Design Engineering.

The table provides our threshold limits at the point where we do enter it into the Corrective Action Program and refer to our other calculation for margin.

To answer your question regarding the three leading edge bores, I can use the drawing here, Mr. Dort, if you can point to shoulder five right above the aux building.

We experienced crack propagation in that region so we have a leading edge tracking bore in that location. Similarly, we have a leading edge bore tracking location on shoulder seven above the aux building.

Our third location is shoulder 13 which is on the right hand side of the initial construction opening. In that location, we have a leading edge bore. We actually installed a fourth bore this year for leading edge tracking on shoulder 15 as well, which is two to the left.

MR. SHACK: Okay, so those large areas up on top have no leading edge bores?

MR. HENRY: We do have a series of bores that do track propagation up there. As far as leading edge bores, the four we've selected are the ones we're tracking.

MR. SHACK: Now, are these in any way correlated --

CHAIRMAN RAY: I think he's saying it's not on.

MR. SHACK: Now it's on.

Are these in any way correlated -- those locations correlated with the analysis that you did? You did a mapping of three thaw cycles on the building?

MR. HENRY: Correct.

MR. SHACK: And, are these locations at the high freeze/thaw -- is there a correlation between those or are you just -- how did you pick these numbers?

MR. HENRY: Those locations were picked based on the evidence of propagation that we saw in

2013. We saw propagation in those areas, we picked the leading edge location on those locations.

We did not correlate it relative to the freeze/thaw cycles that were counted as part of that root cause. We did not correlate to that based on the fact that thermal cycles throughout different years in the future will vary than those cycles looked past.

And then, the second reason is that one of the conditions for propagation, and I believe Mr. Hook will get into this, is the moisture in the building. And, we decided to track the leading edge locations based on where we saw propagation versus trying to do a water transport analysis throughout the building at different elevations and different circumferences.

CHAIRMAN RAY: Let me direct a question to Bill, only because I think it may be simpler that way, but feel free to respond as well.

When we talk about margin, are we talking about just one failure mode? And if so, what is it?

MR. SHACK: No, I mean you would look at all the possible failure modes and then you'd look at the one that had the least margin.

CHAIRMAN RAY: Well, but I just meant practically speaking, does it always turn out to be the same failure mode?

MR. SHACK: I'm assuming in their case, it's the tornado, but I don't know for sure. But, again, they would have to look at all the design basis calcs.

CHAIRMAN RAY: Okay.

MR. HOOK: It's the seismic the one controls. The dead load, live load.

CHAIRMAN RAY: That's what I would think, yes.

MR. HOOK: Yes, that's the --

MR. SHACK: Because you can't meet your original tornado loads.

MR. HOOK: We can't meet our original tornado loads?

MR. SHACK: That's what it says is that your design thing didn't meet the original 176 with the 360 mile an hour wind and now it meets the 230 mile an hour wind in 1.76 Rev. 1.

MR. HOOK: That was an analysis that we did in 2011 when we took -- we had no idea what the rebar capacity was, so that was a very, very lower bound, conservative calculation where we took basically no credit for any of the rebar on the outside in the shoulder areas.

So, that was an analysis that we used to basically start the plant up in 2011.

Since that time, and I'll get into that some more, we did rebar testing at Purdue and Kansas and we established what the rebar capacity is. So, we do meet our --

MR. SHACK: Okay, so that original calc -- that was the zero rebar connection and now you're taking some credit for the rebar in the new analysis?

MR. HOOK: Actually, yes, yes.

MR. SHACK: Okay. And then, the limiting load is the seismic in this case?

MR. HOOK: Right, and our interaction is 0.76 on the rebar and that's assuming laminar cracking is all the way around the perimeter.

MR. SHACK: Okay.

CHAIRMAN RAY: Well, I suspected it would be seismic, so I'm glad that at least that's correct.

But, I must say, as we've talked here, I think everyone appreciates because this has evolved over time or at least the basis upon which the work done in 2011 has changed as cracking propagation has become a concern and so on, it is difficult to digest all of this and get it clearly understood in a fairly short period of time.

So, I would just urge you to be as explicit and precise as possible when we're talking about stuff like we have been. And, even though it may be unnecessary in some people's mind to talk about the things that I've, for example, asked you.

Okay, so seismic is the governing load and the failure mode is associated with seismic loading in all the cases that we've looked at or something of that kind?

MR. HOOK: Correct.

CHAIRMAN RAY: That helps.

But, the questions that Bill has asked here in which it appears that some of the data is conveying some information which has now been superseded makes it even more difficult for us.

So, just be patient and go slowly and, like I say, define your terms as we go.

MR. HOOK: Okay.

MEMBER SKILLMAN: Jon, let me ask this. As I look at this image and I envision your site and the reactor building and your aux building, the portion of the lower portion of the reactor building shield is blocked by the aux building.

MR. HOOK: Correct.

MEMBER SKILLMAN: Did you do any sounding --

MR. HOOK: We did.

MEMBER SKILLMAN: -- in --

MR. HOOK: We did. And, if you were to highlight that area right there. So, that is the main seam line room and we did do impulse response in that area. That's inside the area.

Now, the one thing I want to talk about is the shoulders again. So, architecturally, those shoulders disappear inside the aux building. They are not there.

MEMBER SKILLMAN: So, it's round shield building in that area?

MR. HOOK: It is round shield building in that area.

MEMBER SKILLMAN: So, did you ping in there, too?

MR. HOOK: We did ping, as you can see, along that whole area there looking for anything and that was -- we didn't see anything there except for two very localized areas around the main seam line penetration. And, that was because of the high density rebar as well.

MR. BYRD: If I could add, that also appeared to have extended down from the area above the roof of the -- that's the main steam line room.

So, if you look down lower into the right, you see those two areas down below the main steam line room, down in the aux building?

MR. HOOK: Right down in this area.

MR. BYRD: Right over there. No, other way, go to my right. Right there.

Those areas are down in the auxiliary building and what we did there is we looked at an area that it actually does have high rebar density because it's right by a penetration going in through to the containment. We didn't have any evidence there of cracking.

So, that kind of reinforced what we had -- the root cause which was we had an environmental condition because that area is protected, obviously, from the environment, but that would have had a similar condition of the main steam line penetration.

MEMBER SKILLMAN: Let me ask one more, forgive the elementary nature of this question.

It almost looks like a solar map of the solar incidents from just a tad north of northeast.

MR. HOOK: You are --

MEMBER SKILLMAN: Southwest.

MR. HOOK: Right, right.

MEMBER SKILLMAN: And so, is there a correlation between freeze/thaw and solar incidents as part of this study?

MR. HOOK: Okay, PII did extensive analysis for that. You know, because, again, when -- I'll go into it a little later on, that the stresses are so low in the building, right now it's just sitting there, it's just dead load and you get some wind load.

So, what else is really going on with that building?

MEMBER CORRADINI: What's PII?

MR. HOOK: Performance Improvement International, I'm sorry.

MEMBER CORRADINI: Okay.

MR. HOOK: Okay. Dr. Chiu's company, yes.

So, they did extensive evaluation for looking at that, all the different -- winter, summer, Solstice and all that. And the stresses by itself, again, were not anywhere near what it takes to crack the building.

But, you do had a good point, though, when you look at the building, when you look at the impulse response, you know, if you look at most of the cracking occurs on the east side, south side and west side. And that matches up very, very closely with the -- it's directional for the blizzard of 1978. It was that wind from the south, southwest that came in with the high winds and saturated the shield building.

MR. BYRD: And, I would add to that your observation, when we first identified this back in 2011, I think most of us were convinced it was solar heating. And so, to credit to the root cause is that instead of focusing on that, we looked at, you know, and that was determined not to be the issue. But, when you looked at that, that was clearly where everybody's attention was directed on the thermal cycles from the south.

MEMBER SKILLMAN: Thank you.

MR. HOOK: Now, on an earlier question, Mr. Skillman, that you had about the construction opening that we had, we did put three openings basically in the shield building. And, it was the third opening where we found laminar cracking.

So, let me fly here. So, this is the original construction opening, these little dot black lines, during the original construction that was opened.

So, when we replaced just the head, that was an opening inside that area -- yes, the blue area right here. So, it was all enclosed in the original construction opening and away from the shoulders.

So then, the second time when we put an opening in the shield building where we actually identified cracking, this is the opening that we put in, the white dots. This is the opening.

And, we saw cracking along the top left side, all along the left side and on the bottom left side. This side right here is where we saw the original laminar cracking and that corresponds to this, you know, this is the shoulder area, this is the shoulder area.

So, the first opening that we put in was not in the shoulder area that's why we didn't see any because there's no cracking in the barrel of the shield building, only in the left side along this left edge when we originally saw the opening.

MEMBER SKILLMAN: And that was real helpful. Thank you.

MR. HOOK: Okay.

Next slide, please?

So, a root cause team was formed and involved testing 36 core bores. All the results came back, the concrete is in good, solid condition.

A computer analysis of the shield building reevaluated all the design load conditions such as dead load, wind load and thermal conditions. We also evaluated the effect of the tornado of 1998 that the site had.

And these analyses showed that the stressors in the building are all well below the allowable values.

The root cause team concluded that the design load combinations resulted in stressors that could not produce laminar cracking and that an extreme external event not used in design was the cause, that the high concrete moisture driven by the high winds and the near zero temperatures can produce stressors high enough to cause cracking in the shoulder areas.

And, contributing to that was the

shoulder rebar configuration and the lack of coating on the structure.

The observed cracking coincides with locations of high stressors in the shoulder areas and areas of high rebar density.

The corrective actions included completing the impulse response examination of the shield building, coating of the shield building and then performing independent rebar tests to establish the capacity of the rebar in the splice region.

These tests were performed at Purdue University and the University of Kansas and then we established a long term monitoring program.

So, just a note on the rebar testing. The tests were independently developed and performed at Purdue University and the University of Kansas by professors who are industry experts and members of the American Concrete Institute, ACI, Code Committees.

These tests were observed by FENOC and the NRC staff.

These tests concluded that the full design capacity of the rebar can be achieved in areas of laminar cracking.

Next slide, please?

During our 2013 monitoring program, crack changes were noted. As a result, the sample size was increased to include all 80 core bores. A total of eight bores showed changes.

This impulse response map highlights the changes in shoulder seven from 2012 on the left to 2013 in the middle and then 2015 on the right.

As a point of reference, each dot on the map represents a one-foot grid. The green vertical line is used as a common point of reference.

Between 2012 and 2013, there was an extension of approximately one foot. Each of these IR maps represents approximately a 14-foot wide strip which corresponds roughly to the shoulder width. And, as you can see, the crack is well confined to the shoulder areas.

MR. SHACK: Did you do IR testing along all of the crack edges?

MR. HOOK: No, we did not. It was selective based upon what we saw in our core bores that we needed additional confirmation. We used impulse response in those areas.

MEMBER CORRADINI: So, I don't

appreciate the complexity of -- I thought you were talking about IR, infrared, impulse response.

How complex is it to do that short of testing in difference of core bores?

MR. HOOK: Well, just the logistics, it's pretty challenging. So, you have to hang off a scaffold. You have to have a high rescue team up on top. You know, there's a lot of people involved supporting that activity as you go up and down.

MEMBER CORRADINI: Assuming it's safe, I can appreciate all that, but the actual doing of it is not complex as far as I understand it.

MR. HOOK: No, you just basically have a calibrated rubber hammer that calibrates how much force was imparted into the shield building when you strike the shield building and then you have a receiver on what the impulse response that's coming back.

MEMBER CORRADINI: The receiver, I assume, is you bang here and you get it like around it?

MR. HOOK: It's a handheld -- let's go back to an earlier slide.

MR. SHACK: Yes, he's got a little thing in his hand. You can see it.

MR. HOOK: Right, the one on his hand, that is the receiver.

MEMBER CORRADINI: It's like the doctor hitting my knee?

MR. HOOK: Exactly.

MEMBER CORRADINI: Okay. So --

MR. HOOK: And, we do that at every foot on a one-foot grid.

MEMBER CORRADINI: I got it. So, can you do that on the roof as you're standing in the parapet?

MR. HOOK: You can do that on the roof, correct.

MEMBER CORRADINI: In the -- I mean, if I understand what a parapet is, it's kind of like shielded area where you can walk around?

MR. HOOK: The parapet, it's just like a barrier, like a handrail, a concrete handrail so you don't fall over.

MEMBER CORRADINI: Okay, that's right. Okay, got it. Okay. Thank you.

MR. HOOK: Okay. So, let's go back to slide 20, I believe. One more. Okay.

MEMBER SCHULTZ: Can you go back one slide, please?

MR. HOOK: Okay.

MEMBER SCHULTZ: The first bullet, identified changes in eight of the 80 core bores inspected. Can you describe what is the change and what constitutes the identification of a change and how that's --

MR. HOOK: So, I'd like to let Tom answer that. He's the program owner and --

MEMBER SCHULTZ: What I would like to, thank you.

MR. HOOK: -- he is the one that actually saw the changes.

MEMBER BALLINGER: Before we do that, I want to get a little bit of clarification.

I was around in the blizzard of 1978, I was a graduate student actually.

MR. HOOK: Where at?

MEMBER BALLINGER: MIT, but that's neither here nor there. I apologize.

But, you made an assumption that that was the event that caused the cracking?

MR. HOOK: Yes.

MEMBER BALLINGER: Is that an assumption or is that somehow verified?

MR HOOK: Right. So --

MEMBER BALLINGER: Did you do it by elimination or did you just say, okay --

MR. HOOK: No, no. So, in a minute I can get PII, Dr. Chiu up here, but basically, what they did was they did a failure analysis fault tree, identified 45 possible causes and they went through all that.

And, there was an extreme condition and a couple of things that pointed out for that was based on some OE, operating experience, from Ontario Hydro where they did -- had extensive failures of their concrete -- above concrete water storage tanks where they were getting laminar cracking. And, they evaluated that and assessed that to be water penetrating into the concrete and then freezing. That was in Ontario.

So, based upon that, then we started focusing on this as well. And, so this was the most extreme environmental condition that Davis-Besse has seen, I mean like historically. In late January of 1978, there were three days of high winds, a lot of rain, winds up to 100 miles an hour out of the southwest, penetrated the concrete because the concrete shield building wasn't coated. And then suddenly dropped temperatures of near zero.

So, PII performed those analyses of saturation and then expansion of concrete in addition to the stress concentrations in the shoulder areas. Those two in combination created enough stress that we could actually crack the concrete.

MEMBER BALLINGER: Okay. So, it's still by analysis? I mean, there's no evidence that this is how all the things are?

MR. HOOK: It was done by analysis, yes.

MEMBER BALLINGER: Yes, okay.

MR. BYRD: I think the other part of that, though, was there was no evidence of other events that would have caused that cracking, other extreme weather events. And, we did look for other extreme weather events.

So, that's the basis for the -- in that particular storm being the storm that created this.

MEMBER BALLINGER: But, there were other plants that went through the same blizzard that had the same type of containment, right?

MR. BYRD: No, there wouldn't have been with our particular containment.

MEMBER BALLINGER: None with the shoulders?

MR. BYRD: We have a rather unique containment. First of all, we have a freestanding containment which was kind of unique in and of itself. And then, the shoulders are very unique. So, I think there may be like Waterford which would be obviously in a completely different part of the country. But, it's somewhat unique to our design.

MEMBER BALLINGER: Okay.

MR. HOOK: So, our shoulders stick out significantly more, 18 inches. Some of the plants have shoulders, but they stick out six inches. So, the stress concentrations are not there.

And, if they coated their shield building, they're not going to get the water penetration.

So, this has been identified by the NRC. They issued an Information Notice explaining what happened at Davis-Besse.

MEMBER BALLINGER: Okay, thank you.

MR. HOOK: Okay.

MR. HENRY: Thomas Henry, Design Engineering.

To answer your question, sir.

Regarding -- our Aging Management Program defines any discernable change in the core bore get entered into our Corrective Action Program.

For the definition of that discernable change, if you were looking at shoulder seven, we had a series of bores that were drilled in that shoulder. We saw propagation from one bore that was cracked to a bore that was not cracked.

So, we conducted a bore scope inspection down that hole and saw a crack in an area where we had not previously had not previously seen a crack. So, that would be a discernable change that we did identify and led us into this causal investigation.

If I may continue to address one previous question that was asked? As far as the leading edge cracking, if you actually take a look on shoulder seven on the right hand map, you'll see the 2015 bore that was installed in that location and that is our new leading edge tracking bore for shoulder seven.

MR. HOOK: So, that core bore is there so we can make sure that we're bounded and then we can track how much the building is actually cracking.

CHAIRMAN RAY: Maybe I didn't understand while the gentleman was at the microphone, perhaps he can address.

On the subsequent, the middle and the right hand views, I guess I'm not clear on how many data points were taken to define the parameter, let's say the right hand parameter. I understand --

So, just tell me, how many places along that right hand parameter were measured for crack growth?

MR. HENRY: If you're asking with respect to the impulse response mapping, every black dot is a data point for impulse response.

MR. SHACK: But, that's the original IR testing? What'd you do for the crack propagation?

MR. HENRY: Sure. This figure that you're looking at right now has three different sets of data on it. So, on the left, we have 2012 data. On the right -- or in the center we have 2013 data and on the right hand side we have 2015 data.

So, those data points are new in each one of those years. So, we redid the mapping in each of those years for all the data points that you see.

MR. HOOK: So, the one in the middle from 2013, that's actually what 2013 looked like. Then we redid it in 2015 and that's the new one. And that's how we can compare the actual growth from one year to the next.

MR. SHACK: All right.

MR. HOOK: Next slide, please?

MEMBER CORRADINI: So, just to clarify on the calculation part of it, so if -- how much would have to turn pink before you get in a problem? Let's use colors.

So, in other words, if I took your -- go back to slide -- go back a couple of slides -- in my mind, since I'm not a structural person, Bill's asking tabular questions, but if you went back two slides.

How much of this would have to turn pink before you have a problem?

MR. HOOK: Well, again, they --

MEMBER CORRADINI: Am I making any sense?

MR. HOOK: Right. For the structural calculation, we already assumed a 100 percent cracking all the way around.

MEMBER CORRADINI: So, it's all structural?

MR. HOOK: So, from the structural side --

MEMBER CORRADINI: From the structural side?

MR. HOOK: -- I'm bounded.

MEMBER CORRADINI: For the seismic limit?

MR. HOOK: I'm bounded. And then with the -- right, exactly with the seismic limit.

MEMBER CORRADINI: Okay. Thank you.

MR. HOOK: Okay.

MR. SHACK: So, a 100 percent around where?

MR. HOOK: On the outside mat rebar.

MR. SHACK: But, top to bottom?

MR. HOOK: Yes.

MR. SHACK: The whole wall?

MR. HOOK: The whole wall.

MR. SHACK: The whole wall.

MR. HOOK: The whole wall. It's easier if we can do a bounding analysis so we don't have to keep track of all the individual areas where it was going. So, we, in our structural calculation, we discounted all the way around the exterior. We evaluated it.

MR. SHACK: But now, you are taking some credit for the rebar based on the -- so, this is different from the bounding calc, as Harold said? There was an original bounding calculation where there was no credit, but that wasn't a 100 percent? Now, you're taking credit for the rebar but you're expanding the crack to a 100 percent?

MR. HOOK: Yes.

MR. SHACK: Got it.

MR. HOOK: Okay, next slide?

Okay, as a result of crack propagation, a root cause team was formed again. One of the items the root cause team focused on was what was different from the first root cause in 2011 to the present time?

The major item of note was the coating in the shield building. On the left is a core bore extracted in 2011. Note that the fractured surface is smooth, even shearing the concrete aggregate.

This is typical of all core bores extracted in 2011 and supports the fact that it was a one-time event that caused laminar cracking.

On the right is a core bore extracted

in 2013 from an area of known crack propagation. This cracked surface is noticeably different. The cracked surface has distinct ridges which is different from the relatively smooth core bore from 2011.

This would imply that there is a different mechanism in play than the original cracked condition.

Next slide, please?

MR. SHACK: While we're on this one, I want to go back to that original root cause because the Subcommittee was left in some confusion at the time.

One thing I noticed, I look at Exhibit 61, page 12 where you have the stress analysis for the thing including the shoulders. And, you showed us at that time that there was some molidation in the radial stress in the shoulders, but it was a very small region really. There's a sea of green and then there's two little tiny dots where the radial stress grows to 550 PSI.

There a much more extensive region of high hoop stress that goes up to 1,250 PSI but the root cause always seems to follow on the elevated radial stress which is well below the tensile strength of the concrete.

Why are you so convinced that it's the radial stresses rather than the much higher hoop stresses that are the thing? And, is that consistent with the fractured surface that you've found?

MR. HOOK: So, the concrete -- tensile capacity of concrete is about 600.

MR. SHACK: Well, I think you had like 800, 900 for your concrete.

MR. HOOK: The design strength is 6,000 or 5,000 and is approximately 10 percent of that. So, it would be like 600. Our actual strength is a little larger than what we specified minimum, so you're right.

So, what we're focusing on what the radial stress is, because that will cause tension in the concrete.

MR. SHACK: But, that's such a small region. It doesn't seem to jive with the extent of cracking that you observe.

MR. HOOK: It's an indication that I have high stress concentrations in the shoulder areas at that location where I have --

MR. SHACK: Yes, and then I have a hoop

stress of 1,250 -- you know, if you're worried about 550, why doesn't 1,250 bother you?

MR. HOOK: The difference is shear capacity is different in concrete. It's based upon if I have tensile, compressive or shear capacity. There's different allowables. So, the weak link is the one that's in tension.

MR. SHACK: Yes, but my maximum principle stress is going to be basically governed by that hoop stress. And I would think that would -- I mean I'm not a concrete --

MR. HOOK: That doesn't cause laminar cracking.

MR. SHACK: All right, okay. You know, I can sort of see that, but it --

MR. HOOK: If that was the case, all of the building would be cracked.

MR. SHACK: No, no, you have much higher hoops stresses in that -- you know, the shoulder is definitely a stress concentrator.

MR. HOOK: Exactly.

MR. SHACK: You know, now it's concentrating radial stress and it's concentrating hoop stress. It seems to be concentrating hoop stress a lot more than it does radial stress and that's what -- and yet, the whole analysis focuses on the radial stress and that somehow just bothers me that I have a stress that's twice as big in a very steep gradient.

And, as I say, if I look at the radial stress figure, I've got a little tiny region surrounded in a sea of green. It doesn't really seem to explain much of the extent of the -- when I look at the pink area, it's hard to match up with that thing.

Now, you had another exhibit where you did a much more detailed stress analysis. You actually modeled the -- but then you never showed the stressors from that one. So, I don't know whether that changed the stress picture or not.

Would it be possible to get a stress picture for the model where you explicitly included the reinforcing bars?

MR. HOOK: I don't have those exhibits in front of me, so it's hard for me to respond at this time.

MR. SHACK: Okay.

MR. HOOK: Quite honest, I don't know yet.

CHAIRMAN RAY: Well, consider whether

at some break we can address the question further and we'll come back to it.

MR. HOOK: Okay.

CHAIRMAN RAY: If you're prepared to do so.

MR. HOOK: Okay.

Okay, so wrapping up on this slide, the crack surface is noticeably different. This would imply that there's a different mechanism in play than the original cracked surface.

Next slide, please?

So, the root cause team concluded that ice-wedging was determined to be the cause. The three items required for ice-wedging to occur in the shield building are, one, a pre-existing crack and the shield building does have a laminar crack.

Number two, freezing temperatures. We performed in-situ monitoring of the internal concrete temperatures and confirmed that the concrete would be subjected to freezing temperatures.

And, number three, high relative humidity which results in free moisture collected in the crack.

Our core bore inspections have

identified small quantities of standing water in the core bore. All three of these characteristics can occur in the shield building during the winter months.

Next slide, please?

The major change to the shield building in 2011 to present is the addition of coatings on the exterior surface. The coating affects how relative humidity moves through the concrete. With the exterior surface of the shield building sealed off, the relative humidity in the concrete will not escape to the outside.

Note that the relative humidity in the concrete is still free to interact with the interior surface of the concrete as the annular side is not coated.

This graph shows the increase in relative humidity in the concrete after the shield building was coated.

A couple of things I want to point out are is the lower line, the relative humidity in the concrete is before the shield building was coated. The upper line shows the relative humidity in the concrete in 2013 which is several months after the shield building was coated.

And, the red line represents data from 2015 tests that shows there is a decreasing trend in concrete relative humidity and that, over time, relative humidity will return to the pre-2012 condition.

Next slide, please?

Now that we know that there's an increase in the level of concrete relative humidity, a laboratory test was used to --

CHAIRMAN RAY: Just a second, back up, please.

MR. HOOK: Yes?

CHAIRMAN RAY: One slide back, please.

Do you have any model for that decrease other than the observed red line?

MR. HOOK: So, we did testing at the University of Colorado, Purdue, Dr. Chiu and PII did that. The laboratory tests and they did -- they have an analysis that shows that we'll get -- we have a decreasing trend and will continue to have a decreasing trend.

That analysis was based on our temperatures that we have outside and also in the -- on the annulus.

MR. BYRD: I think we've got the backup

slide that maybe explains a little bit of that. It's slide -- this time, I do think do have one -- slide 50.

So, we did contact Performance Improvement International. What they determined, there's two competing effects going on, what was causing the inner surface to get relatively high. Relative humidity was the temperature. We have warmer temperatures on the inner surface and, as we see on the bottom there, so that's tending to drive the humidity to the outer surface.

And then we have an impermeable barrier on the outside and that's why we were seeing higher humidity on the outside.

Additionally, though, there is on the inner surface, there's lower relative humidity. And we did measure relative humidity in our annulus and it's not particularly high. So, that does tend to dry the building out.

And, as Jon said, at University of Colorado, we took one of our samples and they took data on it and demonstrated the diffusivity through the concrete. And, based on that, they were able to develop a model -- modeled both of these effects and, based on that model, the results that Jon just described about the building dry out is consistent with what we're seeing in the -- or relatively consistent with what we've seen in the data.

So, based on that, we expect within, how many years was it, Jon?

MR. HOOK: Between two and eight years that the drying out to below the pre-2012 values.

MR. BYRD: That's correct.

MR. SHACK: What's a little surprising is the elevation you see from the 2011 to the other values. I mean, that would indicate that the temperature effect is - that would surprise me that would be overwhelming the fact that I would have the low relative humidity. I expected to see moisture going inward and I can't get any new moisture on the outside surface because it's coated.

So, but now, you seem to indicate that we suddenly get a big jump in relative humidity at the outside surface.

MR. HOOK: Initially, the moisture is being driven to the cold side, the outside. And so, that's what we saw there. Then, over time, though, we're getting the slower lowering of the whole curve.

MEMBER CORRADINI: Can I say it to you differently to make sure I'm -- this is what I think I understand, but I'm still not clear.

You're telling me that you coated it and now I'm going to drive the profile of humidity out because of the cold side. But, the whole, give its shape, it's all drying out?

MR. BYRD: The whole curve.

MEMBER CORRADINI: And so, who's predicted the dry out rate? That's what I'm -- maybe I missed that. I'll buy the idea that the shape of the humidity curve inside the solid is changing, but who's done a calculation or some sort of estimate that it's actually going to dry out to where you think it's going and the rate at which it's going?

MR. BYRD: That was done by performance Improvement International. And, maybe we can have Dr. Chiu come up and explain how we did that, if he'd like to come up --

MEMBER CORRADINI: Dr. Chiu.

MR. BYRD: -- to the microphone here and explain how you did that calculation?

DR. CHIU: Let me explain. Chong Chiu, Performance Improvement International.

And, we did analysis for this calculation. What we find out, there's two effects are going on at the same time, is that after the coating, the moisture will be driven to the outside because of temperature gradient.

This is the effect, it's well known in the concrete industry.

So, that effect will drive the moisture toward the outside. At the same time, the inner surface is dry, the lower relative humidity, about 50 percent, 40 percent. Since then, the moisture is driven out and at the same time the inside. So, we balance the two effects.

Now, we'll also look at all the temperature profiles on yearly basis about June, winter, summer and spring. So, we find what would be the worse condition of the temperature profile, I mean conservatively, then we can get a calculation.

The result is about two to six years that we get dry out.

MEMBER CORRADINI: So, Chong, that's documented in the some RAI? How can we look at that? Is there documentation of that?

MR. HOOK: PII has submitted a report

to Davis-Besse and we did owner acceptance on that and got it into our process.

MEMBER CORRADINI: Okay. So, it is documented?

MR. HOOK: Well, it is in our documentation. But, we've never --

MR. BYRD: We've never submitted that as part of a Request for Additional Information.

MEMBER BALLINGER: Can you tell me what the uncertainty is on those measurements? Back to slide number 22. Whenever I see Excel plots with little stars on them, I start to wonder about what those stars actually represent. What's the error bar?

MR. HOOK: They were -- those tests were done at the University of Colorado and normal standard estimate reading, I don't know what that value is for estimated uncertainty.

MEMBER BALLINGER: Well, but you took the material from the site out there to be measured and --

MR. HOOK: Right.

MEMBER BALLINGER: -- so the -- I'm just curious as to --

MR. HOOK: But so --

MEMBER BALLINGER: You have a --

MR. HOOK: Yes.

MEMBER BALLINGER: You have a line which you -- which is --

MR. HOOK: As soon as we took that core bore out --

MEMBER BALLINGER: Like a, you know, multi-parameter fit with all those little bumps and stuff in it on the bottom and I'm just curious as to whether that's in effect a straight line because of the uncertainty in the measurements? And the same thing goes for the upper lines?

I mean it looks to me like there's the red dots, you know, if you can count three points as a trend, that's fine. But, the blue also has this little curve and stuff like that and I'm just curious as to whether that's just an artifact of Excel or whether that's real?

MR. HOOK: So, when we took the --

MEMBER BALLINGER: I'm sorry, I'm just being kind, all right?

MR. HOOK: When we took the core bores out, we immediately sealed them up with silicone, so we preserved it. And then we shipped them off to University of Colorado Boulder. And so, they had that sealed core bore and there's a process, or ASCM, how they drill holes and put measurements in there.

MEMBER BALLINGER: Yes, I know all that and I also know that, in my business, if you have the data, use it. If you don't have the data, use color.

And so, the uncertainty is important on these things.

MR. HOOK: Okay.

MEMBER BALLINGER: So, it'd be nice to have an actual estimate of what the uncertainty is on those measurements. What's the spread? Because going forward, you're going to be measuring this with time, right?

MR. HOOK: Yes.

MEMBER BALLINGER: So, somewhere along the line you have to be able to say, my trend is doing what I think it's doing and that has to be outside the uncertainty of the measurements.

MR. BYRD: So, we have the test report from University of Colorado. We don't have it with us. I think we'd have to consult with that to understand what the uncertainties -- I don't have that information with us here.

But, we did -- we received from the University of Colorado their test report and maybe if we get an opportunity, we can -- we'll see if we can obtain that during our break here and find out what that uncertainty was. I'm sure that is in that report.

MEMBER BALLINGER: Thank you.

MR. BYRD: I just don't have it here right now.

MR. HOOK: Okay, let's go to the next slide, then.

Now, knowing that we have an increased level in concrete relative humidity, a laboratory test was used to determine if the same type of fractured surface in the concrete could be repeated.

The core bore sample from the shield building was used for this test. The sample was prepared with a slot and a tight crack to simulate the existing conditions.

Test results confirmed the laboratory sample had the same type and length of cracked surface as the core bore from the crack propagated area. This laboratory test validated that ice-wedging is occurring.

Next slide, please?

As a result of identification of crack propagation, we increased our monitoring plan sample side from 12 to 23 core bores. We will conduct annual inspections through 2018 and we will continue on an annual basis if any changes are noted.

We quantified the structural margin in our calculation and we performed periodic testing on the shield building concrete relative humidity to establish a trend.

We also considered other mitigating options such as installing dehumidifiers to lower the humidity in the annulus or installing air conditioning units to lower the air temperature in the annulus.

We have not determined at this point if these options would be practical and what unintentional consequences there would be if they were to be implemented.

CHAIRMAN RAY: I don't think your presentation is going to include the structural calculation margin quantification, but what's the model? What's the -- that goes back to the question I asked earlier about failure mode and so on.

I'd like you to think about being able to address that later today.

MR. HOOK: Well, now is as good a time any.

So, we talked about the margin and then on our seismic analysis says I can accommodate up to like 100 additional feet. So, we also, with our analysis that we showed with the drying out, we believe that the drying out will occur between two and eight years.

That will occur well before the margin that we have in our structural analysis or seismic analysis is exceeded.

So, we have a lot of time in there to continue monitoring to make sure the shield building is trending as we believe and that the shield building will dry out. We'll be able to pick that up in the amount of crack propagation we would see in our monitoring program.

CHAIRMAN RAY: Well, but I still would like to see how the calculation is done, what's assumed with regard to the rebar? What happens to the outer layer of concrete when this margin is exceeded? And so on.

MR. HOOK: So, the test done at Purdue and Kansas, those tests confirm that we will get our design allowable values in the shield building. So --

CHAIRMAN RAY: That doesn't go to what I'm asking. I want to see how the -- what's the model for the calculation that's performed? What is the mode of structural loading that results in failure and what is the failure mode that you're talking about?

For example, are you just scanning any compressive strength in the outside three inches or whatever it is outside the rebar?

MR. HOOK: Okay.

CHAIRMAN RAY: Okay, what becomes of that part of the wall? Does it fall off? Is it just --

MR. HOOK: Okay.

CHAIRMAN RAY: -- stays there and is assumed to just playing a role and resisting the bending modes or what?

MR. HOOK: Okay, well, I'll have Tom answer that question again. Tom?

MR. HENRY: Okay, so for the -- again, Thomas Henry, Design Engineering.

So the purposes of the analysis for the shield building, as Jon had mentioned, we have a seismic analysis and we have a structural analysis.

The seismic analysis evaluates certain percentages of cracking. And, as part of the testing that Jon had mentioned at Kansas and Purdue, we determined the capacity of the reinforcement in areas of laminar cracking.

To determine the capacities of reinforcement areas of laminar cracking, we used that capacity in our structural calculation to address laminar cracking and how the concrete behaves.

We went through that building and we applied the shoulders, we applied the areas of cracking as a dead load -- as a load that's attached to the structure, but does not participate for capacity of the building.

We then computed the analysis using all of our design basis load combinations such as tornados, such as earthquakes, computed those load combinations and came up with the capacity of the building.

Does that help to address your question?

CHAIRMAN RAY: Well, maybe, I'll have to think about it.

You know, there's no question, of course, that the loss of participation of three inches of concrete due to a laminar crack on the outside of the rebar isn't going to cause the building to fail to meet its design load. I understand that.

But, I'm asking more precisely about, all right, what is the behavior of the building when this crack is subjected to that kind of loading when this crack surfaced? You're talking about it being a 100 feet, do I get a 100 feet by three inches of concrete falling off on top of the auxiliary building? What happens?

MR. HENRY: Okay. With respect to areas of shoulder laminar cracking, we could go back to the figure, but the shoulders themselves have reinforcement that turns and essentially dials into the structure and staples those shoulders into the structure so they are attached in the seismic cases.

As far as the --

CHAIRMAN RAY: Well, excuse me for a second. We're talking about a laminar crack which

I presume detaches the concrete outboard of the crack from the rebar. So, it doesn't matter that the rebar is connected into the building, at least in the picture I have in my mind.

MR. HOOK: In this picture right here of the shoulder areas, this reinforcing steel here and anchored over here, too, those rebar will keep the shoulder areas intact.

CHAIRMAN RAY: I know and I'm talking about what's outboard of that rebar. What happens to it? That's --

MEMBER CORRADINI: He's talking about the skin.

CHAIRMAN RAY: Yes, I mean you're assuming that the crack occurs as you've shown it here and, therefore, the detached concrete is captured by the rebar --

MR. HOOK: Correct.

CHAIRMAN RAY: -- that you point out is anchored into the building.

MR. HOOK: Right.

CHAIRMAN RAY: Well, fine. In that case, I wouldn't argue that that's not the case. But, the -- you know, I don't know enough about the location of the cracking to know that the concrete which affected by the cracking is always going to be captured by that rebar cage that you're showing holding it into the building there.

MR. HOOK: So the --

CHAIRMAN RAY: And, in fact, excuse me, there is one reference, only one that I could find, to spalling as a result of failure of the rebar as one mode of failure.

Now, it would take me about two hours to back and find it, but it's in the stuff that I read as one of the modes of failure that need to be considered. And, I'm just asking about how did you do that? Or do you assume it just doesn't happen?

MR. HENRY: Specific to the shoulder zones which is the figure that you see in front of you, we did complete an analysis in 2011 that evaluated whether that reinforcement was enough of a staple, enough of an attachment point to maintain that concrete attached to the structure.

We did demonstrate that under earthquake loading, that reinforcement was enough to attach it in.

The red line on that drawing does show the area of laminar cracking being within that reinforcement cage.

We've gone out and we've the IR. We've done actual mapping of that reinforcement to make sure that it does hook in where we have it on our drawing. So, we confirmed all those parameters.

And so, for the areas of the shoulder between our calculation and our field verification, we do have documentation that states they will remain attached to the structure.

CHAIRMAN RAY: Okay, so, all right, this is important. Let me stay with it for a minute.

So, you're saying that the laminar cracks are always in the plane of the inner rebar?

MR. HOOK: Always in the plane of the outer mat of the structural --

CHAIRMAN RAY: Well, I'm sorry, the inner in the sense that that --

MR. HOOK: Right.

CHAIRMAN RAY: -- shows it in the second rebar --

MR. HOOK: Correct.

CHAIRMAN RAY: -- plane in from the outside. That's always the case?

MR. HOOK: That -- in the shoulder area, that is correct. And when --

CHAIRMAN RAY: Well, I'm sorry, I didn't mean to interrupt you, but in the picture we show, you know, there's such a large irregular area affected in some cases on the south side that it's hard to imagine that everything is captured by that rebar cage that we're -- if you want to call it that.

MR. HOOK: Yes, yes. So, in the majority of the cracking that occurs in the shoulder areas, and we've addressed the shoulder areas here, the other areas where we have laminar cracking outside the shoulders is in the top 20 feet of the shield building where we have areas of high reinforcing.

When we did core bores, throughout the whole process, the crack sometimes was in front of, sometimes it was behind the mat rebar.

So, there is concrete attached to the rebar and so, because the concrete is attached to the rebar, that will prevent any spalling.

MEMBER BALLINGER: But, what Member Ray is saying is that you made an assumption, a bounding assumption, where you get a 100 percent crack.

MR. HOOK: That's correct.

Structurally --

MEMBER BALLINGER: Under those circumstances, admittedly artificial I suppose, the anchor point, the little thing with the hook on it there, may keep that piece attached to the building, but what about in between the two sort of architectural things, the shoulders?

MR. HOOK: The shoulders.

MEMBER BALLINGER: Have you thought about whether that particular anchor point is sufficient to keep the whole thing attached to the building when you only have two anchor points between either shoulder? All right, that's what I'm assuming.

MR. HOOK: Well, that was the analysis that Tom talked about. We did evaluate that.

MR. HENRY: For the barrel section of the building, which is what I'll -- the term I'll use for the area between shoulders -- for the barrel section of the building, throughout the bore investigations that we have done, we've shown that that cracked line is not a cracked line that's on the exterior face of that reinforcement.

It does -- I'll use the term meander, through the depth of that reinforcement. So, since the concrete is attached through varying layers of that reinforcement that the depth of cracking through varies layers of reinforcement is attached, we do treat it as attached in our analysis.

MEMBER BALLINGER: So, that's your argument?

MR. HENRY: Correct.

MEMBER BALLINGER: You're going to assume that it's attached?

MR. HOOK: Correct.

MEMBER BALLINGER: But, now that we're out in artificial space, what happens if it's not? In other words, if you were asked, okay, all that stuff just falls down, what damage does it -- is it likely to do? Is the shield -- the building that's there okay under those circumstances?

MR. HENRY: The roof of the aux building, which is the safety related structure below that area of the building, is designed for tornado missiles. We have not gone through the analysis of evaluating a size of concrete coming off equivalent to that tornado missile. We have not evaluated that and the basis for that is the attachment statements that -- the attachment analysis that we have.

MEMBER BALLINGER: Okay, so the argument, again, is you don't need to do it because you don't think it's going to happen?

MR. HOOK: And that was based upon visual inspections and where the crack is located with respect to the outside mat rebar.

MR. BYRD: But, to clarify, we did analyze for the shoulders because, obviously, if they became detached that'd be a much large volume of concrete. And, underlay, it's about three inches and, as Tom said, we also do have a substantial amount of attachment between that concrete with the way the cracks we've observed.

CHAIRMAN RAY: Well, you know, I don't have a problem accepting the idea that the shoulders are anchored at the way that you've shown it here. But, it is that I don't see, at this point, how we're able to rely on that alone as assuring us that there isn't a potential for spalling.

As I say, there is a discussion or mention, at least, of spalling due to the failure of the rebar mat itself which, of course, we would recognize could lead to a spalling occurrence.

But, with the crack propagation that

we've been talking about, it's just not -- and the maps we've been looking at and so on, it's just not clear to me that you can always make the assumption around this.

MEMBER BALLINGER: I didn't make the assumption, they did.

CHAIRMAN RAY: No, no, is describing.

MEMBER BALLINGER: Yes. So my confusion gets cleared up, the analysis that you've done indicates or suggests that even with a 100 percent cracking, the building still meets the design basis, still all the tornado, the wind, everything and end of story then?

MR. HOOK: Correct.

MEMBER BALLINGER: Right?

MR. HOOK: Correct.

MEMBER BALLINGER: So, and even under the worst set of circumstances, the building is fine?

MR. HOOK: Correct.

MEMBER BALLINGER: So, all this analysis of crack propagation and freeze/thaw and all this kind of stuff is good but, in the end, the conservative analysis says that no matter what happens, the building is still stable?

MR. HOOK: That's correct.

MEMBER BALLINGER: Is that correct?

MR. HOOK: Yes.

MR. BYRD: Well, I think to be a qualification in that, Jon, and that would be the seismic loading would change based on your seismic analysis. That's why we have the limit that you were talking about.

MR. HOOK: That's the seismic response scoping studies that we did. But, the structural portion of it, you were right on the structural portion of it.

MEMBER BALLINGER: Okay, so it would not meet -- if under those conservative circumstances, it would not meet the seismic?

MR SHACK: Let's clarify once, again, under the most -- which the seismic load is the most damaging?

MR. HOOK: Correct.

MR. SHACK: You've assumed the 100 additional feet, right, rather than a 100 percent?

MR. HOOK: Right.

MR. SHACK: So --

MR. BYRD: So, if I could clarify a little and just because I think --

So, we did a structural analysis, 100 percent cracked. Seismic load is the controlling load that's calculated in a different analysis, the seismic response. And that is the one where we'd assumed the 100 additional feet. So, we've assumed margin in that and that margin is very substantial, if you notice, we're getting about a foot a year, so a 100 feet, we have a substantial time frame before we'll exceed that margin.

If we do, we'd have to go back and reanalyze it. It doesn't mean we've hit a limit, it just means we have to go back and redo that analysis. We did sensitivities on that.

Have I stated that correct, Jon? I'm just trying to clarify --

MR. HOOK: Yes.

MR. BYRD: -- where we are. So, although we assumed it was a 100 percent, it doesn't mean we're good forever. We have to relook at the seismic loading if we exceed that in our seismic analysis.

MEMBER BALLINGER: But, you have done sensitivities?

MR. BYRD: The sensitivities we have done would suggest the 100 feet of additional, in all these areas, which provides us with a considerable time frame, you know, we're talking many years before we would have to go back, based on our current crack rate, and redo this analysis.

All this testing we've done on humidity suggests to us that we will never reach that point, we'll dry out over a period of time. If we don't, we'll have to go back, reanalyze or look at other options such as trying to dry the building out or do other, you know, other options which we'll have to look at.

MR. SHACK: And, come back to Harold's question again. You know, you say that the -- out there in the barrel region where it really looks like a shell, you still assume the concrete is attached because the crack, although it's cracked, it meanders?

MR. HOOK: That's correct.

MR. SHACK: But, you probably don't do a damage calculation during the seismic event. I mean it's attached now, but do you -- you don't calculate a damage factor to see whether, in fact, the seismic stresses would be enough to, in fact, crack those ligaments?

MR. HOOK: That's correct, yes.

MR. SHACK: So, that's an article of faith that it remains attached?

MR. HOOK: But, keeping in mind when I look at the structural analysis and my interaction is 0.76, that's the highest one is seismic. So, I'm not close to my design limit.

Seismic stressors are the most controlling one, but I still have a lot of margin between what my seismic limit is versus my code allowable limit, if that makes sense.

MR. SHACK: Right, but there is still this question of the spalling issue.

MR. HOOK: Right.

MR. SHACK: And, that's a separate one.

CHAIRMAN RAY: Let me remind us all that, again, we are asking these questions because, ultimately, we want to be able to conclude that what we're doing going forward is adequate to ensure against changes, we're not really asking about what's already been done but because we're concerned about the present licensing basis. That's been addressed seemingly already quite adequately.

But, I do want to ask the question, is these analysis we're talking about here part of the record either in terms of the License Renewal or on the current license docket so that it can be reviewed? We don't sit here asking a zillion questions.

MR. HOOK: I believe these analysis have been looked at by the NRC in their inspections.

CHAIRMAN RAY: In the inspections?

MR. HOOK: Right, I'd have to defer maybe to Mr. Neurauter, if he has looked at some of those or --

CHAIRMAN RAY: We'll ask the staff when their turn comes, but I just, in case we need to refer to it because there's -- it's difficult to absorb and understand all of this on the fly whether we have access to it as a Committee.

MR. HOOK: Okay.

MEMBER BALLINGER: So, not to beat a dead horse again, but I am looking forward to the license extension period. So, there are a set of conditions that could happen during the license extension period when you could get to a situation, no matter how theoretical it comes out, where you don't meet the requirements for the building.

In other words, if the cracks were to

propagate greater than a 100 feet or whatever the number turns out to be and they keep propagating, at some point, the seismic reanalysis that you would do might result in you having to take some other action other than assuming that the building dries out or something like that.

MR. HOOK: Yes.

MEMBER BALLINGER: So, there is this --

MR. BYRD: It's possible that if the cracking were to continue at the rate we're seeing now, or that even at an accelerated rate, let's make something hypothetical, and at some point, we would have to reanalyze the seismic loading which is an input into the structural calculation and it's possible that we might -- several things might happen, we would have to potentially look at other options.

You know, we could remove the coating we have on the building. We've discussed that. We didn't really want to do that because we see long term benefits from having the building coated. It does provide benefit for other type of events, protects out concrete.

We could look at dehumidifying, adding insulation on the outside of the building to prevent it from freezing.

We've thought about a number of options. But, at this point, we're going to monitor until we determine if there's any need to take any of these more -- these are all fairly extensive actions we have to take.

But, obviously, the first thing we do is reanalyze. That's obviously something we'd do, reanalyze and find out what our seismic loading is going to -- and put those into the structural analysis and continue evaluating our margin.

But, at this point, based on where we are, we feel the most prudent thing to do is to continue our monitoring campaign and monitor where our crack propagation is and we're also are looking at building humidity as we progress.

CHAIRMAN RAY: Well, it is the adequacy of the monitoring program and ensuring that the margin is maintained everywhere in the building that is the motivation of our questions at this point.

But, in order to understand that, we need to understand what is it that could occur and what is it that is occurring. We need to understand the phenomena enough to be able to say, yes, this monitoring program will serve to ensure that the margins are maintained.

And, that ultimately takes us to, well, what is the analysis that determines the margin to begin with? What are we assuming about the seismic cracks? What are we assuming about modes of failure?

So, that's why we're asking the questions we are.

MEMBER BALLINGER: Yes, I'm not a concrete person either, but I understand that you've done everything that you can to analyze things to come up with root causes and things like that.

But, there are other buildings, other plants that have buildings, other concrete structures. And so, you're saying that this unique feature here, the shoulder, provided a stress concentrator which is different than every other place that may have the same moisture -- you know, there may be other places, other plants, buildings and stuff -- that that provided -- that it's so unique that that's the cause of our problem? And that no -- if that shoulder wasn't there, we wouldn't be here today talking about that?

MR. HOOK: I believe that is the case. If those shoulders were not there, if that was just a round barrel, that was a contributing cause.

MR. BYRD: Or actually, we -- furthermore, even on our site which saw similar, obviously, all the buildings saw the same environmental conditions we did do, extend the condition on other concrete buildings and we did not have any other cracking of that nature. And, some of these are heavily reinforced buildings such as our auxiliary building which we specifically looked.

MEMBER BALLINGER: Well, with respect to -- so to Member -- to your point is that that monitoring program is really important because there is some probability that all of this stuff is fortuitous but with some other thing which is responsible for this that we don't have a clue about and so, the monitoring is really important.

MEMBER SCHULTZ: With that in mind, Jon, could you describe what you're going to be doing in more detail over the next few years? You've indicated a program to 2018 and if there continues to be findings, you'll extend that. And you have some expansion. Are you continuing to look at humidity measurements?

MR. HOOK: Yes. So --

MEMBER SCHULTZ: Still going to look -- you've got increased bores -- I'll let you explain it, but if you would describe that in more detail?

MR. HOOK: So, we'll do increased core bores. We're at 23 and we're monitoring the leading edge of the crack at at least three locations. And so, if those core bores show cracks, then we'll install loop core bores, so again, we'll keep out in front of that so we'll know exactly where it is.

We'll monitor and trend the crack growth and, if it doesn't subside that what we believe it is, then we'll continue to then take humidity readings and tests to see how the concrete is performing and drying out.

MEMBER SCHULTZ: You'll do that -- you are planning to do that or you're going to do it if the crack growth continues? Because the humidity measurements aren't convincing to me that it's drying out.

MR. HOOK: We will do humidity if the crack trend is not subsiding.

MR. BYRD: Well, I think really the

crack trend is the real thing we're monitoring.

MR. HOOK: Of course.

MR. BYRD: And, we understand that. Now, the humidity is something that we probably will continue measuring on a yearly basis. I mean that's not really part of the program, but it's helpful to us because it's giving us some information on the building. But, really, the thing that's really giving us what we need is the actual crack propagation and we are continuing, as Jon said, to monitor that.

MEMBER BALLINGER: Okay, one last thing. Have you thought about other mechanisms that can come to play other than the cracking that you're seeing now? For example, now you have cracks and rebar exposed to water. So, is there any possibility that you could get another phenomena that complicates your life like ASR or corrosion of the rebar, that kind of stuff that could complicate your life?

MR. HOOK: Well, for one, for ASR, alkali-silica reaction, Davis-Besse is not subjected to that.

MEMBER BALLINGER: So, the aggregate is not susceptible to ASR is what you're saying?

MR. HOOK: Right. As part of testing all these some 35 core bores that we've sent them off for testing, that was one of the tests that they --

MEMBER BALLINGER: Okay.

MR. HOOK: -- actually specifically looked at. So, I'm really comfortable with that, we're not going to have that.

As part as the rebar and any activity associated with the rebar, we've also done a lot of testing on that. Concrete's very high pH, we tested the water that in there, very high pH, so it's not -- the environment isn't there conducive for corrosion.

And then, with sealing of the outside wall, we're not getting any moisture in there also. So, I'm also very comfortable with not getting any unanticipated consequences as a result of rebar and corrosion and spalling on that area.

MR. BYRD: And, additionally, we are doing opportunistic inspections of rebar as we do these core bores which we are doing. We obviously we strike rebar when we do that, we'll do opportunistic inspections and we haven't observed corrosion through any of those inspections.

MEMBER BALLINGER: Thank you.

CHAIRMAN RAY: I'm going to take our first recess here now, even though I know we're just in the middle. I'll give you one second, yes, but only that amount. I know that this may not look like a convenient place, but there's going to be sufficient discussion remaining that I think we'll miss the recess all together if don't take it here now.

Jon, did you want to say something more?

MR. HOOK: No, that's fine.

CHAIRMAN RAY: Okay.

MR. HOOK: I'm good with that.

CHAIRMAN RAY: So, we'll recess until 20 minutes to 11:00.

(Whereupon, the above-entitled matter went off the record at 10:19 a.m. and resumed at 10:40 a.m.)

CHAIRMAN RAY: Back on the record, please. And I interrupted a planned presentation. You guys can restart as you wish with whatever preamble you'd like to give and then we'll continue.

MR. HOOK: Okay, thank you. I would

like to correct one item that I made reference to, the design basis of the concrete. The design basis is 4,000 psi. And I think I misquoted that earlier. And to follow up on two other items, we are trying to establish communication with Dr. Xi from the University of Colorado at Boulder to find out what the uncertainty instruments error that he has in his analysis, so hopefully we'll get that information shortly.

And then the other item, you talked quite a little bit about the hoop stress and the radial stresses, yes. And concrete has different properties and different directions. The capacity of sheer in concrete in a hoop direction is significantly more than the stresses in the concrete when you're trying to tensile. So that's why when we looked at the shoulder areas, we were concerned about the lower number because when I maxed up those stresses with the tensile capacity of the concrete pulling apart, that's more limiting than versus what is the stress around the hoop compared to that. So that's not a controlling parameter, if that helps explain that.

MR. SHACK: Well, as I say, I'm not a concrete man, so I'll ponder that some.

MR. HOOK: Okay.

MR. SHACK: Just to come back to another question to clarify, the 100 feet. Obviously, you had to have some true configuration of a crack to do the structural analysis. How was that 100 feet assigned? That's a cumulative number over the current cracking dimensions. You added some extra amount to each crack?

MR. HOOK: It was just a total population. We took the crack and expanded it to another 100 feet. That affected the second --

MR. SHACK: Okay, but you expanded another 100 feet by what? Filling all the flutes with cracking and then stretching the cracking out around the barrel?

MR. HOOK: We'll have Tom address that one because he's seen that calc.

MR. HENRY: Thomas Henry, Design Engineering. For the purposes of that analysis, we did treat the shoulder areas as cracked. And then we would additionally remove areas of the barrel cracking in order to obtain the correct percentage that we wanted and convert the percentage of the circumference to a linear foot number.

MEMBER BALLINGER: So you took the pink

area --

MR. HENRY: Correct.

MEMBER BALLINGER: And you created a crack based on the pink area emanating from the shoulder?

MR. HENRY: Correct.

MEMBER BALLINGER: And then extended that 100 feet.

MR. SHACK: Cumulative.

MEMBER BALLINGER: Cumulative. See now I'm wondering what cumulative meant?

MR. HENRY: What it means is that we didn't take it and assign it as a 100-foot section emanating from one leading edge. We didn't take it like that. We took it as a percentage of the circumference.

MR. SHACK: But you didn't put new cracks on the north side. I mean you just expanded all the south side cracks?

MR. HENRY: Right. We took it -- we actually took it as a percentage of the outside diameters is how we took it. So we didn't assign it to any specific area. We took the shoulders out. What we're talking about is we're talking about the calculation of the moment of inertia of the structure. So we took out the thickness of the shoulders which are obviously a huge contributor on a moment of inertia. And then of the remaining perfect circle, we took out a percentage of the circumference and took out the moment of inertia on that as well.

So it wasn't that we took one crack and extended it 100 feet. We took out a percentage of moment of inertia based on outside diameter.

MEMBER BALLINGER: I'd like to see a drawing.

MR. HOOK: We basically took where the crack was in the shoulder, then expanded each one proportionately and divided it out.

MEMBER CORRADINI: So I think I understood what he said, but if I had a cartoon that said I see pink and now I had additional yellow to the pink by some assumption, then in my mind visually I think I've got it. So you ignored any contribution of the shoulder to seismic strain and you expanded everything that was into the, what you call the barrel region enough so that you decreased the moment of inertia and then you back calculated 100 -- the 100 feet is still bugging me.

MR. HOOK: Okay.

MEMBER CORRADINI: So I understand what you did by reducing the moment of inertia, but how did you get to the 100 feet? That's what I don't understand.

MR. HENRY: Okay, so the moment of inertia is a function of outside diameter, okay? So the percentage cracking -- when you take percent crack, it correlates to OD length. And so that OD length, the difference in percent analyzed on OD length is the 100 feet.

MEMBER CORRADINI: Can I say it back to you differently? Are you telling me that you decreased the -- you did an appropriate structural calculation that the affected circumference which went into the moment of inertia calculation was less by 100 feet?

MR. HENRY: That's correct for diameter.

MEMBER CORRADINI: Okay. All right.

MR. SHACK: For diameter?

MR. HENRY: Circumference.

CHAIRMAN RAY: You guys are talking in foreign languages here. It sure would be nice to have a picture, but in any event that's why I ask about the availability of the analysis itself, recognizing there's more than one.

Continue.

MR. HOOK: So now I'm on slide 25. So in conclusion, the test results and evaluation indicate a crack propagation will decrease as the Shield Building dries out; that the margin in the structural calculation is sufficient to allow continued monitoring during the time the concrete is drying. In addition, the margin in the structural calculation also provides additional time to develop additional actions if the drying out rate is not predicted. And then a monitoring program is effective in identifying changes in the Shield Building as evident by the identification of crack propagation in 2013 and the frequency of the early inspection is also appropriate since the cracking occurs only during the winter months. Therefore our Shield Building monitoring program is effective and acceptable in monitoring crack propagation.

I'd like to at this time go to the slide that we had difficulties in getting earlier.

CHAIRMAN RAY: Okay, but if we could just stay on the last slide for a moment, please?

MR. HOOK: Yes.

CHAIRMAN RAY: I just want to point out that we need more discussion of the conclusion points concerning the monitoring program being appropriate for the reasons that I said earlier. I won't repeat myself, but at the end of the day what we will opine on, at least one of the things, is yes, we agree that the monitoring program will ensure that any propagation that could possibly exceed the structural margin required is sufficient. That's what we have to say. And that means we need more than what we had thus far in terms of why you conclude that this is an adequate program.

Now also, of course, there's still the question of whether we're only talking about the failure mode that was just discussed in terms of the building inertia against horizontal motion, seismic, in other words or whether there's any possibility that monitoring should consider spalling as a possibility. So in any event, our focus is on the monitoring program, why do you reach the conclusion that you do. I know you reached it and I've read it to be the case, but that's what we have to ultimately say yes, we concur. And so it may be that we'll come back to that later in the day or you may dig a little deeper into it now if you wish. But I just want to make that point and then say go ahead.

MR. HOOK: Very good. Well, can we pull up that core bore location. So this again -- this is the layout of the Shield Building exterior. The magenta colors are the areas of cracking. And the Xs and the solid black dots are the areas that we are monitoring. So the Xs are areas of existing cracks, so we're monitoring those for changes in crack thicknesses and then the black are areas of solid concrete and we're monitoring those for crack propagation.

As you can see, we're monitoring all the shoulders. Four 5, 6, 7, 8, 9, 10 are low and we're also monitoring some flutes and also up on top.

Tom, is there something else you want to add to that?

MR. SHACK: Okay, the Xs you already have cracks there and you're looking at the crack width, is that --

MR. HOOK: That's correct.

MR. SHACK: And the black dots are uncracked at this moment?

MR. HOOK: That's correct.

MR. HENRY: I'm Thomas Henry. I'm just going to enhance that answer by stating that the shoulders that we talked about earlier with 5, 7, 13 and the 15, where we added additional leading edge bores, the leading edge bores are actually not shown on this drawing. These are the 23 that we've committed to as part of our program. The leading edges are supplemental on top of that, so there are additional uncracked bores on those shoulders that you don't see in that drawing.

MEMBER CORRADINI: Okay, now I'm really confused. I thought the black dots were the leading edge bores?

MR. HENRY: Black dots are bores that we monitor where there is no evidence of cracking.

MEMBER CORRADINI: Right.

MR. HENRY: So we do detect leading edges in those. On top of that specifically in our AMP, in our Aging Management Program, we've committed to monitoring the leading edge where we see propagation. And so I may have been confusing. Where we see propagation such as shoulder 5 or shoulder 7, we've installed additional black bores, black dots, that are uncracked, but allow us to detect a leading edge.

MEMBER CORRADINI: And that aren't shown.

MR. HENRY: Those bores are not shown.

MEMBER CORRADINI: Okay, so since you're up here, just help me. None of these are up high.

MR. HENRY: Around shoulder 9, around the center of the drawing, there are bores that are in the top 20 foot area that we talk about.

MEMBER CORRADINI: But the logic of at least focusing on low is because that's where you think the stress concentration is?

MR. HENRY: The direction or the selection of low bores allows us to inspect them without using scaffold equipment.

MEMBER CORRADINI: Okay, I think of that as the answer. So why not hit them with the hammer there so that you have a backup monitoring that is more complete.

MR. HENRY: Our Aging Management Program does allow us to use -- we have specifically built into our Aging Management Program the use of the impulse response nondestructive examination. We do have that included as an option in our Aging Management Program.

The definitive information about what's going on subsurface is the core bore examination. So that's what we've -- that's the 23 bores we've defined. And we will selectively IR as we've done, as we need to obtain a bigger picture.

MEMBER CORRADINI: So can I say it back to you just so I understand?

MR. HENRY: Yes.

MEMBER CORRADINI: So you will do IR, but you're not committed to doing IR.

MR. HENRY: That is correct. We have not committed to do IR. We have in the past and I -- yes, we have in the past, and do have it as an option.

MEMBER CORRADINI: But there's also a good correlation between the two as you explained earlier in the discussion, is that correct?

MR. HENRY: Yes.

MR. BYRD: Right, but I think the clarification would be that IR is not really what -

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a qualified method. So using a core bore provides us with definitive information regarding where a core is. Not only that, but it tells us how deep the core. That's why in our original method here we went and we did impulse response testing. It has a huge advantage. It's nondestructive. You can do it over larger areas. But then we've confirmed that with the core bores because that is actually a method that we can rely on.

MEMBER BALLINGER: But the core bore came after the fact. The IR and the impulse allowed you to localize where you did the core bore.

MR. BYRD: That's correct. Well, initially, if you really want to get down, we started out doing core bores before. Then we realized we needed to do something. We don't want to put holes all over the building. We started doing impulse response testing. Now that we have this overall map of the building, we were able to identify more logically where to place core bores which is what we've done.

And now I think what Tom is explaining like if you were to go to -- and it's hard to see this. Some of these ones where you see multiple cracks, we've placed -- you might want to point out one additional core bore now that we're monitoring any progress of a propagation in those areas. And we are doing impulse response testing which is what we showed you previously.

MEMBER BALLINGER: This looks like a slide which we don't have which if it was better annotated with all the places we've discussed would be very helpful.

MR. DORT: It's now part of the record.

MR. HOOK: It will be included in the records, yes.

CHAIRMAN RAY: Well, you said you were able to more logically locate these. Once again, let me just repeat. We have to say yes, that's enough. That will confidently detect any problem before it becomes serious, I'll say, to keep it simple.

How to convince us that yes, these are the right places? What is the logic?

MR. HOOK: We identified the shoulders. That's the area of crack propagation. We want to make sure that the cracking is confined by the shoulder areas. That's the rebar that ties it back in. So we are monitoring all those shoulders where we have cracking. So that's where we're concentrating on. That's where we've seen crack propagation based on an IR and that's where our leading monitor edging -- or leading edge monitors are.

We also have selected the ones up on top as well. So it is a cross section of flutes and shoulders and barrels, high and low, inside the main steam line room and on the outside. It is representative sample. Keep in mind that we had only 13. With 13 we were able to pick up crack propagation. So we've increased the sample size to up to 23. I'm sorry, it was 12 to 23.

MR. HENRY: For clarification, that was 2013, the population was 12.

MR. HOOK: Right, and we were able to pick up crack propagation with 12 strategically located core bores. And now we've expanded that for additional margin.

CHAIRMAN RAY: Well, let me be logical for a minute. The fact that we picked it up doesn't mean that monitoring of it is therefore sufficient by the expansion that you've made.

Let me illustrate it another way. The IR methodology can be used more widely and with discretion that the core bores, you know, logically can't be because they are where they are. I realize you can make more of them, but you can't just go around and bore holes in the Shield Building whenever somebody feels like it. But you can use the IR.

Now you said it was something that was available to you and you would use if you felt it was needed. Why isn't it a part of the program?

MR. HOOK: Not officially part of the program, but --

CHAIRMAN RAY: Well, I'm talking about you're only going to get credit here for what's official.

MR. BYRD: Why don't you speak to that, Tom? It is back up in our program.

MR. HENRY: Right. Impulse response mapping is a backup in our program. We've committed to the bore inspections explicitly for the purposes that a bore inspection will give us width of crack and it will give us a depth of crack that IR mapping will not give us.

MEMBER BALLINGER: But you're making an assumption that those core bores constitute the set that gives you the -- that's going to work, right? I come back to an experience with steam generator tube examination. All the plans that I've seen for steam generator tube examination consists of a statistical distribution of places where they really have seen cracks or where they expect to see. But then there's an additional number of tubes that get inspected which don't have any cracks.

What they're trying to do is to cover their you know what by doing an inspection just in case. And if they suddenly see something there later on, then they adjust the distribution of tubes which they expand, the distribution of tubes.

So what I'm looking for is an inspection plan here which sort of looks like that. In other words, you really have a good idea and you're confident that that's where you're going to see the crack propagation. But there's the but. There may be at some point going down the road where you may get cracking which you had not expected and you'll never see unless you've got some kind of sort of other places which you look at by methods which obviously not core bores, but IR or testing and stuff like that just to make sure that your analysis which you've done a good job on is working.

MR. HENRY: So I'd like to point out

that the distribution of bores around that building is weighted towards the areas of greater cracking, on southern exposures, on the -- a little bit to the east and west.

In order to have that propagation phenomenon, there does have to be an existing crack. So you center those bores around the locations where we already see cracking and therefore would likely see a propagation since that's the fundamental requirement to see propagation. So we have used that as part of the selection of bores.

MEMBER BALLINGER: So you're saying that no more cracks will initiate?

MR. HENRY: I'm saying that one of the conditions for propagation is the existence of a crack.

MEMBER BALLINGER: Okay, and I'm saying, I'm asking, are you confident that no more cracks will initiate?

MR. HOOK: Let me. Part of our program is whenever we go do a core bore inspection if we find any changes at all, we identify it in a Corrective Action Program. So that's our program.

Under the Corrective Action Program,

then we're into either analysis or increased inspections. What we did in 2013 is we saw one change in one of our core bores. Entered it into the Corrective Action Program. As a result of that, we increased our sample size to all 80. So it wasn't in a written down that you have that in our program. That's in our Corrective Action Program how we're going to address that.

And so we did increase it to all 80. We did do impulse response testing to satisfy ourselves what's going on with the Shield Building. So a key part of our program is any time we see something different, we identify in the Corrective Action Program and we've got to take whatever actions are necessary to satisfy ourselves that we understand what's in the -- going on in the Shield Building.

Whether we do another root cause because it's a different phenomenon, we don't have all those identified, laid out in our AMP. But we do have the flexibility captured in our Corrective Action Program. That will drive getting the appropriate analysis, the appropriate inspections that we have to do, and increase our sample size accordingly. So we're not locked into 23 and we're only going to do those. It's a living program based upon what the changes are in the Shield Building. And we'll check and adjust and modify the monitoring program as necessary.

MEMBER BALLINGER: But that's based on what you now see and the core bores that you now have.

MR. HOOK: That's correct.

MEMBER BALLINGER: What I'm asking about is what if you get a crack that grows in some place where you don't have a core bore, will you ever know it? You've got existing cracks. There's no core bores there. Are you confident enough that those cracks will not grow because you've got this 100 feet that you're adding here.

MR. HENRY: So the 23 that we've committed to, as Jon pointed out, in 2013 we inspected all 80. And I mean over the course of this program we've drilled in excess of 110, drilled in excess of that. So the 23 that we've committed to as part of our program are the population that we will always look at.

In terms of that 100 feet number and the margin topic, as we use up that margin, that's something that we address in which shoulders we postulate propagation based off of the 23 samples that we collect. Just because I didn't necessarily look at a bore on every single shoulder, we can use up that margin at our discretion in our calculation to bound areas where we may not look. We have that flexibility.

MR. HOOK: So what would cause crack propagation is again it goes back to existing cracks, freezing temperature and relative humidity in the concrete. So those three characteristics or parameters exist everywhere. It's not going to only occur in one little area and not going to occur anywhere else such that we wouldn't see it. It's going to happen in the Shield Building.

MR. SHACK: Well, that's sort of my question. When you did the analysis of the freeze-thaw cycles, you're focusing here on the lower portion of the Shield Building. When I did that analysis -- at least for the three circles that are in the root cause report, there's a considerable difference in the number of freeze-thaw cycles for a given weather history that you saw that went from 18, I think to 6. Does this match up with what you think are essentially the high freeze-thaw cycles? That would be a logical way to me to locate my inspection sample. Have I covered what I think are the most damaging conditions?

MR. HOOK: There's a lot of variables that go into that. The depth of where the crack is, whether the crack is at 4 inches or the crack is at 12 inches. What's going on with the temperature in the concrete? But the samples that we have is a representative sample of various depths and various locations in the Shield Building that I believe, I firmly believe that we have a good way of monitoring what's going on in the Shield Building.

MR. BYRD: I think this might be a good opportunity to let Dr. Chiu speak.

MR. CHIU: This is Chong Chiu. I want to back you up on one data, why we selected those few points. Because when we selected is we try to understand where is the most severe conditions. As you know, when we change from an early thermal is one big impact and caused the fracture to a progressive. So when you do a progressive, we call it ice wedging, it's not really a freeze-thaw. Freeze-thaw is sort of a surface condition and freeze and thaw causes concrete to crack.

This is almost like a -- you know 2,000

years ago when they cut all the rocks, they used the water to put into the crack and freeze it. That cut the rocks. And this is a phenomena. So we distinguished that from freeze-thaw and we used the term ice wedging. It always happens at the bottom because that's where the water will accumulate. As you know, there's other cracks over there. There's a lot of channels. The water has gravity, will eventually will accumulate at the bottom. So the analysis with Jon, what we find out is that majority of crack is probably at the bottom, not on the top. The top will have a few, a core bore. There's no propagation. So there's sort of a logical reason why we have to choose more at the bottom versus the top.

MEMBER BALLINGER: And you're assuming then that that coating is not permeable.

MR. HOOK: That is correct. We chose that coating to prevent moisture from being driven in up to like 90 miles an hour. It was an ASTM certified coating that was tested for that. That's why chose that particular coating.

MEMBER BALLINGER: And your coating is you've certified that that coating has got the right thickness. There's nothing going on here that affects the permeability or the time to which water transport can get inside?

MR. HOOK: That coating was put on with one primer and two top coats. It was inspected during the process of that. We took readings during it and we have a program that we do our inspections every five years on the coatings. So it does match what the manufacturer said. The manufacturer gave us a certificate saying it's good for I think it was 20 years. And meets ASTM standards.

MEMBER SCHULTZ: Can you describe the inspection frequency and the program associated with the bore evaluation?

MR. HOOK: So the inspections are performed. Right now, these 23 will be done yearly. We have two people, individuals, go look at those bores. They independently confirm the condition of what's going on in the core bore. So there's like an independent check with the visual inspections that's going on. Does that answer your question?

MEMBER SCHULTZ: I think so. They're looking independently. In other words, they're looking at different bores at different times, so they're not together as a team and they're experienced to do these --

MR. HOOK: They are experienced, but they'll go to one core because of scaffolding, just access. So we're at this core. One person will spend 10, 15 minutes looking at it with a borescope. And then independently, another individual will do the same thing and then they'll confer what they saw.

MR. BYRD: You might have an opportunity for Tom Henry, he's actually one of the individuals that does the inspection. You might want to explain how you do that, Tom?

MR. HENRY: Sure. So for bore inspections it is as described. We will open the bore. We'll record any obvious changes in the bore just based on the surface condition. We'll use a borescope. We'll use flashlights, crack converters, all those sorts of tools that are in our procedure that we're allowed to use. We use all those sorts of tools to conduct that inspection. One person will do it. A second person will do it. We'll confer and we'll go back and look at any areas where we may have any discrepancies.

MEMBER SCHULTZ: Then you describe, Jon, that if you find something different and it's to believe you wouldn't find something different in your annual inspection, then it goes into the Corrective Action Program. I want to understand what you anticipate happening once it goes into your Corrective Action Program?

MR. HOOK: Well, first -- the first part you said it was hard to believe there wouldn't be any changes. Well, no. We have many core bores that have no changes at all.

MEMBER SCHULTZ: But you said if there was one core bore that was identified as being different, it entered into the Corrective Action Program.

MR. HOOK: Right, right.

MEMBER SCHULTZ: Going forward, I'm expecting that would happen again.

MR. HOOK: Absolutely. That is written in our monitoring program. Any noticeable changes will get identified in the Corrective Action Program.

MEMBER SCHULTZ: But Tom, you agree that when you do your next inspection you think that there's a likelihood, reasonable likelihood that there will not be changes?

MR. HENRY: I anticipate that there will be changes based on the propagation phenomenon that we know exists in the building.

CHAIRMAN RAY: Well, speaking of the propagation phenomenon, notwithstanding the comment that this is an old technology, I know that there's been comment to the effect that it is less certain a mechanism and its rate of progression and what the conditions are that are required for it to propagate just because it's a relatively new phenomenon in this case.

And so I look at the picture up there. It's displayed of where the red Xs and the black dots are and I have to ask myself well, is that sufficient. The red Xs are, of course, to allow an increase in the crack width to be detected. The black dots to detect the progression of the interface, crack interface. And I'm still wanting some persuasive argument to be made that says I don't need -- again, I'm not suggesting drilling more holes in the containment, I mean in the Shield Building. But why wouldn't I monitor the leading edges of more areas than we are by these black dots, assuming that I don't put that much confidence in measuring the crack width as a means of detecting crack propagation. I really want to know whether there's been recognizable progression which means the black dots.

Why wouldn't I use something else that's readily available and has been used to map those profiles up there already and just require IR to be done to validate what I'm going to find using the points that you've indicated already.

I'm wandering around, but I mean you get my point. Why wouldn't that be a responsible thing to do? I think the answer must be if I can hypothesize it, that it's not necessary. And I'm trying to figure out okay, how do you convince me it's not necessary?

MR. HOOK: Using IRs based upon our inspection results is an option that's available for us and we have used that. I see no reason why we would not use that in the future. So that the primary inspection would be to do the visual inspection of the core bores and then if we find out anything, enter it into our Corrective Action Program and then develop a course of action that could include additional core bore inspection or additional core bores or even IRs. I'm not eliminating. That is a tool available for us. We have used it in the past and I don't know why we wouldn't continue it when it's appropriate in the future.

CHAIRMAN RAY: Well, you've answered my question, I think. I would just say that as we reflect on this it's also an option looked at from our standpoint. The question is should it be more than an option? Should it be a requirement? And so in order to answer that it goes back to the discussions we had earlier which is it's very hard for us to figure out from what we've been able to see well how important is it to detect crack growth which goes to the whole issue of structural analysis and margin and so on. So it's not an easy thing to reach a judgment about. But I don't want to dwell on it now.

We should go ahead, I think, before we break for lunch and make sure we've given you the first go round here to answer the questions any of us has and complete your presentation because there are other topics associated with license renewal than the Shield Building.

MEMBER SCHULTZ: Harold, just to react to what you've said, I would feel better if when you describe that if you find something you're going to enter the Corrective Action Program which you've done in the past, that then you would tell us what you anticipate the program plan would be within the Corrective Action Program to follow up on this. In other words, if this, then that and so on and so forth to determine and convince us that you've got a Corrective Action Program that's going to thoroughly investigate the issue.

The way it sounds, given what you've described, is you may go into additional inspection. You may go analytical. You may use a different methodology or approach in terms of the sampling or the measurement technique. But those are all options, unspecified options. You may go here or there. It would be better if you could identify a program that you would follow to address the issue of a change in information.

MR. HOOK: The program that we follow matches very closely to ACI 349.3-R on how to evaluate that. So we're in Category 3 where we don't have a passive crack. We have an active crack. And that program identifies several options to use which includes testing, analysis, or increase inspection. So if you're looking for what we're doing is that anchored in some code, it is anchored in ACI 349.3-R. And we're following that and we are committed to that as well.

MEMBER SKILLMAN: Jon, let me ask a question here and I'm going to lead with my chin because I feel quite confident saying this. I read the license renewal application. It's 1800 pages. I read your SER 2013. It's 900 pages. I read the supplement SER which is 190 pages. And in the supplemental SER, commitment 46 is implement the Shield Building monitoring program as described in LRA Section B2.43.

If my colleagues and I had the original license renewal application, the original license renewal application stopped at B.41. So there is obviously an amendment to the LRA. At least I didn't see and I got a hunch my colleagues didn't see and based on these questions, I don't think any of us really saw that Shield Building monitoring program which I believe codifies everything you gentlemen have been talking about for the last several hours. So I think we might have missed a key reference in the dozen or 15 documents that each of us probably pored over for the last 6 weeks.

Here's my question. All of the things you've talked about that point us to the ACI codes, these are your CAP program, what actions you will take and when, when you find a leading edge change? Are all of those commitments in your Shield Building monitoring program which is your commitment 46?

MR. HOOK: Tom, you're the Shield Building program owner. Want to hear from your words.

MR. HENRY: Thomas Henry, Shield Building Aging Management Program owner. The Shield Building Aging Management Program does commit us to the inspection of the bores. It commits us to entering the Corrective Action Program. And obviously, we're committed to maintaining our design basis through analysis. Does that answer your question?

MEMBER SKILLMAN: Not quite.

MR. HENRY: Okay.

MEMBER SKILLMAN: Chairman Ray asked a very important question. He said where's the calc that pulls all of this together?

MR. HENRY: Okay.

MEMBER SKILLMAN: Is the basis for the

description of that calc in your commitment 46 Shield Building monitoring program?

MR. HENRY: Allow me to open the program and I will get back to you.

MEMBER SKILLMAN: What I'm really looking for here is we've said -- many of the members have said we would be more comfortable if we knew this stuff was on the record. That commitment 46 is on the record. What is in that commitment? I must say I don't know because I've never seen that program and that could be my failure. And I acknowledge that. But based on my read of all of the stuff that we were given for our prep, I don't believe that program was part of our required reading. I think if it had been, we might have had some different direction in the last several hours.

MR. HENRY: Okay, I'd ask to follow up on what documents have been submitted and get back to you.

MEMBER SKILLMAN: Well, that's only a piece. My greater question is what Harold Ray asked about the importance of that calculation and its being on the record. Is the basis of that calc, the information of that calc attempts to extract part of this Shield Building monitoring program?

MR. HENRY: In my quick review of the Shield Building Aging Management Program, we do not make reference to the calculation specifically. That is a fundamental requirement we have to maintain a design basis conformance for our building.

MR. HOOK: That would get captured, when we do our condition report and we do our corrective action so we have something different in the Shield Building. First thing we've got to do is maintain operability and document that. So we would have to revise the calculation. If the calculation isn't already bounded by that, we'd have to acknowledge that and that's just -- we have to do that to maintain configuration, control, and design control as well.

That's a little different than if we find anything in the plant that's different from the drawing, on any component, we've identified in the Corrective Action Program. We evaluate it based on its impact, the operability, and our design basis. Revise those documents accordingly.

CHAIRMAN RAY: Jon, I understand that.

What I'm really trying to get to here is in this commitment 46, what is in that program such that we can look at that program and understand how we can conclude that for the period of extended operation this Shield Building is acceptable even with the cracks that exist? That's the conclusion that we're going to be asked to make. Is that commitment 46 going to get us there? Because that commitment is on the record.

MR. BYRD: It would. The calculation is, it will be part of our design basis. We're in the process of completing that activity. But going back to what Jon said, the commitment requires us to write a -- put this in our corrective action process. We write a condition report. At the time that's done, we have to -- an immediate operability determination has to be completed with you write a condition report. At that point, if we are not consistent with our calculation, we would not be operable and at that point -- that is what ties the calculation to that commitment. And it is specifically through the corrective action process because this calculation is what would determine our current operability. And we discuss this margin. If you are actually at a point where we couldn't demonstrate we had margin, we wouldn't be operable at that point.

MEMBER SKILLMAN: Thank you.

CHAIRMAN RAY: With that, I think -- let me keep you from moving on for at least another minute. This is awfully hard to deal with because the -- so much of the information that pertains to the issue of analysis methodology is in the domain of the current license. And we're not going to go there. But we need to understand it. That's the problem.

As you know, there was an on-site violation having to do with the code usage and the reference and all of that is explained at length in the inspection report. It concludes saying that you -- I don't remember the exact word, but the implication was that the person writing the inspection report expected you would amend the license to reference the methodology that was used which I believe was found acceptable. But nevertheless, has that been done?

MR. HOOK: We have -- your question was?

CHAIRMAN RAY: Are you going to amend the license?

MR. HOOK: Yes.

CHAIRMAN RAY: Okay, but you haven't yet done that?

MR. HOOK: No, we have not. We're in the process of preparing the written 50.59 evaluations and putting the package together. We fully intend to do that.

CHAIRMAN RAY: All right, but the reason for asking the question is that the approval of the amendment then endorses the methodology.

MR. HOOK: Correct.

CHAIRMAN RAY: And absent that, we are in a situation in which we have to rely on a methodology and analysis methodology that is explained at length as not -- what do I want to say -- not being for the purpose of analyzing crack concrete structures. It can do it, apparently. At least people think so. And that the -- so I'm back to the issue of the analysis, the margin, and so on. And let me tell you why. It's because the notion of how much margin do you really have is something that I don't take as a settled issue. You've taken a position about it. But to me it's not yet settled.

Which brings me to the issue of the use

of IR to add to our confidence that there isn't something undetected occurring because the black dots are really in my mind the things that we are relying upon at this point to tell us whether the crack propagation is occurring in some areas. And by the way, I take for granted that there's non-uniformity here. I mean all you need to do is look at the picture and you can see that although there is some degree of uniformity, there's also a lot of scatter in the data.

So I'm back to the issue of well, maybe that's fine if we assume absolutely that the analysis done to establish the margin is sufficient and complete. But if we wanted to have greater confidence that the crack growth isn't occurring, undetected by monitoring those black dots, then IR would be a way to do that and I just ask if you have any further comment on it I think you've commented sufficiently to say that it's available and that you would use it if you thought conditions warranted.

MR. HOOK: I understand your concern and I appreciate the challenge for that. I really do. I don't want to appear to be too defensive. I'm just trying to tell you what we've done. And I do fully understand and appreciate your comment.

CHAIRMAN RAY: Very good. Well, let's go ahead then and make sure that we've done all we can with you folks and then rather than have the staff start and stop, we'll take a lunch break and resume after that.

MR. BYRD: In that case, moving on, we have one other area and I'm going to keep Jon up here for a few more slides here. And during our previous subcommittee meeting, there were several questions about the containment vessel. We're on the next slide.

Specifically, there was questions regarding groundwater in the sand pocket and what effects groundwater would have on the exterior of the containment vessel. There was also questions about refueling canal leakage and the effects of border water on the interior of the containment vessel and we have done a considerable amount of investigation. Again, I'll have Jon discuss that.

And we also provided an improved slide from what we had in our last subcommittee meeting.

CHAIRMAN RAY: Jon, were you at that last subcommittee meeting?

MR. HOOK: Yes, sir. I was.

CHAIRMAN RAY: Okay.

MR. HOOK: I tried to verbally explain what's in this picture and I failed miserably.

CHAIRMAN RAY: You may remember our present chairman, who is not with us today, had a question about the centering and getting to the lowest point, all that kind of stuff. Now I'm going to have to convey to him whatever it is you're going to tell me, although you're probably going to have to repeat it in the full committee meeting. So let's make darn sure that we fully probe this issue.

MR. HOOK: I think we can do that in a couple of slides. Thank you.

So this slide is a general orientation cross section of the Shield Building. The red circle on the left and on the right identifies the sand pocket area. The sand pocket area goes around the entire perimeter of the foundation. And then the red circle on the bottom is the bottom elevation of the containment vessel.

So next slide, please?

The Shield Building foundation does have a waterproof membrane that extends well above the groundwater table. However, the groundwater is migrating through the opening in this barrier along the outside of the containment vessel and into the sand pocket area.

This sketch is a cross section of the sand pocket. The sand pocket --

CHAIRMAN RAY: Could you show us where the membrane is, please? Or is it out of the sketch?

MR. HOOK: Previous slide. It's along the perimeter, the outside of the concrete.

CHAIRMAN RAY: The outside of the concrete, okay.

MR. HOOK: Right. You lay the membrane down, then you put the concrete on top of that and then you put the --

CHAIRMAN RAY: Okay.

MR. HOOK: So the sand pocket is a notched area, so the sand pocket is this little area right here. This little V, V-notch area. It's 4.5 feet deep, approximately 15 inches wide at the top. And the nominal groundwater elevation is approximately 570 feet. And the bottom of the sand pocket is approximately 562 feet.

So any water that does seep into the sand pocket area would be -- the one thing I do want to point out is that the bottom of the sand pocket area, this area is sloped. It's sloped away so if there's any water that seeps up against the sand pocket area is channeled into two drains which would prevent any standing water being in contact with the vessel.

So to address the effect of groundwater on the containment vessel, during our last outage, our 18 refueling outage, we inspected five areas, five separate areas around the perimeter of the sand pocket area. We took nine UT readings at each of these five areas. Three UT readings were taken three inches above the grout containment vessel interface. Three readings were taken at the grout containment vessel interface. And then three readings were taken three inches below the grout containment vessel interface.

The results came back very positive. All UT readings at and below the grout surface were all above the mil. specified tolerance. So basically, acceptable as is, no degradation for that area.

MEMBER BALLINGER: So what is the mil. tolerance?

MR. HOOK: The nominal thickness of the

containment vessel is 1.5 inches. The mil. tolerance is 1.49 to 1.65.

MEMBER BALLINGER: So what you're saying is it's within the uncertainty of the as-received material.

MR. HOOK: It's within manufacturer tolerance of 1.5 inch thick plate, correct, at all the readings we've taken.

MR. SHACK: Now are you actually getting seepage into the sand pocket? I mean do you get water coming out of the drains?

MR. HOOK: Yes, yes. We go in there every outage and we look at that. We inspect it and we do see damp concrete, some dampness. Sometimes --

MR. SHACK: Standing water?

MR. HOOK: Standing water at a few locations and we sample those -- the water the best we can and take a look at that.

MR. HENRY: Thomas Henry. Shield Building Structures Monitoring and Aging Management Program owner. Just to elaborate on your question, we don't see water from the drains. We see water coming up against the grout.

MR. HOOK: In the trench.

MR. HENRY: Vessel interface.

MEMBER BALLINGER: Well, they better hope you don't get run over by a bus.

MR. HOOK: Okay, next slide, please. So the other concern was associated with borated water leaking from the refueling canal, migrating through the concrete and resting at the bottom of the containment vessel interior. A core bore was located as close to the center line as possible using ALARA principles.

Where did Mr. Ray go?

MEMBER CORRADINI: Mr. Ray is -- I'm taking notes for Mr. Ray.

MR. HOOK: All right. Thank you. So we did a core bore and we did visual inspections of the area. We also took UT readings of the containment vessel. The inspection results came back also very positive. There was no presence of water on the inside surface of the containment vessel and the UT readings that were taken was above the 1.5 nominal thickness value. It actually was 1.59, so again, it was within mil. tolerance for that.

So these inspections not only confirm that there are no effect on the containment vessel from the borated water from the refueling canal, but the UT test also shows there is no effect on the containment vessel from the groundwater from the outside.

MEMBER SKILLMAN: Jon, before you change that slide, that is the entrance into the primary shield from the basement, I guess. Is that what that is?

MR. HOOK: That is underneath the containment vessel and that little notch, the key notch would be like the in-cores.

MEMBER SKILLMAN: Oh, that's the in-core chase?

MR. HOOK: Yes, that notch area.

MR. HENRY: That notched area is the hallway to the normal sump.

MEMBER SKILLMAN: Oh, okay. And so you took bores in the floor at that location?

MR. HENRY: That is correct.

MEMBER SKILLMAN: I understand. Thank you.

MR. SHACK: Can you go back to the pervious slide?

MR. HOOK: To the previous slide?

MR. SHACK: Well, two slides.

MR. HOOK: Yes.

MR. SHACK: Can you tell me there where the core was taken?

MR. HOOK: Well, let's go back to the other one. It was on one of the axes of the center line of the containment. It was dead on and the other axis was eight feet off from the dead on --

MR. SHACK: But it's a long way from the bottom of the -- that last point?

MR. HOOK: It's eight feet.

MR. HENRY: Thomas Henry, Design Engineering. For this layout, as Jon was starting to explain, it is along the center line in one axis for the containment and it's offset eight feet horizontally in the other axis. So we are alongside alignment one axis and just eight feet off on the other axis.

MR. HOOK: For me, it's dead center.

MR. HENRY: As part of that commitment, we did commit to the location of that UT reading being within ten inches vertically to the bottom of that containment vessel.

MR. SHACK: Within ten inches of the bottom?

MR. HENRY: What's what we committed to, yes.

MR. HOOK: In elevation. Bottom dead center. Our core bore was ten inches and higher than bottom dead center.

CHAIRMAN RAY: Okay. So to make it simple, if there was nine inches of water, it would affect areas not seen by the core.

MR. HOOK: By the core.

CHAIRMAN RAY: But ten inches or more would be assuming water seeks its own level, would be within the area examined.

MR. HOOK: Okay, with that, that's all I have, so I will turn it over to Mr. Tim Byrd.

MEMBER SCHULTZ: Just one question with regard to these last two issues. You've investigated and have not found any issues?

MR. HOOK: That's correct.

MEMBER SCHULTZ: Is there any plan to investigate further in time? Is there any rationale to suggest that you should?

MR. HOOK: The one for the refueling canal, I think the commitment was we'll go verify what the condition is right now and then also another commitment was to mitigate the refueling canal and we have mitigated that.

MEMBER SCHULTZ: That's been done?

MR. HOOK: That has been done during 18 hours as well.

MEMBER SCHULTZ: Would you tell us what you found or what you did to mitigate, please?

MR. BYRD: Let's let Trent Henline, the owner of that, speak to those activities.

MR. HENLINE: Trent Henline. I'm the implementation manager. I kind of led the projects to resolve these issues. So my understanding was the first question is did we mitigate the refueling canal leakage? And the answer for that is yes. Greater than 99 percent and we're going to confirm during our spring of 2016 outage there were three primary areas that we historically saw refueling canal leakage.

So during the mitigation efforts and post-mitigation efforts we set up live cameras to monitor these three areas to make sure that we had it. And what we saw was shortly after failing we saw a small amount of borated water. The wall became damp and then a puddle about the size of a cup appeared and then dried up long before we drained the refueling canal. So what we believe happened was prior to mitigation we had filled the canal to move fuel.

We are fairly confident that a small amount of water got trapped between the stainless steel liner and the concrete subsurface. When we filled the canal back up, it pushed that water out. It showed up and then dried up. So this upcoming outage, we're going to go do the inspection, confirm that we got at 100 percent.

If we do confirm that we got at 100 percent, then there's no commitment associated with that particular work to do a follow up inspection or mitigation effort. However, our work at the program, every outage, walk down every room inside containment and would identify any new leakage. If there were new leakage, then we would go back and do a leak search and then mitigate.

MEMBER SCHULTZ: What was done to mitigate the three areas?

MR. HENLINE: Steven, can you go to backup slide 37 and 38?

So we mitigated 99 locations. We utilized operating experience from another utility, as well as leak search efforts that we made, to mitigate every pipe and/or stud that penetrated the liner. So the majority of our leakage, we believe was from the up-ended support plate which you see here and we used a two part silicone and a stainless steel cover plate on these areas.

Like I mentioned, we mitigated all the piping penetrations, the fuel transfer tubes, up-ended support plates as well as the V-bend drain.

Next slide, Steve.

This shows the scope of what we mitigated and these are all primarily in the intermediate and deep end of our refueling canal.

MEMBER SKILLMAN: Back up one slide, please. Is what we're seeing there basically caps that have been applied over the threaded portion of the stud?

MR. HENLINE: That is correct. The caps were filled with two part silicone and then placed over the threaded stud.

MEMBER SKILLMAN: Thank you.

MR. BYRD: Okay, if there's no further questions regarding the refueling canal leakage, we'll go to our closing remarks which should be slide 29, Steve.

So just in closing the application has received a thorough staff review. It's concurrent with interim staff guidance expectations and our implementation efforts do remain in progress.

So going to our final slide, do we have any additional questions?

MEMBER SKILLMAN: Yes, I do, Ken. The 50.59 relative to ANSYS, in the extent of condition for that violation in your CAP program, are there any other incidents where there was a miss on a 50.59?

MR. HOOK: I can answer that.

MEMBER SKILLMAN: Do you understand what I'm asking?

MR. HOOK: Right. That's a newer version and that's the only time we have ever used that. That was one of our contractors who did that analysis for us and that was the program that we chose. It's not used anywhere else.

MEMBER SKILLMAN: My real question is your design team did not account that change as a change in method and that was really the basis of the low-level violation.

My question is in all of your CAP data is there any other incident where the design team missed on a 50.59 call? Any other incident?

MR. BYRD: I think we have -- let's let -- Dennis Blakely is our 50.59 program owner. This will be an opportunity for him to answer that question.

MR. BLAKELY. Is this on? My name is Dennis Blakely. I'm the safety analysis supervisor at Davis-Besse and I've been the 50.59 program owner for approximately the last five years. And I've been involved with it extensively through my 29 years at the site.

To my knowledge, we have not had any misses on 50.59 evaluations that miscategorized the need to obtain a license amendment. We have occasionally failed to go to the evaluation process, improperly screened items out, but when they were taken to the evaluation process, it was found that there was no license amendment needed.

So our most recent 50.59 inspection was held last year and there were some minor violations regarding the completeness of some of the screenings that were done, but no findings beyond this one issue with the ANSYS analysis in the Shield Building work with respect to 50.59 evaluations that were improperly performed.

MEMBER SKILLMAN: Thank you.

MR. BYRD: Thank you, Dennis. Any additional questions?

CHAIRMAN RAY: Okay, hearing none, that

doesn't mean that we're done asking you questions today, but we're going -- you've been patient with us for throughout the morning. We appreciate that. We'll recess shortly for lunch period and I believe the staff will be coming before us then and that may lead to questions.

I realize that when it gets toward the end of the day, understandably, certainly true of us, people start thinking about when am I going to get out of here to go to the airport, but we don't want to have another meeting like this if we can avoid it. So if we have to come back to you, I hope you'll be able to respond. I just can't predict right now whether that will occur.

I'm sure you'll be interested in the proceedings this afternoon anyway. With that said, unless there's anything from the members for me, we'll recess until 1 o'clock.

(Whereupon, the above-entitled matter went off the record at 11:45 a.m. and resumed at 1:00 p.m.)

CHAIRMAN RAY: Back on the record resuming this afternoon the Davis-Besse license renewal proceeding that we began this morning. We'll begin the meeting this afternoon with the staff. We welcome you to the table. Who's going to start for us? Rick? Okay. Thank you.

MR. PLASSE: Okay. As we went through the morning session I slightly modified my thought process on a few of the slides. They're redundant and also based on some of the questioning I took some side notes. I'll try to maybe address some of the issues from the morning.

My name again is Rick Plasse. I'm the license renewal project manager for Davis-Besse license renewal safety review. We're here today to renew the license renewal application as documented in the SER, which was issued in September 2013, and the supplement in August 2015. Here at the table with me on my right is Dr. Thomas, George Thomas. He's a DLR senior structural engineer. On my left is Phyllis Clark. She's a DLR safety project manager. She'll be running the slide presentation for us. And from the region Jim Neurauter. He's a Region III senior reactor inspector. And we also have Benny Jose, who ran the 71002 inspection team, and he is on the phone. And then in the audience, as we said earlier, we have the members of the tech staff who participated in the various aspects of the license renewal review and conducted the on-site audits.

Next slide. This slide is basically redundant to the lead-in from FENOC this morning, so we'll skip that slide.

The next slide is just the facts of we had the SER open items, the final SER supplement in the original Subcommittee meeting, so that's discussed already. We'll skip that one.

The next one on the safety review results. We had the four open items which we've mentioned, and I'm going to go into detail in the subsequent slides. So that's it for that slide.

The next slide, safety review results, the final SER, as we mentioned that issued September 2013, we closed all the open items. And in total there were 44 Aging Management Programs reviewed including 43 programs which were reviewed by the staff during that initial safety review of the application. After the final SER was issued, they had the crack propagation. We ended up reopening the shield building item.

But also as we went through the supplemental SER and the ISGs, a new program was identified for service level 3 coatings and linings and was submitted for review. And staff review and approval of that new program is in the supplement SER, so the number went up from 43 to 44. That's basically all I have on that slide. And this is basically the breakdown of which ones were consistent, which ones had exceptions. And there were 10 plant-specifics.

Next slide, getting into the open items. And Open Item B.1.4-1, Operating Experience, during the review of Davis-Besse OE Program the staff issued ISG-2011-05, which was Ongoing Review of Operating Experience. The open item was identified to determine how Davis-Besse addressed the recommended framework for operating experience review activities in the ISG, and to adjust the ISG in the open item the applicant provided additional information to describe how it will enhance its current AMPs or develop new AMPs based on plant-specific and industry operating experience when necessary to ensure that age-related degradation is managed during the term of renewed operating license.

With that I'd just like to just point a few key attributes of that program as they docketed. It will screen out incoming OE for age-related degradation. It includes an aging flag in both the

Corrective Action Program and the OE Programs. And also the Corrective Action Program is used to revise or develop new AMPs based on the OE evaluations. So there was some questioning earlier.

I think one of the members brought up if they find additional issues with their monitoring program, are they going to change the program? This is kind of the key of the Operating Experience Program. Those things will go into the Corrective Action Program. They'll do extended condition. And if a program needs to be changed: an inspection sample, a frequency, or maybe even a new type of test, that type of thing should logically fall out of the Corrective Action Program. And if you look at the situations, the correct propagation, you can almost see how that played out as an example, if you will.

Any questions on this slide?

MEMBER SCHULTZ: Rick, didn't the open item also, as you described I think just a moment ago, reflect on the program that Davis-Besse did not have associated with examining operating experience across the industry, or are you talking only about operating experience at the site?

MR. PLASSE: No, it's both, but the

first key attribute I just stated, screen out incoming OE --

MEMBER SCHULTZ: Yes, that's what --

MR. PLASSE: -- that would be industry OE that they would put into their Corrective Action System and look at their programs to see if they need to do any tweaks to the programs.

MEMBER SCHULTZ: But you're --

MR. PLASSE: And if I'm speaking out of line, if someone from FENOC wants to correct me, but I believe that's what it is.

MEMBER SCHULTZ: And then you're also expanding to make the comment that in your view this also means or would intend to imply that it ties into the Corrective Action Programs to the on-site operating experience review and how that all functions within the facility and its staff and operations. So, that's providing you with confidence that what -- it described this morning about, well, it would be in our Corrective Action Program and we would respond accordingly and appropriately. That provides you the confidence that this piece of it ties into that and that the overall function would be properly performed.

MR. PLASSE: Yes. In fact, not only

that, we have a checks and balance. I'm kind of going into Part 50, and I have Jim here who can correct me. The regions do a -- part of their normal ROP Program, they do problem identification and resolution, PI&R reviews, where they do focused reviews of the Corrective Action Program to make sure that all those elements are working.

Now that this is part of that program, when they do those reviews in the future they would be looking at that element also because it's now part of the agreed upon program.

MEMBER SCHULTZ: Yes, I understand the oversight, but again, what we were focusing on this morning is to provide whatever additional assurance we could see that the licensee is proactively incorporating, as you've said, the external operating experience and their own operating experience into the Corrective Action Program and the Oversight Program that they move forward with. Thank you.

MR. PLASSE: Yes, that's the intention. And I will get to a point where we will have a slide on the regional inspections over the last three years. And I'm sure there will be some opportunities for Jim to speak, and maybe he can expound on his experience during those activities.

Any other questions?

(No response)

MR. PLASSE: Next slide. Okay. The next slide is Open Item 4.2-1, Reactor Vessel Neutron Embrittlement. For Davis-Besse the applicant performed updated 60-year upper shelf energy calculations for the reactor vessel shell, nozzle and weld components in the beltline region of the vessel. The staff determined that the applicant did not have sufficient plant-specific un-irradiated upper shelf energy data for those beltline welds that were fabricated using Linde 80 weld flux materials.

Under this open item the staff requested the applicant to submit an equivalent margin analysis basis for accepting the upper shelf energy values for these reactor vessel weld materials. To close the open item the applicant sufficiently demonstrated that the EMA basis is given in specific NRC-approved B&W reports. The equivalent margin analysis basis was reviewed by the staff and found to be a valid basis for accepting the upper shelf energy TLAA under the requirements of 10 CFR 54.21(c)(1)(ii). And demonstrating that the upper shelf energy EMA analysis has been appropriately projected to the end of the extended period of operation, the item has been closed by the staff.

Any questions on this particular item?

(No response)

MR. PLASSE: Okay. We'll go to the third open item, the P-T limits, Open Item 4.2.4-1. For Davis-Besse updates of the plant P-T limits are performed in accordance with the tech spec requirements for implementing pressure temperature limit report, or PTLR processes. The applicable tech spec is given as Tech Spec 5.6.4, which invokes the methodology in Babcock & Wilcox' topical report BAW-10046-A, Rev. 2 for performing updates of P-T limits.

The open item is associated with the potential issue that the methods in the B&W report for generating P-T limits may not be conservative if stresses for reactor vessel non-beltline near geometric discontinuities would cause those components to be the limiting components for P-T limit calcs. FENOC resolved and closed the open item by demonstrating that the methodology in the B&W report appropriately accounts for impacts of stress and tenses for non-beltline components including those near geometric discontinuities.

Thus, FENOC was able to demonstrate that the approved methodology remains valid for generating P-T limits that will be needed for the period of extended operation and that this forms an acceptable basis for accepting the P-T limits TLA in accordance with 54.21(c)(1)(iii) in demonstrating that the P-T limit update basis is valid to manage by analysis loss of fractured toughness in the reactor vessel.

Any questions on that open item?

(No response)

MR. PLASSE: Okay. Next slide. Okay. This slide, you know, we're a little unique. Typically when we go through this process the region does a 71002 inspection, and barring a major issue like the shield building, we wouldn't have these four additional inspection reports. Everyone reflected on how complex this is. Normally a review takes two years. We're talking five years now from when the application came in. And then this shield building issue changed over time as different things were identified.

So what I'm going to do is I'm going to run through this slide. The 71002 aspects, they were discussed in a previous Subcommittee, and I'll just kind of reiterate the results of that. The 71002 inspection results support a conclusion that there's reasonable assurance that the effects of aging will be adequately managed. The scoping of the SSCs was acceptable and the documentation supporting the application was auditable and retrievable. And I do have on the phone Benny Jose if anyone wants to go back to that, but --

CHAIRMAN RAY: Well, Rick, what is the reference you just gave us? What are you referring to now in what you just said?

MR. PLASSE: The 71002 inspection, that's the regional inspection that they do where they do a sampling of all the programs. That --

CHAIRMAN RAY: Oh, I was reading down the inspection report, blah, blah, blah.

MR. PLASSE: Oh, okay.

CHAIRMAN RAY: Where is what you said documented?

MR. PLASSE: The four inspection reports.

CHAIRMAN RAY: Yes, I'm just asking. You made a statement --

MR. PLASSE: Okay.

CHAIRMAN RAY: -- and I was trying to know which one of the inspection reports that was reflected in. Is it all of them, or --

MR. PLASSE: No, the 71002 inspection is documented in two reports: 2011-10 and 2011-12. Those are Region III inspection reports.

CHAIRMAN RAY: Okay. That's what I was missing.

MR. PLASSE: Yes. I didn't get to that detail here because my intention was that was discussed in the first Subcommittee and there weren't any issues with it, but I do have Benny Jose on the phone if someone wanted to go back to that. Otherwise, I was going to focus on the shield building --

CHAIRMAN RAY: All right.

MR. PLASSE: -- with the region. That's why we brought Jim to this meeting.

CHAIRMAN RAY: Sure. Okay. Fine.

MR. PLASSE: Okay. So in addition to the 71002 inspection several Region III Part 50 inspections were conducted over the past three years on the review of FENOC activities and resolution of the shield building laminar crack issue. Jim Neurauter, the senior reactor inspector, he was on the first inspection of June 21st, 2012, but he was also the lead for the next three subsequent inspections. We have him here. He can address the activities that they reviewed.

And I took some notes on here of some of the things that came out earlier, and I'd like to maybe -- probably it's a good place to address it here. One of the things of -- a question of -- it seemed like a little bit of -- it was very hard to go through and figure out which of these documents were docketed.

And to go back, I'll start with the timeline. The application, it came in in 2010, August 2010. The original laminar cracks were identified and put into the Corrective Action System in October 2011. By December the regional review -- and, Jim, correct me if I get something wrong here. We had a confirmatory action letter on the issue and FENOC was in the process of doing their reviews and they -- to close out the corrective action letter the 2012 root cause was docketed. So that's how that got docketed. That wasn't docketed in license renewal space. That was docketed in Part 50 space. So that's how that is available for our review.

And then again in our write-up in the

supplemental SER -- we'll fast forward just for a moment to -- the final SER was issued. We intended to have a Full Commission meeting. And they were doing the Monitoring Program. They actually identified the crack propagation while they were performing those activities which we thought were elements of the adequate Aging Management Program at that point in time. That resulted in an apparent cause evaluation, which again was docketed by FENOC to the staff, and we capture that in the supplemental SER on page 3-40. So those two detailed evaluations, technical evaluations, are on the docket.

There are a lot of other activities that are captured in the inspection report, typically in Part 50 space. Inspectors go to the field. They review things and they assess them and they document them in their inspection reports. And so a lot of the other things we talked about this morning, they're not on the docket, but if they were appropriate as part of the reviews that were done by the region, they would be captured in their assessment in the inspection reports.

CHAIRMAN RAY: Okay. Well, let me stop you for a second.

MR. PLASSE: Okay.

CHAIRMAN RAY: At least one of what you just referred to I think is this FACE report --

MR. PLASSE: Yes.

CHAIRMAN RAY: -- the Full Apparent Cause Evaluation. I think that what we were looking for this morning and are still looking for; and reading the latest inspection report of May 28th, the one that's listed there as No. 4, it still seems to me something that we need to look for, is -- although I understand it's in the current licensing basis space. Nevertheless, as I explained this morning, we need to understand that sufficiently to make a judgment about the Aging Management Program. Okay?

MR. PLASSE: I'm going to hopefully get to a little bit of that.

CHAIRMAN RAY: All right. I'm sure you will. But in any event, the cause evaluation that you've mentioned and the other report also we have gotten access to. What is still, at least in my mind as something I'm trying to nail down, is how did we reach the conclusions that we reached recognizing that they were only dealing with the current licensing basis? I understand that. That's very clear. But how did we reach those conclusions, because that will help us then decide how to decide that the Aging Management Program in the future is appropriate.

MR. PLASSE: Okay. That's a good segue to my next --

CHAIRMAN RAY: Good.

MR. PLASSE: -- aspect I was going to address on this slide. The supplemental SER, it's about 17 pages of logic to that answer.

CHAIRMAN RAY: Very dense 17 pages, I must add.

(Laughter)

MR. PLASSE: Yes. Well, I mean, as we spent the whole morning, it is not an easy subject. So I think that's kind of part of that reason.

If you look at logically how any AMPs -- we kind of organize them pretty much the same, but this one being more complex and getting into the concrete issue. It's very detailed. It changed over time and there were sets of RAIs based on what we understood. And we weren't dealing with this -- and the reason I make a key point of bringing up the inspection reports -- and also the regional administrator letter with their conclusions from their point of view captures all these inspection reports, because it's all material to their reasoning and their logic. We didn't work in silos.

Whenever we wrote RAIs based on the information we were getting through Part 50 and from FENOC, my people here; George's group, would communicate with Jim's group. They would look at each other's work. We would send the RAIs to the region. The region would send them back. And the same thing that you mentioned in the May 28th report -- I wasn't on the project in the previous years. I came on this project in around the end of March. And one of the first things that came to me was the May 28th draft report, which was reviewed by the DLR tech staff. And so we were all kind of coupled together as we went through the process.

So even though the Part 50 -- there's some blurred lines, the elements that are material to the decision that we made are logically -- and as complex as they may be when you first read them, they're logically put together in the supplemental SER in Section 30339. Basically, in the beginning there's the lead-in of the technical evaluation.

Then there's a staff evaluation section. And it grabs all the RAIs through the process and what was the staff driving to at that point in time based on the information and the technical issue as they understood. And then the responses were responded to as FENOC understood the issue at those periods of time. And then we go through all the other AMP elements in logical sequence and then come to the conclusion.

And someone brought up the application says Commitment Authority 6, but that was like done in 2010, or whatever, and we've had all these things. Well, that's true, but in the conclusion of the supplemental SER all those RAIs and all the changes, whenever they changed the program, and whatever elements of the program going forward are captured in the FSAR update. So, yes, there's lots of parts. Actually for this whole process over five years there's 59 license renewal application amendments, and all those amendments had something material. Some of them may have been minor. Some of them were other issues. But a lot of them were related to the shield building. And those things are all captured in the logic of the supplemental SER as it sits here. And then the conclusion is based on that.

CHAIRMAN RAY: Okay. Let me interrupt

you --

MR. PLASSE: Yes, go ahead.

CHAIRMAN RAY: -- and try and get a little more focus here, Rick, on what I think we're struggling with.

Let me read something from the May 28th inspection report.

MR. PLASSE: Okay.

CHAIRMAN RAY: Once again I'll say this has to do, I know, with the Part 50, but nevertheless we need to understand it so that we can do our job.

It reads, near the bottom of page 7, "Hence, it appeared to the inspectors that the original design codes were no longer applicable to the current condition of the shield building. Therefore, the inspectors questioned if laminar cracking in proximity to the outer face reinforcement was a condition not in conformance with the current design and licensing basis."

Okay. That question gets asked and answered outside of our footprint, but how it is answered is important. And I can't figure out how it was answered so that we can then take that and project it into the future and ask ourselves whether the Aging Management Programs are consistent with the answer to that issue that I just read.

MR. NEURAUTER: Is that not the section where we gave them enforcement for the 50.59 that they need a license amendment?

CHAIRMAN RAY: And I asked about that this morning, as you probably know, what the status of that was. And so, the thing that that leaves is, well, however that ultimately is processed and resolved is potentially an issue that affects the Aging Management Program. And how do we opine on the Aging Management Program absent that resolution?

Now in fairness, the report goes on to say that we think this is okay, that it goes on to reach a conclusion that the -- here it talks about the licensee completed two corrective actions to reestablish the design and licensing basis of the shield building laminar cracking, the implication being that we agree with that. But it mostly talks about what the licensee did. It doesn't talk about what we did as an agency other than to recognize that they had taken this corrective action and so on.

So I just wanted to tell you that because I don't think what Rick is talking about or summarizing goes to the issue that is most troubling at the moment, which is, okay, we're satisfied that it's okay. Just tell us how we got there. And that way then we can say, okay, that's the basis on which we're satisfied today. And understanding that, we can make some sense out of the Aging Management Program.

MR. THOMAS: Yes, this George Thomas. With regard to the first question whether laminar cracking is covered under the current ACI code, it is not covered with regard to the effect of the cracking on the bond capacity of the rebar. And therefore, to address that the licensee did some lap splice testing at two universities for crack widths that exceeded the current extent of cracking. And further, that's captured in the Acceptance Criteria Program.

CHAIRMAN RAY: Well, the issue of the effective cracking on the rebar, the interface between the concrete and the rebar is one issue, of course that's true.

MR. THOMAS: Right.

CHAIRMAN RAY: It's not the only issue, I wouldn't think.

MR. THOMAS: But finally there are three

concerns: One is structural capacity. And with regard to capacity it's the bond between the rebar and the concrete. Second, the cracking could affect the stiffness of the structure specifically with regard to dynamic response and loading like seismic. And the applicant has in Part 50 space evaluated that in their structural calculation.

CHAIRMAN RAY: And does this inspection report cover our review of that analysis?

MR. THOMAS: No, that will be the subject of a future license amendment.

CHAIRMAN RAY: Well, okay. I won't ask you to solve this problem, but that leaves us with the problem of, well, it's going to be analyzed sometime in the future and yet we're taking action now presumably.

MR. THOMAS: Right. So based on the current evaluation they have a valid operability determination.

MR. PLASSE: I apologize. I try to address things; I got a little bit off the plan, for the next few slides. And then we'll get into the details of the whole --

CHAIRMAN RAY: Whatever you say, Rick. That's all right. Go ahead.

MR. PLASSE: Okay. All right. Next slide, please. This slide is just giving an overview of what's in the SER supplement in the logic of what we have in there. Basically, the first item -- well, the applicant updated its plant-specific reactor vessel internals AMP and submitted the Reactor Vessel Internal Inspection Plan in late April 2015. That was a commitment required two years prior for NRC review and approval. It was also one of the license conditions. The AMP and the Reactor Vessel Internal Inspection Plan are based on conformance with the recommended sampling-based inspection evaluation criteria in MRP-227 for B&W design reactor internals.

The staff found the reactor internals AMP and the Reactor Vessel Internal Inspection Plan to be acceptable because: (A) for internals conforming to the generic design in MRP-227 the applicant will be implementing the approved protocols; and (B) for components deviating from the generic design the applicant appropriately adjusted the AMP and the Reactor Vessel Internal Inspection Plan in a manner that was found to be acceptable to the staff. Thus, the prior license condition for this AMP in the final SER was closed in the supplemental SER.

In addition, as we kind of mentioned this morning, several ISGs came into play, so updated information and commitments in response to the recent industry operating experience were captured in the supplemental SER. Also, there were three annual updates in the last three years which the staff addressed as appropriate changes to some AMR items and some TLAs.

And as I had mentioned earlier, for the coatings ISG an new plant-specific program, Service Level III Coatings and Linings, was captured. And as the applicant had mentioned this morning, they replaced their steam generator. So that was a major rewrite because the steam generators had different issues. So basically, for the steam generator replacement the design mod results and some changes resulted in TLA changes: a number of metal fatigue, evaluation TLAs for the specific steam generator components and aux feedwater system components. The staff found those TLA changes to be acceptable based on the new steam generator design. And those updated evaluations of the TLAs were appropriately accounted for in the updates of Section 4.3 and 4.7.

The next several slides will discuss

additional items that were commitments completed specifically on the steel containment vessel and improvements to the FAC Program based on another recent OE event.

Next slide. This item we discussed this morning. Commitment No. 39 related to the ASME Section 11, Subsection IWE AMP. The applicant committed to address the potential for degradation of the steel containment vessel due to borated water leakage from the refueling canal by taking the actions they discussed this morning.

The results of those inspections were documented in a letter June 23rd. It was Amendment No. 50 in the annual update. They stated that they had completed Phase 1 of the commitment during the cycle 18 refuel outage. The performed core bores to access the inside surface of the containment vessel and conducted UT measurement of the exposed plate. Core bore concrete and rebar samples were assessed in a concrete lab for borated water degradation by visual exam, concrete petrographic exam and compressive strength testing. The core bore interface vessel less than 10 inches above the low point.

Results were satisfactory as they showed no visual evidence of borated water in the concrete or degradation of the shell due to borated water at the location of the bores. And the containment vessel core segments were in good condition. No boron observed. Rebar surfaces in contact with concrete did not exhibit corrosion. Core compressive strength showed values above specified design strength. And UT thickness of the plate was above the nominal of 1.5 inches. That commitment, that was Phase 1. That specific exam was Phase 1 of Commitment 39 and the staff documented completion of that in the supplemental SER.

There is a similar core bore assessment which will be performed in 2020. That's Phase 2. And that still remains in the FSAR supplemental.

Any questions?

(No response)

MR. PLASSE: Next slide. This also was discussed earlier this morning. This is the sand pocket region inspection, Commitment 35. Again, it was Phase 1. And basically it had the same results. They completed the Phase 1 during the same refuel outage. They performed UT of the outer surface of the containment vessel in the sand pocket region. UT results were consistent with previous UT of the containment vessel. They were above calculated min design thickness requirements per the code and were determined to be acceptable. The staff reviewed that and show that as complete in the supplemental.

And again, there is another Phase 2 still in the commitment list in the FSAR and it will be repeated prior to the end of 2025.

Any questions?

(No response)

MR. PLASSE: That's it for that item. The next slide, they did have an event in May of this year, and it was an OE that had resulted in some changes and additional commitments on the Flow-Accelerated Corrosion Program, the FAC Program.

In May 2015 a four-inch elbow immediately downstream of an orifice in the moisture separator reheater second stage reheater vent pipe failed. It resulted in a steam leak that led to a rapid shutdown of the unit. The steam leak damaged several non-safety-related cables and caused actuation of the fire suppression system that wetted several motor control centers.

The upstream orifice was modeled as a three-inch inside diameter, whereas the actual orifice size is 0.859 inch. The incorrect modeling of the orifice occurred in the original model developed in the '87-'89 time frame.

For the FAC Program the initial LRA discusses another event in 2006, which was a steam leak in a different part of the moisture separator reheater system. That event identified incorrect modeling of the two-phase portion of the system downstream of a level control valve. The corrective actions, according to the LRA, stated that they would improve the documentation on quality of the software model and to include a second level of verification for entering data into check works.

The staff looked at this event earlier and felt comfortable with the applicant's corrective actions because the problems appear to be limited to a specific aspect of the FAC modeling. As a result of the recent event NRC staff asked the applicant to update it's OE and to address any additional implications for the FAC Program. The applicant provided a supplement to the LRA with new discussion about the FAC OE and a new commitment with several actions to improve and maintain the fidelity of the data in the FAC. The staff determined those actions to be acceptable. It's documented in the supplement SER and the additional commitments are documented in there.

Any other questions on that event?

(No response)

MR. PLASSE: With that, we'll go to the --

CHAIRMAN RAY: We don't have questions because we have read them and they seem fine.

MR. PLASSE: Okay. Now, we'll go through the shield building again. This first picture just -- it shows the building. It shows the architectural -- the flutes.

Next slide. We saw -- again, some of this may be redundant, but some of it is good to refresh. The illustration on the left is a sectional elevation view showing the free-standing containment vessel, the shield building surrounding. And there is a four-foot-six-inch-wide annulus space between them. The shield building cylindrical wall is 30 inches and the dome is 24 inches. The height of the shield building from top of foundation to the dome apex is approximately 280 feet.

The illustration on the right shows a cross-sectional plan view of the shield building's cylindrical wall with the eight monolithically constructed architectural flute reveals that consist of shoulders protruding 18 inches outward from the shell and gradually tapering back into the outer cylindrical wall.

And the functions of the shield building. As stated this morning, the environmental protection for tornados and missiles, biological shielding and controlled release of annulus atmosphere through emergency ventilation system under accident conditions.

Next slide. Here's a blow up of the architectural flute shoulders and also a crack comparator on the right-hand side. So this is -- again it's -- the architectural flute feature of the shield building was provided for basically aesthetics. It's not specifically for additional design aspects. And as stated before, there's two protruding areas from the shell called the shoulders, one on each side for each flute.

Hairline laminar cracks were discovered in fall 2011 on the outside adjacent to the outer horizontal reinforcement of the cylindrical part of the wall, and it's indicated in red. These cracks are primarily in the flute shoulder regions. The crack comparator on the right of the slide is provided as a perspective of the crack width of the observed hairline cracks. The max cracks widths observed were 10 to 13,000th of an inch and the majority of the cracks in the 5,000th of an inch range and smaller.

The structure implication of the laminar cracks is that it could potentially affect the bond capacity between the concrete and the rebar that ensure proper transfer of stresses between the concrete and the rebar. The most critical location being where the rebar is lap spliced. The critical parameters affecting the bond or splice capacity is the crack width, which is the limiting parameter, and also the length. Note the rebar --

CHAIRMAN RAY: Well, let me interrupt you for a second because of what you just read. The picture shows and your statement indicates that the cracking is in this shoulder region. And you indicated that the cause of concern would be the bond between the concrete and the rebar. I think you have as a backup, but just recalling the slide that FENOC presented in which there are colored areas -- were they red or whatever color they were. Anyway, that seems to me to indicate that in some cases, particularly at the top, the cracking extends across and outside of the area that's captured by the shoulder rebar, I'll call it.

So the reason for me saying this, Rick, is that it seems to me that it's not -- and maybe I made this comment this morning, too -- it's not just a question of the bonding between the concrete and the rebar, but it's the retention of the concrete as part of the structure that can become an issue, because although if the cracking is inside that V-shaped region, presumably it's captured then by the fact that it's behind the shoulder rebar. But there is some, as I see it anyway, that's outside that or, looking at this picture, to the right of where it's shown here.

So the question then becomes, okay, is what you've said still true even if the cracks propagate beyond where they're behind the shoulder rebar?

MR. NEURAUTER: When the licensee did their splice testing capacity, they had about a five-inch concrete cover.

CHAIRMAN RAY: Concrete cover over what?

MR. NEURAUTER: Over the top of the splice.

CHAIRMAN RAY: Well, but I'm asking if there's any cracks that propagate into a region in which if the concrete were to separate from the outside wall to the crack -- if that were to separate from the building, would it still be retained by that rebar cage that's anchored into the building there? We talked about that this morning.

MR. PLASSE: My last sentence -- you want to read the last sentence and I'll let you do it.

CHAIRMAN RAY: Yes. All right.

MR. PLASSE: Go ahead.

MR. THOMAS: Yes, as I indicated the majority of the cracking is in the shoulder region, and there are some areas in the --

CHAIRMAN RAY: You have to turn so that the microphone will pick up your comments.

MR. THOMAS: Okay. So majority of the cracking is in the shoulder area. And as you see, the rebar are laying in there. The shoulder rebar, they are tied into the main shell and they're anchored using standard hooks, and therefore they provide confinement to the concrete. Even if the crack propagates further into the shell, that rebar does provide support to that. In the worst case there may be some color that may start. It should be indicated in regional inspections.

CHAIRMAN RAY: Yes, I think that's right. You would certainly see it. And there may be some. I just can't see how you can say all of the concrete that may be detached as a result of the crack -- all of it is captured by that shoulder reinforcement, because the map shows that some of the cracks extend beyond that point. So you're saying to me, I believe, that notwithstanding that any spalling that took place would be detectable and not a hazard, not significant.

MR. THOMAS: Right, and also it's a continuous structure, so there is support provided by the adjacent regions, too.

CHAIRMAN RAY: Well, I understand. I think what you're saying is that even a cracked piece of concrete is attached to other concrete further out that isn't cracked, but I think we're --

MR. THOMAS: Yes, and part of --

CHAIRMAN RAY: -- stretching a little bit here in terms of what we're imagining would happen.

MR. THOMAS: And for it to spall off will have to be some other degradation going on.

CHAIRMAN RAY: Say that again, please?

MR. THOMAS: For it to spall off --

CHAIRMAN RAY: Yes, like an earthquake, for example.

MR. THOMAS: Well, it's unlikely, but possible.

CHAIRMAN RAY: Well, in this Committee we deal with things that are unlikely.

MR. THOMAS: Yes.

CHAIRMAN RAY: Not just things that are likely.

MR. THOMAS: Right. And, yes, even falls off it will be locally pieces of it falling.

CHAIRMAN RAY: All right. Go ahead.

MR. PLASSE: Any other questions on this slide?

(No response)

MR. PLASSE: Next slide, please. As the applicant noted, the hairline laminar cracking was discovered in the fall of 2011 in multiple locations adjacent to the outer horizontal reinforcement of the shell primarily in the flute regions with some cracking outside the flute shoulder in the top 20 feet and around the main steam penetrations. These regions outside the flute shoulders are areas of dense reinforcement. The applicant determined and characterized the extended condition by NDE testing using the impulse response technique and additional core boring. The blizzard of '78 involved extreme environmental conditions with sustained high winds, heavy rain and very low temperatures.

The applicant's root cause concluded and the staff found acceptable cracking was initiated by the following combination of factors: rapid freezing and expansion of moisture driven into the concrete from the extreme conditions during the blizzard, lack of an exterior protective sealant or coating on the shield building, an inherent stress concentration associated with the design configuration of the architectural flute and the rebar arrangement and density. The above combination of contributing factors was unique to the shield building which provided a reasonable explanation for the staff concern why cracking occurred only in the shield building.

Although the root cause determined the initial cracking was event-driven, the staff was concerned that the degradation could grow and potentially affect the safety function, therefore it should be monitored during the period of extended operation. To address this concern the applicant submitted a plant-specific AMP, the Shield Building

Monitoring Program, to monitor and manage the effects of the laminar cracking through the PEO.

They also applied an exterior protective coating between August and October of 2012 as a preventive corrective action to reduce future moisture ingress, and the coating applied are acceptable because they are qualified per ASTM standards, Delta 6904 for the walls and Delta 7311 for the dome, and are capable of resisting moisture intrusion and weather conditions present during the '78 blizzard.

That's the background. Any other questions?

(No response)

MR. PLASSE: Okay. The next staff would capture chronology from the '78 blizzard when the crack was identified, the root causes. The three items in red were the three products from DLR.

During the review the staff asked several rounds of RAIs, which are documented in the documents. As we stated, the Shield Building Monitoring Program was first proposed in April 2012. It was in response to an RAI, B2-39.13, which the staff then issued follow-up RAIs, B2-43.1 through 3. And these RAIs sought additional details and clarification on the coating qualification, the crack monitoring, specific acceptance criteria, frequency in inspector qualms and the scope of the program.

At the time of the first ACRS Subcommittee the applicant's response and revised program dated August 16th was under staff review. The applicant addressed further follow-up RAIs where staff requested additional information to support scope of program, inspection sample size, impulse response testing and why other structures were not susceptible to the cracking.

Based on the program that was last revised in the applicant's November 20th, 2012 response and response dated February 12th, 2013 that addressed why other structures were not susceptible, the staff documented acceptability of the program in the final SER, which was dated September 2013.

Subsequently, the additional OE, the staff became aware of in August and September 2013 inspections that identified indications of crack propagation for which staff requested additional information related to the impact of the OE on the structure's Shield Building Monitoring Program. And this was documented through RAIs B-2-43.4 issued in

April of 2014.

The applicant evaluated the inspection results based on which changes were made to the program detail related to inspection sample size, frequency and locations and provided a revised program that incorporated the operating experience as provided for in an original program and its response dated July 3rd, 2014.

The staff had further follow-ups. They're RAIs B2-43.5 through 8 related to the characteristics of the representative sample, adequacy of opportunistic rebar inspections and evaluation criteria and quantitative acceptance criteria. That last RAI response was provided January 28th, 2015, following which the staff documented in the evaluation in the supplemental SER. So all those RAIs are addressed in the evaluation section of 30339.

CHAIRMAN RAY: Okay. Now, let me -- maybe this is where you meant to ask to wait until.

MR. PLASSE: Yes. Okay.

CHAIRMAN RAY: in which of these, or in something that you've referred to previously such as the inspection reports, do we indicate how we concluded that the structural analysis was acceptable in demonstrating both the acceptability of the current condition and to define the margin, which is really what I'm interested in, against where that would not be the case? Where does that show up?

MR. NEURAUTER: Back in 2011 when the condition was first discovered the licensee did an evaluation to demonstrate that the shield building would perform its safety functions. We did not consider that to be a design basis calc. It was performed with very conservative assumptions with respect to the rebar bond strength in proximity to a laminar crack. And staff in the region and in headquarters reviewed it and determined that the licensee had provided reasonable assurance that the shield building could. But again, it was not a design basis calculation. That precipitated the CAL to understand why the cracking took place and chartered the licensee to do a root cause evaluation to determine the cause of the cracking.

Part of the corrective action out of that root cause evaluation was to perform testing for re-bond strength. And in 2013 the licensee completed that. They also completed rebar mapping -- or excuse me, impulse response mapping and put that into what they call a design calculation that we reviewed -- started to review in 2013. And at that point we questioned whether or not this calculation needed to be reviewed as a part of a license amendment. So there was margin in that calc that the licensee used rebar splice strength from tests and the condition of laminar cracking identified up to 2013, which was prior to the identification that the cracks were propagating.

So at this point in time, yes, we still consider the shield building to be functional and capable of performing its design basis functions but not conforming with this design basis, and reestablishing the design basis would be performed as part of a license amendment.

CHAIRMAN RAY: Okay. Well, I don't want to imply that I'm questioning the accuracy of the condition present either, but I thought you might go back to that 2011, and I was hoping you'd say what you did, which is we can't really tell from that -- again if I'm taking -- well, what is the current foundation upon which we rely to assure that we're in compliance with the licensing basis? And then from that project in the future and say, well, how critical is it that we -- how much margin do we have, how important is it that we monitor for any increased cracking and so on?

That's the piece that just escapes my ability to run it to ground. I don't think it's in any of that list of stuff up there and it's only touched on really in the inspection report that you and one other person wrote. And so I believe it is the case that we're awaiting that license amendment, its review and approval. That's my judgment. I may be wrong, but that's what I've come to now.

MR. NEURAUTER: That is correct.

CHAIRMAN RAY: Okay.

MR. THOMAS: Also, if I may add, in the May 28th inspection report that the previous operability was further substantiated with the new design calculation and rebar splice testing.

CHAIRMAN RAY: Well look, there's been a lot of testing done. My God, I don't know of anything I see that has more data to refer to. That's not my point. My point is who has reviewed it on behalf of the Agency and concluded independently of the applicant, yes, this is a satisfactory and complete update to reflect the condition of the plant as it is?

MR. THOMAS: Yes, the region inspected

it and they made a determination that it needed a license amendment.

CHAIRMAN RAY: Well, and I think that was supported not just at the region level, but that's another matter perhaps.

In any case, I don't hear anything that changes what Jim and I just agreed was the case.

MR. THOMAS: Right. Well, the program incorporated an acceptance criteria with regard to the crack width, which is the current observed maximum. And that crack width still has margin based on the lap splice testing. And the region did inspect -- that that's part of oversight.

MR. NEURAUTER: I agreed that the licensing basis has not been reestablished at this time. And until it is we can't say 100 percent how much margin they have within the design calculation until that is established.

CHAIRMAN RAY: Yes, that's all I'm trying to --

MR. NEURAUTER: And I would agree with that.

CHAIRMAN RAY: That's the only conclusion I'm trying to come to. It has been a struggle to get there. But in any event, I think that's the conclusion that one has to draw from what at least we've been presented. And all the discussion of the cause of the cracking, the cause of the crack propagation, what has been done to define the extent of condition today, all of that's relevant, but I don't have any problem with any of it. I'm just trying to figure out -- like I said, when we look at the Aging Management Program, what is our frame of reference in terms of what's needed? And so, unless anybody's got anything to say more about that; and I welcome them if they do, but we can go. I just want to get it clear where we are. Okay?

MEMBER POWERS: Is there any doubt that we'll be able to reestablish the design basis?

MR. NEURAUTER: In the inspection report we didn't have a technical concern with what the licensee did. It was a process concern, whether or not it needed a license amendment or the region could inspect it. And we had a TIA, a Technical Interface Agreement, and headquarters concurred that what the licensee did was a change in method of analysis that required prior NRC review. And as you found this morning, the licensee is preparing the documents to submit a license amendment request to have headquarters review it.

MEMBER POWERS: So there's no major doubt?

MR. NEURAUTER: Well, no, the only doubt would be would the staff agree with what the licensee did and do they have to derate rebar strength or just what? But eventually they're going to come to, yes --

MEMBER POWERS: Some agreement will be reached?

MR. NEURAUTER: -- some sort of an agreement with the licensee.

CHAIRMAN RAY: Anything else on this point? Otherwise, we can continue.

MEMBER POWERS: I mean, I just recall our experience with Beaver Valley where they had a failed containment and were asking for license renewal. That did not fly with the Committee because they had a failed containment, a non-functional containment and there were questions about whether it could be rendered functional successfully. And so the Committee was not about to give a license renewal on something where there was doubt. That doesn't seem to be the case here. It seems like a functional containment exists and it's just a matter of knowing what that functionality is.

CHAIRMAN RAY: Yes, and of course in this instance the containment vessel is separate from the shield building, which is what we're talking about. And so, that may also be something that would result in less concern. But I don't know enough -- the process I think, as the region has outlined it, is the correct one, as I understand it. I have no expectation that it won't conclude successfully, but I think you have to go through the steps. And the reasons for going through the steps are clear enough. I can think of one or two analyses, one of which I'm going to have to chair one of these days if it ever gets back on our agenda in which -- an analysis methodology that everybody swore up and down was totally correct. Turned out to be wrong. And there were a lot of people who were confident in it. So, that's just where it is right now, and I just want to be clear enough about that.

Back to you, Rick.

MR. PLASSE: Okay. Next slide. We're going to go through the program now. The Shield Building Monitoring Program is a plant-specific prevention and condition monitoring program to manage aging effects; for example, propagation on the shield building laminar cracking. The program supplements the original Structures Monitoring Program. The preventive aspect is the application of the coating.

The scope of the program includes the concrete and reinforcing steel of the shield building's cylindrical wall and exterior concrete coatings on the shield building. The program uses periodic visual inspections using a bore scope of the interior surfaces of a representative sample of core bore holes, currently a minimum of 23 selected from 80 existing core bore holes, to monitor the shield building for new indications of laminar cracks and/or changes to existing laminar cracks. Visual inspections using a bore scope are appropriate because it can measure crack width, the detection of laminar crack propagation during baseline inspections and the fall of 2013, provides proof that visual inspections are effective. The AMP has provisions to supplement visual inspections with NDE techniques such as impulse response testing if necessary for extended condition determination noting that impulse response testing cannot measure crack width.

The program conducts opportunistic visual inspections of rebar near laminar cracks for corrosion indications when exposed for whatever reason. The staff found opportunistic inspection of the rebar acceptable to manage aging effects of potential rebar corrosion near laminar cracking because, one, inspection of rebar in areas of laminar cracking in the construction opening in fall of 2011, over 30 years after the laminar crack initiation, did not indicate degradation, chemical analysis of water samples from within the cracks showed pH greater than 10 indicating an alkaline environment, mitigating nature of applied coating and limiting the ingress of moisture, oxygen or other deleterious material required to sustain a corrosive environment. And the lowest elevation of laminar cracking is at least 31 feet above grade precluding any interaction between potentially aggressive groundwater environment and laminar cracking.

Visual inspections conducted under the Structures Monitoring Program and Shield Building Monitoring Program are capable of detecting indications of corrosion such as surface staining, cracking or spalling of the shield building exterior or in the core holes. The coatings are visually inspected for loss of effectiveness at an interval of five years, which is consistent with recommendations and industry standards and reapplied every 15 years. Inspections under the program are conducted and results are evaluated by personnel meeting qualification requirements of Chapter 7 of ACI Report 349.

Any questions?

CHAIRMAN RAY: I think you used the word "proof" in there somewhere, Rick, if I heard correctly; I was diverted here for a second, about the fact that the bore holes detected growth in cracks, showed that they were effective. Is that right? Did I hear you correctly?

MEMBER BALLINGER: I think he said the IR approach doesn't tell you crack size.

PARTICIPANT: You're referring to the 2013 findings.

CHAIRMAN RAY: Yes. Yes.

MR. PLASSE: Yes, it said the detection of laminar crack propagations during baseline inspections in the fall of 2013. Well, maybe proof -- evidence --

CHAIRMAN RAY: Proof --

(Simultaneous speaking)

MR. PLASSE: Yes, provides -- well, evidence. Evidence would probably be a more appropriate word.

CHAIRMAN RAY: Yes, I mean, I just thought that was a little stronger than --

MR. PLASSE: Yes.

CHAIRMAN RAY: Because crack propagation could have occurred without it being detected in a bore hole in that case.

MR. PLASSE: Any other questions?

(No response)

MR. PLASSE: Next slide. Okay. We're getting into operating experience program element. The operating experience program element includes provisions to evaluate and incorporate future plant OE such as inspection findings and industry OE is applicable and necessary. During the baseline inspections of core holes conducted in August-September 2013 the applicant discovered unidentified cracks indicative of laminar crack propagation in 8 of the total 80 core holes inspected. The applicant's apparent cause evaluation characterized this 2013 plant OE to be the result of ice wedging mechanism, which is the freezing and expansion of free water at a leading edge of preexisting laminar cracks.

The applicant determined that for this condition to occur requires preexisting laminar cracks, trapped water in the cracks and freezing temperatures. The application of exterior coating was designated as a contributing cause because while the coating application effectively prevented external water from entering the shield building, its application also prevented a finite amount of water from leaving the structure and thereby provided the water accumulation in the cracks.

The applicant evaluated the OE using a three-tier evaluation criteria in Chapter 5 of the ACI 349.3R and determined that the condition was not passive and will be monitored at increased frequency but bounded by the design basis documentation.

CHAIRMAN RAY: I would like us to look at that more, that reference, ACI, here more specifically. How is that conclusion reached using that ACI?

MR. THOMAS: The backup slide 6.

MR. PLASSE: Backup slide 6.

MR. THOMAS: This is George Thomas. The program -- this is -- it evaluates the inspection results against the evaluation criteria shown in this figure from ACI 349.3R. And basically you see the first tier and second tier.

CHAIRMAN RAY: What are these criteria, George?

MR. THOMAS: Yes, these are some evaluation criteria to evaluate common degradation that are commonly occurring in structures, like surface cracks or spalling.

CHAIRMAN RAY: Cracking, for example? Is that one of the --

(Simultaneous speaking)

MR. THOMAS: Laminar cracking is not covered in the quantitative criteria. And with that crack the criteria also says that it should be passive, which means there is no recent growth and there's no active degradation mechanism. So in evaluating the inspection results of the laminar crack propagation it indicates that condition is not passive. And therefore it goes into the tier three criteria, which is conduct further enhanced inspections, testing and analysis. And following which the condition could be accepted after evaluation or it could result in one of the other options shown there.

So the applicant evaluated the condition and determined that it was acceptable after further evaluation with regard to the structural adequacy. But because it was not passive, they also went into the three options given: repair, monitor at increased frequency and replace. So in this case it was decided to monitor at increased frequency. And therefore the frequency of inspection was adjusted in the program.

CHAIRMAN RAY: Okay. So this basically just led to that conclusion that it needed monitoring at an increased frequency. It didn't address the kind of cracking specifically that we have here.

MR. THOMAS: Yes.

CHAIRMAN RAY: That experience.

MR. THOMAS: Yes, that again was done in the further evaluation, the structure evaluation that was conducted by the applicant.

CHAIRMAN RAY: Yes.

MEMBER SCHULTZ: George, the hierarch that you're showing here, this is a generic approach --

MR. THOMAS: Correct.

MEMBER SCHULTZ: -- that allows you to

follow the pathway?

MR. THOMAS: Yes, it's a procedure.

MEMBER SCHULTZ: And it's used as a procedure. It's used in many applications. And here as you've described it, you talked about how it can be applied to this particular evaluation?

MR. THOMAS: Correct. And --

MEMBER SCHULTZ: And what you've said is that it followed itself all the way down to the bottom of the chart indicating that increased frequency of monitoring would be appropriate?

MR. THOMAS: Correct.

MR. PLASSE: And that kind of leads into the final discussion on this slide. They did do the review. We talked earlier about how they went from 20 to 23 to include 3 monitoring bores to identify changes to the limits of cracking. They also increased the inspection frequency. Since the observed propagation is not considered passive the inspection interval will now be annual from 2015 to 2018. Then it will increase to every two years from 2018 to 2026, and four years thereafter.

The interval is increased only if no aging effects; i.e., indications of new cracking or propagation of existing laminar cracks, are identified. Changes to the inspection schedule, sample size and locations and parameters monitored will be evaluated if aging effects are identified. And the staff found the inspection interval for core hole inspections acceptable because they are conservatively biased and increase progressively only if no aging effects are identified.

MEMBER SKILLMAN: Rick, what did the staff base that judgment on? Why are those frequencies acceptable?

MR. THOMAS: The annual inspections -- typical inspection frequencies recommended in ACI-349.3R is five years. And since propagation was indicated, an annual frequency is considered reasonable and conservative.

MEMBER SKILLMAN: And it's once each two years, or once each one year?

MR. THOMAS: It will be once every year for the next four years. And then it could be increased to two years, but only if no aging effects are found.

MEMBER SKILLMAN: Okay. Thank you.

MEMBER SCHULTZ: George or Rick, can you describe what you believe is intended by the licensee as the improved strategy for monitoring crack propagation, the last part of bullet 3 here, the strategy. How has that changed and why is the new strategy more acceptable than what's been done in the past?

MR. THOMAS: Yes, well, the inspection results were evaluated and that indicated crack propagation. And the licensee added three more cores to the sample to capture the leading edge of crack propagation.

MEMBER SCHULTZ: Doesn't that go to increasing the sample size?

MR. THOMAS: Yes, it did.

MEMBER SCHULTZ: I'm trying to understand what is meant by the strategy for monitoring has changed, is improved. Is that what's intended by the last phrase?

MR. THOMAS: Yes, one was increase in inspection frequency.

MEMBER SCHULTZ: Yes.

MR. THOMAS: And they also evaluated the locations and some adjustments were made.

MEMBER SCHULTZ: Okay. But how does that relate to the strategy? They have a better database upon which to base their judgment if changes are in place? Maybe the licensee could respond.

MR. THOMAS: Yes, request the applicant to --

PARTICIPANT: Could you mention again what you're focusing on?

MEMBER SCHULTZ: I'm just focusing on what the staff has indicated are the improvements to the program, which include sample size, frequency and strategy for monitoring propagation. And I'm wanting to understand what the improvement is with regard to the strategy for monitoring crack propagation.

MR. HOOK: Okay. I'm Jon Hook. I'm the design engineering manager. And what we added was we added additional -- like Mr. Thomas said, we added three new core bores to monitor the leading edge of the crack based upon our previous inspections where we believe the crack was actually happening. We wanted to capture that and make sure we monitor that progress.

MEMBER CORRADINI: So can I just ask one follow-up question to Steve's?

So you don't view the IR approach as a useful tool in the strategy as trying to decide where you do the -- I don't want to say where to put the bore in, but where to look further to determine where a crack may be or going?

MR. HOOK: IR is an important tool that we use to get a more global view, but we still need core bores to establish where is the crack --

MEMBER CORRADINI: No, that part --

MR. HOOK: -- and the thickness? So that's --

MEMBER CORRADINI: That part I get. What I'm trying to ask is something slightly different. I'm trying to understand what you lead with that gives you a leading indicator, although not necessarily quantitative as much as you'd want, but it gives you a leading indicator of where to look further. And I --

MR. HOOK: Core bores. Core bore inspections.

MEMBER CORRADINI: Okay. Not the IR?

MR. HOOK: That's correct.

MR. THOMAS: And in this case the application did some additional IR to update the extent of condition.

MEMBER CORRADINI: So, can I try it a different way, because he's going to ask a technical question. I'm still trying to figure out the strategy. I'm trying to decide what you do first that leads you to do something second that then follows on. I think that's where Steve was going with this and I'm trying to -- so the core bore is the thing that you would lead with that gives you the indication. And only then would you employ -- only then is staff expecting the applicant to employ the IR to do further -- what's the thinking of the staff in this regard?

MR. THOMAS: That if there's a discernible change in core --

MEMBER CORRADINI: Say again, please?

MR. THOMAS: If there's a discernible change in the core bore condition.

MEMBER CORRADINI: Where do you have the -- so let me just push one more time, then I'll stop. What if you put the core bore in the wrong place? Wouldn't the IR be the logical qualitative mapping to decide where to go and drill again, or in addition? Excuse my English. In addition. That's where I'm struggling in the logic. I think the -- well, maybe others aren't, but I am.

DR. SHACK: Why don't you go to the next slide?

MR. PLASSE: Yes, the next slide -- I

think there's a lead in the next slide. The adequacy of the sample size and strategy location of the inspection core bore is discussed in the next slide.

MEMBER CORRADINI: Okay.

MR. PLASSE: So let me go to that slide. So on this slide the minimum representative sample size of 23 core holes to be inspected in their distribution is --

MEMBER SCHULTZ: I'm sorry, Rick, to interrupt you there, but you call it the required minimum. And how was that established that there should be 23? Is there some evaluation that was done to determine 23 is appropriate? Did the staff validate -- it was proposed by the applicant and the staff agreed that 23 is appropriate? Just trying to understand.

MR. THOMAS: Yes, it covered areas with high prevalence of cracking. It covered the flute shoulders, it covered the cylindrical region where cracking was observed beyond the flutes, as well as it covered the area around the penetrations.

MEMBER SCHULTZ: So those are the types of arguments that were developed to indicate that -- it's not that 23 was determined to be adequate.

It's that the appropriate coverage is attained by these sample holes?

MR. THOMAS: Correct.

MEMBER SCHULTZ: And it matches up with their strategy and they've got some with and some without.

MR. THOMAS: Correct. They have --

MEMBER SCHULTZ: That I consider to be appropriate.

MR. THOMAS: Yes.

MEMBER SCHULTZ: It's not that 23 was statistically significant or anything like that?

MR. THOMAS: No.

MEMBER SCHULTZ: Okay.

MR. THOMAS: No.

MEMBER SCHULTZ: Thank you.

MEMBER BALLINGER: The problem I have is the words "representative" and "strategic." Okay? The 23 was a result of the analysis, period. So nothing is representative for strategic. It's just what they had.

Now, going forward how do you know that these bore holes, which you're going to use going forward, are representative and strategic? How do you know, how do we know that there's not going to be another rainy day?

MEMBER POWERS: I thought they had 80 bore holes, or something?

MEMBER BALLINGER: Well, yes, they have 80, but they got 23 that they're -- they're going to check 23.

MEMBER POWERS: I understand they're going to check 23, but the implication is this is the only 23 they have. They in fact have 80.

MEMBER BALLINGER: Oh, that's right. I take that back. But beyond 23 hasn't been mentioned.

DR. SHACK: Well, let me just come it at a different way. Minus the highest prevalence of cracking, we don't have that figure in front of us, but as I recall there were like three samples up in the region with the most cracking and the rest of them were all concentrated down in the region with the least amount of cracking. It was cracking, certainly, and there was propagation there, but again, there were vast regions of pink up at the top with a very limited number of samples.

CHAIRMAN RAY: Just to add to that, Bill, there was an argument put forward that water would migrate downward and therefore --

DR. SHACK: The usual thing that we do with most of your inspections is you always look for the bounding location, that if somehow this is the most fatigued susceptible location, this is the worst place for erosion corrosion. That's the only argument we've heard today that this is in fact the worst location.

MR. PLASSE: I think we touch upon some of that, if I get a chance to read --

DR. SHACK: Okay.

MR. PLASSE: -- the rest of the slide. You guys are just looking at the bullets. But let me just kind of read the details, and I think we cover some of that.

The minimum representative sample size of 23 core holes to be inspected and their distribution is acceptable because, one, they include 14 cracked core holes that cover 8 of 10 flute shoulders with highest prevalence of cracking, 4 in the upper 20 feet of the shield building and 2 at the main steam penetrations, which are areas with cracking outside the shoulders, and a range of observed crack widths including maximum observed, as well as those that define the leading edge of observed propagation. Two, they include nine uncracked core holes which are located near areas of known cracking providing ability to monitor for crack propagation. And three, the program includes provisions for expansion of sample, consideration of past evidence of crack propagation and choosing inspection locations and for addition of new core holes for inspection if needed to bound crack propagation limits.

Further, each representative bore in a sample provides information regarding crack characteristics; i.e., width and planar limit, which helps monitor maximum crack width and/or planar propagation. The staff notes the sample consists of core holes that define maximum observed crack widths as well as planar propagation limits, therefore the program includes appropriate monitoring and trending of the limiting crack width parameter to effectively detect aging effects of potential crack propagation on the bond capacity of the adjacent rebar which is the primary structural concern related to laminar cracking.

MR. THOMAS: And the approximately five cores they had in the top, it did include the core with the maximum crack width that was observed so far. And it did include one or two that were uncracked. And there was larger number in the lower levels because that's where the propagation was observed. And the sample consists of a range of crack widths. So the crack width parameter is monitored as well as un-cracked, which enables detection of propagation in the planar.

MEMBER BALLINGER: We're beating this to death here. The thing that comes to mind is I'm old enough to know what happened when BWR pipe cracking started. It was only in the four-inch-diameter pipe. It was never going to happen in the larger diameter pipe. Then it happened in six-inch-diameter pipe. And we swore up and down that it would never get any further than that, but ultimately we ended up replacing all the piping. Still hung up on being able to find the rainy day if we guess wrong going forward with the inspection program. And that's what we're all dealing with.

MR. THOMAS: Yes, actually based on the robust design and construction, which is currently yet to be resolved -- but the original operability determination was done very conservatively, and therefore there is significant margin. And the intent of the program is aging effects should be detected prior to loss of internal function. And because there is significant margins, you need to see significant change in the crack condition before internal functions are affected. And therefore, it will show up at least in one of the 23 cores. And if propagation or change in condition is indicated, the program has provisions to expand the sample, which they did in the last inspection, too.

CHAIRMAN RAY: George, you used the phrase "significant margin" three times there. That's what I've been talking about. And I'm just trying to figure out where you get that --

MR. THOMAS: No, the reason I --

CHAIRMAN RAY: -- conclusion from.

MR. THOMAS: The reason I say is their initial operability determination assumed that the rebar is not affected.

CHAIRMAN RAY: Well, you're back -- now you're just focusing on the rebar, and you're talking about something that, as far as I know, the Agency hasn't bought off on as to the methodology and so on. So I mean, I think you should qualify the statement about significant margin so that at least it says what you're basing that on.

MR. THOMAS: Yes, well, it's based on the operability determination.

CHAIRMAN RAY: By?

MR. THOMAS: By the applicant.

CHAIRMAN RAY: By the applicant. So you just say that, based on the margin that the applicant determined.

MR. THOMAS: Right.

CHAIRMAN RAY: I think that's what you mean, unless I misunderstand you.

MR. THOMAS: That's it, yes.

CHAIRMAN RAY: Okay.

MEMBER BALLINGER: And have they looked at the uncertainty in the calculated margin? In other words, is it a deterministic calculation? Do we know -- we have this much margin, right? What's the --

MR. THOMAS: Yes, the operability was based on a worst case situation. Because of the cracking that other horizontal layer of rebar is not affected.

MEMBER BALLINGER: Maybe I'm missing something, but to do the seismic analysis they had to assume the availability of the rebar and its effectiveness for doing that. And so at some point they said if the cracks were to grow 100 feet; that's the number, then we would have to do a reanalysis of the system including the seismic analysis. So the margin gets eaten up somehow. So the conservative one didn't work when you considered the seismic. Am I reading that wrong?

DR. SHACK: I don't think that's quite right.

MEMBER BALLINGER: What?

DR. SHACK: Well, I got confused here because there are so many analyses going on, but I think there's -- the first operability analysis was the very conservative one that had no bonding on the splices. That's what they used basically with the condition as is. Then they did an analysis taking into account the results on what the actual rebar resistance was based on the lab tests. And then they could expand the cracking by 100 feet and demonstrate that it was okay. So I think there's those two analyses. So you got to keep in mind the one that was done for the operability is the very conservative one, but it has a somewhat more limited amount of cracking involved. The second one has the much larger expanse of the cracking. I get confused, but I think that's correct.

MR. NEURAUTER: That's what I heard this morning.

DR. SHACK: Yes.

MR. NEURAUTER: We have not reviewed the second calculation. We reviewed partially a calculation that had extent of cracking in 2013 before crack propagation was expected.

DR. SHACK: Okay. But still a limited amount of cracking.

MR. NEURAUTER: Well, an analyzed amount of cracking. And the calculation had margin with respect to rebar strength and concrete strength. So the licensee would argue that they had margin -- put margin in that calculation to account for limited crack propagation.

MEMBER SCHULTZ: George, I think where you were was you were saying that if the applicant finds anything in the inspection going forward, as they said this morning, if it finds anything, looks in any of the holes and finds any change, then that will be input to their Corrective Action Program and the program either be addressed or expanded in order to figure out what is happening.

MR. THOMAS: Yes, that's correct.

MEMBER SCHULTZ: That's what you understand.

MR. THOMAS: That's correct.

MEMBER SCHULTZ: And then the second point is in only one instance that I understand, which was in the spring of 2012, did they look at what they had already bored and did not find a change. Otherwise, in 2013 and as they've gone forward every time they've looked they found something different. So I think we can expect that this is going to continue to evolve in some way. Perhaps it won't, and that would be wonderful, but I think the Corrective Action Program could be quite active in this area over the next --

MR. THOMAS: That's correct.

MEMBER SCHULTZ: -- several years.

MR. PLASSE: Any other questions?

DR. SHACK: There's not necessarily any notice to the NRC though when they find something if it's just going into the Corrective Action Program, obviously. Is this somehow different from other items that end up in the Corrective Action Program?

MR. NEURAUTER: The resident inspector gets all of the CRs that the licensee -- or not -- applicant -- licensee in Part 50 writes. And if it's significant, they flag it, and in this case would go to the region for assistance.

MEMBER SKILLMAN: Would they come to the

region for assistance based on an inspection protocol, or would they do that because of the history of this issue?

MR. NEURAUTER: Well, this issue is very high-profile --

MEMBER SKILLMAN: I understand that.

MR. NEURAUTER: -- and I've been on it since 2011. And if the resident senior -- he's been on it also. So if he sees something that he needs help evaluating, he has no hesitancy in coming to the region.

MEMBER SKILLMAN: Okay. But to Dr. Shack's question, there is not an automatic toggle to region by the resident. It is at this point up to the resident to make the determination that he should speak with region.

MR. NEURAUTER: That is typical, yes.

MEMBER SKILLMAN: I think maybe the underlying question is because of the importance and the visibility of this should there be more than just an on your honor discussion with region by the resident?

MR. NEURAUTER: I can bring that back to the region to discuss.

MR. MILLER: This is Chris Miller. If I

could just speak.

MEMBER SKILLMAN: Yes. Sure, Chris. Yes.

MR. MILLER: The resident is the region. I mean, a resident is the on-site focus for the region and the resident is required to review the condition reports on a daily basis, and then reviews the ones that are significant and brings in additional assistance. And the part you're talking about is additional assistance, but that's part of the program. There's also an evaluation. I think we're still doing that in the ROP, right? We're doing an evaluation of the Corrective Action Program. So that would be another toggle where they would get to review those.

And certainly the significant ones are the ones that have to be reviewed in that program, in the Corrective Action Program. So you have a couple of different ways of looking at that. There's also some inspection opportunities with the 71003 and they would follow on the 71003 Program. So there's a number of different opportunities where the region could get a more detailed look, but the resident is the first step and is a representative of the region.

MEMBER SKILLMAN: I understand that. Thank you.

MR. PLASSE: Next slide. This slide does cover the acceptance criteria and it kind of addresses what we were just talking about. When they do their inspections and they find items, if -- the acceptance criteria is in the slide -- if they're not met, the findings are evaluated in the Corrective Action Program for conformance with the design and licensing basis documents. Since this condition is considered not passive, the laminar cracking will be subject to increased frequency monitoring until determined to be passive and continuing ongoing monitoring during the PEO by the Shield Building Monitoring Program. In addition, as they stated, when they put in the corrective action and the extended condition, they may change their inspection frequencies in the future.

The long-term monitoring program did identify crack propagations during 2013, which demonstrates the program is effective in identifying aging effects of the laminar cracks. And based on the review throughout these slides the staff's concerns on potential aging effects of laminar cracking during the PEO had been adequately addressed.

Other questions at this point?

CHAIRMAN RAY: Well, I think we've pretty well exhausted it. We'd be repeating ourselves, Rick, to go through the same things over again. Does this complete your presentation?

MR. PLASSE: Yes, pretty much. I mean, the next slide is based on the review the staff concludes there's reasonable assurance that the aging effects of shield building laminar cracking will be adequately managed during the PEO by the Shield Building Monitoring Program such that the intended function of the shield building will be maintained.

And then the final wrap-up slide, the next slide. On the basis of its review the staff concludes the requirements of 54.29(a) have been met for the renewals of the Davis-Besse license. So that's pretty much --

CHAIRMAN RAY: All right. We are going to take one more break this afternoon. We are going to afford -- is there something funny I said? Is it morning still?

MEMBER CORRADINI: We're on a roll. I thought we --

CHAIRMAN RAY: I see. We want to afford the licensee/applicant an opportunity to make any further statements that they wish to make. We have a member of the public who's asked for an opportunity to make a statement here in the room. And we have the bridge line still. And then there's time for discussion among the Subcommittee members.

So all of that will take place after a break that we'll take now. We'll recess until five minutes to 3:00.

(Whereupon, the above-entitled matter went off the record at 2:37 p.m. and resumed at 2:59 p.m.)

CHAIRMAN RAY: Okay. We're back on the record. Now, I indicated before we broke for our final recess of the day that the first thing after we got back would be to afford FENOC an opportunity to make any comments, add anything they wanted to say given that they've now been a party witnessing the discussion we've had this afternoon, there may be things that they'd like to add or even questions that they want to pose for us to consider. So with that, please proceed.

MR. BYRD: All right. Thank you. First of all, I wanted to address one specific question that we had been getting an answer for and that was regarding the uncertainty we had the question about from Mr. Ballinger. And I think Dr. Chiu has the information regarding that, if he could provide that please.

DR. CHIU: Thank you. Chong Chiu of Performance Improvement International. The data was taken with a Sensirion probe, humidity probe at Colorado. And the data uncertainty is 1.8 percent. Probe Number 75, I think, Model 75.

CHAIRMAN RAY: So that deals with one of the parameters, I guess, that would go to the total uncertainty?

MEMBER BALLINGER: Yes.

CHAIRMAN RAY: Okay.

MR. BYRD: All right. Thank you, Dr. Chiu. Now, the next thing I wanted to talk about a little bit more generically was the entire issue of the impulse response analysis. And we recognize the concern that the Committee has regarding the use of the impulse response analysis. And we have used impulse response analysis when we have identified changes in our cracks or changes in crack widths or changes in propagation. And we've used that in localized areas, although that is not specifically required as part of our aging management program. So based on the concerns, sir, we understand the concern and we'll take that back and look at the potentials we would have for making that part of our program as far as having some impulse response potentially to use in specific areas if we identify changes in the program. It is something we have been doing and we don't see any reason why we couldn't make that a part of our program.

CHAIRMAN RAY: Well, you can certainly address that at the full Committee meeting if you wish to put something on the record --

MR. BYRD: All right, your honor.

CHAIRMAN RAY: -- as to what the details of your intent --

MR. BYRD: We'd need to go back and work through that, but --

CHAIRMAN RAY: I understand.

MR. BYRD: -- I understand your concern and we are doing it so we don't have a --

CHAIRMAN RAY: I understand.

MR. BYRD: -- significant problem with that. The third issue I think is really the one that's been a complicated struggle for us is on the analysis and the margin of the analyses. And I heard a lot of comments and I know it's very hard to understand. I think Dr. Shack, very correctly, outlined how our analysis were done in the last exchanges. We did have the initial analyses, which we -- where we disregarded or neglected the reburn in certain areas. That was for operability. That was the basis for operability.

Subsequently we have done design calculations, which we are intending to submit under the Part 50, which will be the design basis for our building. Those analyses are the ones which we can discuss where we do have significant amount of margin in those calculations. Even at the current crack growth rates, we would have a margin for an extended period of time. We currently, before we even have to do reanalysis, it would be over ten years at the current crack growth rate.

So we're -- at this point, there is a substantial amount of margin within those analyses which gives us time to take additional actions and it's an indication of the robust nature of the design of the building. And that's really the -- just trying to reiterate where we are with that. It's a complicated topic and I'm not sure we were very clear in some of our discussion on that. And that may be partly something we could have done better.

CHAIRMAN RAY: But this -- I'll just say, yes, it is complicated, but the simple analogy I would use if somebody said that they were in compliance with a particular section of the ASME code with regard to the pressure boundary part, everybody would know right away what they meant because it's something that's endorsed in 50.55(a) or whatever. And this is complicated in the sense that we don't have a methodology that has that status. And it's made worse because parts of it seem to go back, as the inspector indicated, all the way back to 2011, there are different stages in which the analysis has been done and so on.

I don't know at this point sitting here now what the best way for us to get our arms around that is. I'm hopeful that we can simply say, well, that's going to be put to bed in an amendment that you're going to submit and it'll be dealt with before the period of extended operation occurs and that's it as far as we're concerned. And quit having to try and understand it. The problem is, though, that, as I've said repeatedly, the extent of the margin can really only be determined after the

Agency has endorsed the methodology by which the margin is determined, okay? That's the only time that it can really be relied upon unless we want to undertake, ourselves and the ACRS, and it is not a practical thing to do, to independently review everything that has been done to come up with a determination. So, we need that to occur.

I'm confident it will occur before the period of extended operation. And my task is to try and build in some way that, that takes place such that it supports the aging monitoring program that is what we're actually looking here or it's consistent with it. If the aging monitoring program, for example, depends on a really big margin like you just described, but at the end of the day, the margin isn't that big for whatever reason I can't imagine, but just bear with me, if that were to be the case, then there would be a mismatch between what we thought was the case and what it actually turned out to be subsequently.

So we have to overcome that. We're not going to overcome it by our ability to independently review and agree with the analysis that's been done under these circumstances. It has to be, the methodology has to be adopted by the Agency and then we can rely on it as the means by which the margin is determined. So, with all of that having been said, it's something I would simply observe, I'm not trying to give you any input here, I'm just observing that, that milestone, that point at which the methodology that's used for the structural analysis of a structure with these particular crack phenomena, is something that is yet to happen and we will have to rely upon it happening at some point in the future when you make your submittal. And I think that's doable, but I just have to figure out how to do it.

While I'm on that subject, one thing I'd like you to address, and I think you can readily do this -- by the way, can you put up our famous picture with all the -- does anybody know how to access it and do it? Can you get there on to --

MR. BYRD: Could you help us here please?

CHAIRMAN RAY: Does the staff have it? Okay. Because I want to use that for a second to make one more comment as long as I've got the microphone. Ta da. Okay. We observe, for reasons that are well understood, where the laminar cracking is predominate. And they're in the shoulder areas as we know. And the mapping indicates they're pretty uniform in some of the shoulder regions. The question, which I don't want you to attempt to answer now unless you feel you must, but I'd prefer you think about it, is simply, you look at that and you say, well, what's holding those shoulder pieces in place is the rebar? It's not any remaining -- when I say the shoulder pieces, I'm just talking about the long strips that are shown there in red, and I realize there is a transition and they're attached beyond the cracks, and I appreciate all that.

But just as a limiting case, if a large section of the shoulder fell off because those hooks that go back and hold it into the building fail for some reason, is there anything critical that they would impinge upon? It's not got to do with the structural integrity of the building, that's not the issue. The question is, if they were to detach and fall away from the building, would they create a safety problem? And you don't need to say, well, that will never happen. If you can say, well, they won't hit anything that's going to cause an accident or create a safety problem, that then means we don't have to worry about if it were to happen. So that would be the best outcome.

But they are large areas in which, at least as portrayed here, there is a separation between the outer portion of the reinforced concrete shoulder and the building itself. It doesn't contribute to the integrity of the building or anything, it's just a question of if that were to come off because the reinforcing steel corroded unrecognized and there was a seismic event, for example, that imposed inertial loading on that reinforcing steel and a section of it fell down, would it hit anything safety significant? Now that's -- I just ask you to consider that. I wouldn't think that we ought to engage in, well, that can never happen kind of a discussion here now because I'm just trying to deal with a limiting consideration in this way and get it out of the way.

MR. BYRD: Well, I won't attempt to answer it right now fully, because you asked me not to. But we did consider this, obviously we had to. And this was something we considered very early on when we identified cracking back in 2011. And the answer is, yes, it could impact components that are safety related.

CHAIRMAN RAY: Feel free to expound.

MR. BYRD: No question about that. We

have, first of all, the auxiliary building, which you can see clearly on this picture is safety related. And so having concrete falling on top of the auxiliary building is definitely impacting a safety related structure. We also, on that area to the left-hand side, we have our boring water storage tank, which is safety related. And obviously if we had large sections of concrete falling off the building, that would also effect the boring water storage tanks. We recognize that potential right in the beginning when we identified this condition.

Which is why we specifically had an analysis done, which was part of our operability, that looked at the potential that if this were fully cracked all the way through and we weren't getting any kind of -- would these things actually come loose? And that was evaluated and we do have that and I think Jon Hook, if you can add any more about that particular analysis, because that was part of our initial operability.

CHAIRMAN RAY: Go ahead, take whatever time you want.

MR. HOOK: Okay. It was part of the initial calculations that we started up with. We were concerned about that, like Ken indicated, that if it were to fall down. And that's where we focused on the rebar. So those rebar are one inch diameter rods, they're spaced every 12 inches. So every foot, there's a rebar that holds it in place. And again, we looked at that analysis, specifically during a seismic event because that's the only thing that it would really cause it to fail. And then there's adequate load carrying capacity in those one inch bars spaced every 12 inches to keep the shoulders intact.

CHAIRMAN RAY: Okay. So, that's good. I mean, I think that is on the record as responsive to something you've looked at. We didn't pick it up in anything that we read and so it came up as a missing issue. One inch is a fair sized rebar when talking about a lateral inertial load. So, that's fine for now.

MR. BYRD: Thank you.

CHAIRMAN RAY: Thank you.

MEMBER SCHULTZ: Let me just pull that thread a little more. If that separation were to occur, then those one inch or those one foot on center one inch rebar would then be, if you will, in sheer and bending, putting a cantilever load back on the shell. Is that part of your operability determination?

MR. HOOK: Right. What we looked at for the rebar, the rebar takes tension. It doesn't -- we looked at it as a solid mass and there's enough anchorage in there so, for tension, for peeling away, we looked at that. For dead load capacity, just sitting there, that would be sheer. And it was acceptable for that as well.

MEMBER SCHULTZ: What I'm really getting at, Jon, is there's now a prime moment that is applied once that slab of concrete is "disconnected", it tries to tear out of the anchor, which is through shield building circular shell.

MR. HOOK: For the overturning, though, you've got a huge moment arm. If you were going to take the whole shoulder as a rigid mass and then want to peel away, then up on top, it only sees tension. You've got a big take out moment for that. That was part of the analysis that we looked at.

MEMBER SCHULTZ: Okay. Satisfied my question, thank you.

MR. BOLES: And just a couple comments from me. We do understand the comments desiring a stronger resolve to use the impulse response testing as Ken referred to, to characterize changes and help ensure no other changes are occurring. We'll certainly re-look at that. The methodology that was used to determine the structural functionality of the building, as mentioned, has not been given staff approval for this specific case. But we do see that as a, not as a technical concern, but as Mr. Neurauter mentioned a process issue.

We are in alignment on that. We think the technical aspects of that will clear all reviews. And lastly, I'd just like to say on behalf on First Energy Nuclear Operating Company and Davis-Besse team that I'd like to thank the Committee for the dialogue and the engagement today. We appreciate the insights that have been provided and we look forward to continuing through this process.

CHAIRMAN RAY: Well, we'll look forward to a full Committee meeting. We'll be in communication with you about which items we think should best be touched on there. It's, of course, a much shorter meeting. But there are members who will be part of the decision making who will need to be briefed in a much more succinct way than we've done today. Hopefully they won't have questions that we subcommittee members can't respond to if necessary.

MEMBER POWERS: Yes. They will have to -- the Committee will have to get the full-blown view. I mean, not just this one aspect of it, but the entirety of the thing. So it's very compressed.

CHAIRMAN RAY: You need to talk fast. But we do it all the time. So it'll work fine, I'm sure. Okay. Thank you very much, if you don't have anything else? All right. Okay. Now, I'll ask staff if there's anything more they want to say before we turn to members of the public.

MR. MILLER: No, thank you. I appreciate the review and the discussion.

CHAIRMAN RAY: Okay. The bridge line is open, but before that, I believe, let's see if I'm correct, we have a member of the public here, Mr. Kamps, in the audience, who wishes to make a public statement. Okay, thank you. Each of the subcommittee members, I believe, has been given a series of documents that we were provided by Mr. Kamps. And let me just say again, sir, I don't know if you've heard me, I've, for various reasons, said it a number of times. We're here talking about license renewal, not the current license. And, therefore, we'll take whatever comments you have, but I just wanted you to understand that's what we're about is the --

MR. KAMPS: Right.

CHAIRMAN RAY: -- renewal of the license, not the current licensed operation. Please, go ahead.

MR. KAMPS: Very good. Thank you. My name is Kevin Kamps with Beyond Nuclear, based here in Takoma Park, Maryland. But I'm also on the Board of Directors of Don't Waste Michigan. And both groups, as well as others, are engaged in the license renewal application proceeding at Davis-Besse. We filed an intervention on December 27, 2010, and it's still underway. It was mentioned earlier today that we're also a part of the Nuclear Waste Confidence Appeal to the Federal Courts, which applies to this proceeding as well. And so, that's all still in process. And thank you for handing out the materials to the members of the Committee here today. These are documents that have been generated in the course of this proceeding.

The first one that is entitled Davis-Besse Atomic Reactor: Twenty More Years of Radioactive Russian Roulette on the Great Lakes Shore essentially is a history of the near misses that have taken place at this atomic reactor. And it's fair to say, to the best of my knowledge anyway, that Davis-Besse has had more near misses than any other single atomic reactor in this country. And just to drive that point home, I don't think I included it in this backgrounder, but I was in Kiev, Ukraine in 2006, that was the 20th anniversary of the Chernobyl nuclear catastrophe, listening through a headset to a Ukrainian gentleman, a whistleblower from the Chernobyl Nuclear Power Plant, speaking about his experiences there. And so, I was getting the English translation.

And I heard him say Davis-Besse out loud before I heard the translation. And he was -- this was a Chernobyl whistleblower speaking, his point was, it's not just RBMKs that we should be talking about here. There are other reactors in the world that have problems. Let me tell you about Davis-Besse. And his point was about the hole in the head fiasco of 2002 that had just taken place four years earlier. So that's the main point of that handout, is that this atomic reactor has had a lot problems, some very serious problems, some very lucky breaks.

And the radioactive Russian roulette part is the lining up of all these risks. And that is what prompted our coalition of groups to intervene against the license extension. Our members on the ground there, Phyllis Oster is the individual who got Beyond Nuclear standing in this license renewal application proceeding. She intervened against Davis-Besse before it was built. And the cracking issue has been quite illuminating in that regard because the first documented crack that we found out about in the revised root cause analysis in mid-2012 was documented in 1976, August of 1976 cracking at the dome, a different kind of cracking. But that was over a year before the blizzard of 1978.

So that's kind of a segue into the second document I wanted to touch on. And the title here -- by the way, the date of the second document is August 2012. What Humpty Dumpty Doesn't Want You to Know: Davis-Besse's Cracked Containment Snow Job. So the snow job refers to this theory of the blizzard of 1978 as being the root cause. And First Energy and its legal team were quite effective in the license renewal application proceeding before the Atomic Safety and Licensing Board Panel in denying any age-relatedness to this cracking, throughout 2012, throughout 2013, and halfway or more through 2014, where we had at least a half dozen major filings where we were trying to say, hey, this is aging related and deserves a hearing in this license renewal application.

So the snow job is that -- I really encourage the, and you'll find it in here, documented to some extent, this is a summary, but the requests for additional information that staff generated in late 2011 and early 2012 that we had to FOIA and we got that FOIA return, at least partially, in June 2012, the NRC staff really generated 27 areas of potential root cause. Not just one, not just the blizzard of 1978, but some that come to mind right now included the blizzard of 1977, which was another bad one. Another one was that cracking I mentioned at the top on the dome. That was a very serious one. That was a top-down, water flow infiltration pathway that staff was concerned about. Another one that I'll bring up, I don't remember if it was in the RAIs, another source of moisture in the shield building, in the walls, is a wicking mechanism from this standing water in the sand bed region.

So, the potential -- I mean, it's kind of been bragged up, what we call the whitewash of

2012, this weather sealant that was applied 40 years too late, I should hasten to add that, that is what locked the water in the walls, it can't get out, so it's dammed up behind the walls. And this ice-wedging crack propagation was caused by the only corrective action taken in response to the cracking, which is very ironic. So there's a lot of history here.

From the NRC RAIs, there are 27 potential root causes. Something we tried to get across, not very effectively apparently, in the license renewal application intervention is, what about synergistic effects? And so, it wasn't until July 2014, two and a half years after First Energy knew about the water locked in the walls, that we found out about it, in this full apparent cause evaluation, the FACE. And so, guess what, yes, it is aging related. It's getting worse with time. And I heard one of the First Energy spokesmen today put out a figure, perhaps I can't remember it clearly now, but I thought he said, an inch of cracking growth per year.

Well, I think it very much depends on the weather. So it's every freeze, thaw, freeze cycle. And remembering from July 2014 the revelations, there were some figures in there of something like 5.5 inches per year of crack growth. It depends on how many of these cycles take place in a given year. And we've been having some pretty wild weather in the Great Lakes. It wasn't just 1977 and 1978, it's 2014, one of the most severe, record breaking winters in a very long time.

So, I would like to thank the Committee for its coherent questions today. Certainly, the rate of crack growth is very significant. I think just attending this session today, for me and I've been involved in this for many years now, clarified some things. Things that have been obscured throughout this process. If you were at the January 5, 2012, Camp Perry meeting down the road from Davis-Besse, it would have been very unclear to the 300 members of the public who were in the room that night that this spalling of major sections of the shield building was even possible. So it's been very difficult to swim through the public relations obscuring versus the technical issues for all these many years.

I'm glad that it was said very clearly that concrete falling on safety related structures could be a problem at Davis-Besse. I think it's also a public relations problem for the company, at the very least, that this building is literally falling apart with age. And it gets -- I think another point I wanted to make today is, there has to come a point, and I know that NRC's regulations are very byzantine and very strict by design, that in a license extension proceeding, you can only deal with the license extension, but these management failures, these failures of quality assurance, date back to the 1960s now.

Because that's when the decision was made by Bechtel Corporation and the companies involved that a weather sealant need not be applied. And as Congressman Kucinich said, I think it was in late 2011 or early 2012, everybody in Northern Ohio knows, you need to paint your porch or it is going to fall apart after a certain number of winters take place. So, there has to come a point, there has to be an area at this Agency, and perhaps it's the ACRS, where some of these basic, safety related questions get addressed.

And I remember the ACRS that included Ed Teller on the Fermi 1 Reactor proposal where they said, this looks like a bad design. Perhaps it should not be built. They were overruled by the

Atomic Energy Commission, Fermi 1 was built, and on October 5, 1966, it partially melted down. And luckily it was just partially, because there was a lot of plutonium involved. So in this particular case, what we're talking about here is the containment on this atomic reactor that's had so many near misses all ready, how many more are yet to come? The same companies are involved as were involved before. And this is the ultimate line of defense protecting our members downwind, countless members of the public downwind and downstream, and I just encourage you to make sure that the containment holds.

And I guess I'll just -- I've talked about the cracking here. The other handouts include things like the experimental steam generator replacements, we'll see how that goes, if this is going to be another San Onofre in the making. There was talk today of a license amendment request in the works on this particular issue of the cracking as well. There's just any host of issues at this facility. And so, as members of the public watchdogging this atomic reactor for not years, but decades, we just encourage you to make sure that the containment, including the inner steel containment vessel, which is corroded, we now know, will do its job when called upon. Thank you very much.

CHAIRMAN RAY: Thank you, Mr. Kamps. Yes, sir?

MEMBER POWERS: Just one question.

CHAIRMAN RAY: Excuse me, Mr. Kamps? One of the members had a question.

MR. KAMPS: Oh, I'm sorry. I didn't realize --

MEMBER POWERS: In some of the materials that you passed out, you mentioned the steam generator.

MR. KAMPS: Yes.

MEMBER POWERS: I'm going to have to turn away from the --

MR. KAMPS: No problem.

MEMBER POWERS: In that you questioned the alloy that was used for the tubing, what in particular was your concern about the alloy used for the tubing?

MR. KAMPS: Well, I mentioned the San Onofre experience. And so what we tried to do and our coalition, which includes other groups like the Green Party of Ohio, Citizens Environmental Alliance of Southwestern Ontario, but in the steam generator intervention that we filed in early 2013, we also got the Sierra Club as a co-intervenor with us. And it was really following on the San Onofre experience, which was underway at the time. So there were major changes made between the old and the new steam generators at Davis-Besse. And we retained as our expert witness in this intervention Arnie Gunderson of Fairwinds Associates, who was the expert witness at the San Onofre 50.59 intervention. And the timing was interesting because San Onofre did not announce permanent shutdown until June 2013. We filed --

MEMBER POWERS: Well, I'm really not so much interested in San Onofre as what's your specific concern about the tubing in the replacement steam generator?

MR. KAMPS: I can't quite hear you, I'm sorry.

MEMBER POWERS: I'm interested in -- I mean, you specifically called out the tubing in the steam generator. And I wondered what prompted you to call out that tubing alloy? I mean, you specifically called out the alloy, which as far as I know is 690. And, in fact -- I mean, there must be some reason that you called attention to that tubing alloy.

MR. KAMPS: Well, I think the main reason, and it was very similar at San Onofre, is when there are changes made between an old and a new replacement, that should prompt the opportunity for a public hearing, a full adjudicatory public hearing on this major change, the significant change to a very safety related system in an operating nuclear power plant.

MEMBER POWERS: So you didn't --

MR. KAMPS: That did not take place --

MEMBER POWERS: -- have --

MR. KAMPS: -- at San Onofre, and the worst -- well, the worst didn't happen because there wasn't a catastrophic radioactivity release. But it could have and the plant permanently shut down.

MEMBER POWERS: But as far as I know --

MR. KAMPS: So Davis-Besse --

MEMBER POWERS: -- San Onofre had nothing to do with the alloy.

MR. KAMPS: Well, this was a change. This was a change from the old to the new --

MEMBER POWERS: Okay. I --

MR. KAMPS: -- this alloy --

MEMBER POWERS: -- understand. Thank

you.

MR. KAMPS: -- and there were many other changes too. And we were not given our day in court on any of that.

MEMBER POWERS: Thank you.

CHAIRMAN RAY: Okay. Now, I believe we'll turn to the bridge line. Thank you, sir. For any comments by members of the public who wish to do so over the telephone line. Hello?

MR. LEWIS: My name is --

CHAIRMAN RAY: Go ahead.

MR. LEWIS: My name is Marvin Lewis.

CHAIRMAN RAY: Marvin, go ahead. We'll then take whoever's next.

MR. LEWIS: Okay. Thank you. Look, I had to -- couldn't hear the whole day, but I heard much of the day. I'm very pleased to hear that you're actually taking a look at the concrete and the problems with it. I don't know if it's an adequate look. I'm not saying it is, but at least that you're taking a look. My point about the concrete is this, it's cracking. Pieces may fall down. And yes, of course, there's no nuclear consequence of a few pieces falling down from a facade or an apron, but there is a danger to somebody walking by, to traffic, or whatever. Surely it's not in the middle of a desert with nobody around for miles, there are employees. And if you've got concrete, as bad as licenses and inspections is in Philadelphia, they will close you down.

And this is what I'm suggesting to you. You've got concrete, close it down, close the traffic down, until and unless you have a pretty much guarantee that whatever you can do to stop any cracking from causing spalling and pieces falling down. Close it for a while, fix it, don't just argue it. Don't just say, well, we're only looking at the renewal. There's always a thousand ways you can talk around it, there's always a thousand justifications. Heck, you can ask your lawyers. Your lawyers will tell you, it depends on what the definition of is, is. Well, that is inadequate. That is inadequate, close it down for a while. Thank you very much, bye.

CHAIRMAN RAY: Bye, Marvin. Who's next? Anybody else?

MR. KEEGAN: Hello?

CHAIRMAN RAY: Yes?

MR. KEEGAN: Michael Keegan --

CHAIRMAN RAY: Michael, go ahead.

MR. KEEGAN: -- with Don't Waste Michigan. I am an Intervenor on the Davis-Besse. Yes. Mr. Kamps did point out that the spalling and cracking predates the blizzard of convenience by at least two years. I was particularly taken aback by a call by the ACRS for an integrating document asking, there must have been a license amendment made somewhere. And to learn that it has not been made yet and everything is contingent, decisions are being stacked on top of the license amendment being approved. So there's a lot of pressure being developed to go ahead and approve it when the analysis and the time that you have to make a decision, you don't have the proper information.

I do have problems -- I'm a sociologist by training in the scientific method, research design, statistical analysis and methodology. And the methodology used to come to the blizzard of convenience is quite contorted. I have a problem, statistically speaking, when you have a structure, the shield building, some 280,000 surface square feet, and you're only looking at the 23 bores in that. There were a total of 110 bores taken, 80 were looked at, and 23 are being examined. What became of the ones that were tossed out? And how in the world can 23 bore samples represent 280,000 surface square feet?

The order in which the -- the bore holes then indicated where the IR should occur. It should have been the reverse. The entire universe should have been examined. The entire shield building should have been examined with IR and from that, then indicate where the 23 bore holes or the 110 bore holes should occur. This methodology is just ripe for cherry picking. Gathering hodge-podge here and there and then weaving together some kind of coherent -- I'm hearing about a 17 page document that is heavily logic, premise upon premise, but if you really track it and follow it, it really makes sense.

Well, in the sciences there's something called Occam's Razor, when things are so complex that you have to explain the solar system with all these elaborate orbits, when Copernicus came along, he demonstrated that the solar system was actually quite simple. So Occam's Razor would suggest that there are problems here that have not been looked at. It's twisting, mental gymnastics to get this methodology to get towards approval.

What analysis has been done, the structure weighs between 20,000 and 25,000 tons of concrete and rebar. There were two engineers in 2011, NRC engineers, who suggested that in a minor earthquake, 90 percent of the concrete building, the shield building, the concrete would crumble. What analysis has been done if 25,000 tons of concrete come tumbling down into the secondary containment? Throughout this meeting, I heard a lot of good questions, but I heard the ACRS critiqued as they asked questions and they accept lousy answers. I hope the answers that you accept are very well reasoned and scrutinized.

But it seems much of this is a rush for plausible deniability, to be able to say, well, we had the paper report that said this analysis was okay, therefore we're covered. But if this should collapse, there will be forensics. If there's a catastrophic accident, there will be forensics. And it's going to be wanted to know, who decided to give the approval? Now, I've also heard about the embrittlement issue. The equivalent margin analysis being used. I didn't see any of that in the documentation coming through. How did this get utilized?

Regarding the steam generators, the Inconel 690 was a new metal being utilized and it was not known until two years later that this metal acts differently than the Inconel 600. And the putting too many tubes into the steam generator also were contributing factors at San Onofre. All this was allowed to occur at the Davis-Besse because they did this under a 50.59. There are nine very different aspects to the steam generator that was installed than the one they pulled out. They should not have been able to do the 50.59 process. There should have been NRC independent scrutinization, there wasn't. So whether that comes unglued or not remains to be seen.

Back to the shield building, this is a building that the least amount out of tolerance in any 25 foot direction, the least amount of out of tolerance is 1.25 percent. Gravity, gravity on 25,000 tons of concrete and rebar, how will that play out at Davis-Besse? And there's problems with the plant wicking up water into the concrete. There's problems with the pH factor in the soil. There's a multitude of problems that are not being adequately addressed by NRC staff.

It's a big push to get to yes. ACRS

members talk about the hope that they can get to a good solution, they hope that they can get to a good answer. But the scrutinization needs to occur of this shield building and the Davis-Besse. This was a long meeting and it was very informative, but there are certainly a lot of avenues that I'm not able to go through here. I would like the opportunity to be able to review the transcript and then to communicate to the ACRS my comments once I've seen it in writing. It's difficult to do by phone, but I did my best. Thank you for the opportunity to present.

CHAIRMAN RAY: They contact you for the transcript, don't they? Yes. With regard to the transcript, we'll advise you now as to how to get a copy of it.

MR. KEEGAN: Okay.

MR. HOWARD: Mr. Keegan, you can contact me, Kent Howard, the guy you talked to yesterday.

MR. KEEGAN: Okay.

MR. HOWARD: Yes.

MR. KEEGAN: Good. All right, thank you, Kent.

MR. HOWARD: Thank you.

MR. KEEGAN: Okay. Thank you. Bye.

CHAIRMAN RAY: Anyone else on the line who'd like to make a comment? Hearing none, let's close the bridge line then and we'll conclude with a discussion among subcommittee members. Steve?

MEMBER SCHULTZ: I thank the staff and the Applicant for the presentations today and for the many clarifications that have been provided to us. I did want to address a couple of items that I thought would be appropriate to include in the full Committee presentation. One is, as was already stated, I just wanted to reemphasize that I believe it's important to address each of the open items with some level of detail.

For example, the open item associated with operating experience. I think that would be good to address not only what has been done in closing the open item, but part of that is a demonstration of what will be done associated with integrating operating experience that will be found within the period of extended operation. So I think a fuller description of what has been done and what will be done with regard to operating experience would be a good example of how that particular item might be addressed.

CHAIRMAN RAY: And you would like that by the Applicant as opposed to the staff?

MEMBER SCHULTZ: Yes. I think, that I would hope to hear from the Applicant. We've heard of the improvements that have been made to the facility, both as a result of ongoing operation as well as operation in an extended period. And I know the full Committee would like to hear the detail there at the appropriate level considering the time frame. But, for example, the details associated with the inspections that we heard today of the sand pocket region should be presented. I know that's an area of interest.

And also, there's a program that the staff referred to with regard to how that's going to be incorporated with additional ultrasonic testing during the period of extended operation. So anything that is associated with those open items or ongoing activities that has been proposed as programs within the license extension period would be useful for the full Committee to hear. Thank you.

CHAIRMAN RAY: Thank you. Dick?

MEMBER SKILLMAN: Thank you, Harold. What I would like to suggest is we hear in the full Committee meeting how the shield building monitoring program is going to protect the design and licensing basis of the shield building for the PEO. To me, that's the major issue. I'm comfortable with the commitments. There are 55 commitments in Supplement 1 of the SER and as I reviewed all of the documentation that was presented to us, with the exception of having reviewed the shield building monitoring program, I believe those 55 commitments really cover what is important for license renewal. So my razor focus would be on that shield building monitoring program and protection of the design and licensing basis for the future. Thank you.

CHAIRMAN RAY: Thank you. Dana? No further comments from Dana. Mike?

MEMBER CORRADINI: No comments. I think what Steve and Dick brought up is perfectly appropriate.

CHAIRMAN RAY: Ron?

MEMBER BALLINGER: I'd like to echo what Steve and Dick have indicated. But I'd more like, in addition, I think we've asked Kent to see about getting a copy of that shield building monitoring program. And I'd like to have that in my hands to read.

CHAIRMAN RAY: Anything else? I'll let

Bill conclude. Let me finish the member comments with a couple comments of my own. I realize, and in fact I have used the term myself, to appropriately categorize the issue of using an approved methodology, one that in this case requires a license amendment, as a process issue. But sometimes people use that as a way of saying it's unimportant. Having been a licensee for 35 years before I wound up in this job, I don't look at process issues as unimportant. Most times they don't have a significant consequence, but sometimes they do.

So, that is the issue that, as I've said before, it has to do with the methodology used to ensure structural adequacy and the determination of margin, which is important to the monitoring program that we've already talked about. I'm not going to ask that, that be discussed at the full Committee meeting necessarily, but it will be a discussion item among the full Committee members I'm sure. And, therefore, I think it would be wise if it were addressed there. That's all I had. Bill, as a consultant, why don't you finish this up here?

MR. SHACK: Okay. Well, I was sort of focusing basically on the inspection program. And this monitoring program, I think, is reasonably well designed, but since you can't identify a bounding case, it becomes difficult to know when you have enough. And the answer to that partly depends on margin. That if you have large margins, and as we've discussed, we think we have large margins, but we've really never seen that analysis and it's not been really reviewed by the staff in any great amount of detail.

So I think it's important or I think it would be helpful if there was a broader inspection program using the impulse response to better map out the condition, at least for the first year or two. It may well be that the conjecture that the crack growth rates are decreasing is true, the argument is made that the water is going down by gravity and inspection of that upper region, which is admittedly difficult. But I think for a year or two it would be helpful to have a better mapping just to convince ourselves that the crack growth is understood and the growth rates are manageable. And I'll leave it there.

CHAIRMAN RAY: Thank you very much. With that, this subcommittee meeting is adjourned.

(Whereupon, the above-entitled matter

was concluded at 3:50 p.m.)

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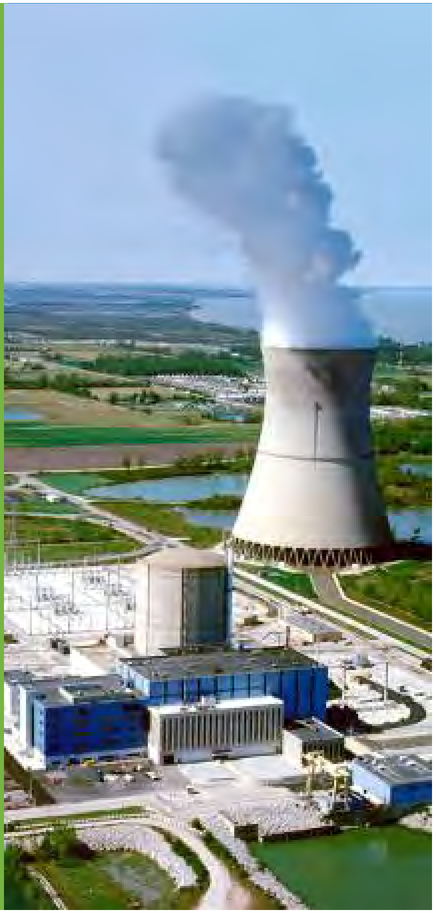


Davis-Besse Nuclear Power Station License Renewal Application

Advisory Committee on Reactor Safeguards
License Renewal Subcommittee Meeting
September 23, 2015

AGENDA

- **Introductions & Opening Remarks**
- **Background**
- **License Renewal Application Description**
- **Shield Building Discussion**
- **Containment Vessel Inspections**
- **Summary & Closing Remarks**

Introductions

- **Brian Boles – Site Vice President**
- **Ken Byrd – Director, Site Engineering**
- **Cliff Custer – Fleet Project Manager**
- **Steve Dort – Site Project Coordinator**
- **License Renewal Core Team Members**
- **Aging Management Program Owners and Subject Matter Experts**

Background – Site

Davis-Besse Site

- Southwestern shore of Lake Erie in Ottawa County, Ohio
- ~20 miles East of Toledo, Ohio
- 954 Acre Site
  - 733 acres leased to US Government as wildlife refuge
  - 221 acres for Plant structures & equipment

Background – Plant

- **Design**
  - Pressurized Water Reactor
  - Babcock & Wilcox nuclear steam supply system with raised-loop design
    - 2817 Megawatts thermal / 908 Megawatts electrical rating
  - Bechtel Engineering construction management
  - Facility Operating License expires April 22, 2017

Background – Upgrades

- **Equipment Improvements**
  - Replaced Steam Generators, related Feedwater piping & Reactor Coolant System hot legs
  - Replaced Reactor Head
  - Installing Emergency Feedwater System

License Renewal Application – Details

- **Developed to NUREG-1801 Rev 1, reviewed to Rev 2**
  - AREVA; FENOC core team; Site review and concurrence
  - Industry peer review prior to submittal
- **44 Aging Management Programs**
  - 13 New (6 are plant-specific)
  - 31 Existing (4 are plant-specific)
- **55 License Renewal commitments**

Closure of Open Items

- **4 Open Items were addressed and closed in the Safety Evaluation Report (Sept 2013) [Section 1.5]**
  - Operating Experience
    - Developed a process to align with LR-ISG-2011-05, “Ongoing Review of Operating Experience”
  - Reactor Vessel Neutron Embrittlement
    - Provided Equivalent Margins Analyses for the RV shell region weld materials
  - Pressure-Temperature (P-T) Limits
    - Revised LRA to ensure future P-T limit curves will be developed consistent with 10 CFR Part 50, Appendix G
  - Shield Building
    - Developed a plant-specific Shield Building Monitoring Program

License Renewal Application – Review

- **LRA Review Timeline**
  - NRC Audit and Inspection Period 2011
  - Extended review period due to Waste Management Decision and Shield Building evaluation
  - Interim Staff Guidance (ISGs) through LR-ISG-2013-01 have been addressed
  - Annual update submitted - June 2015
  - Final SEIS issued - June 2015
  - Supplemental SER issued - August 2015

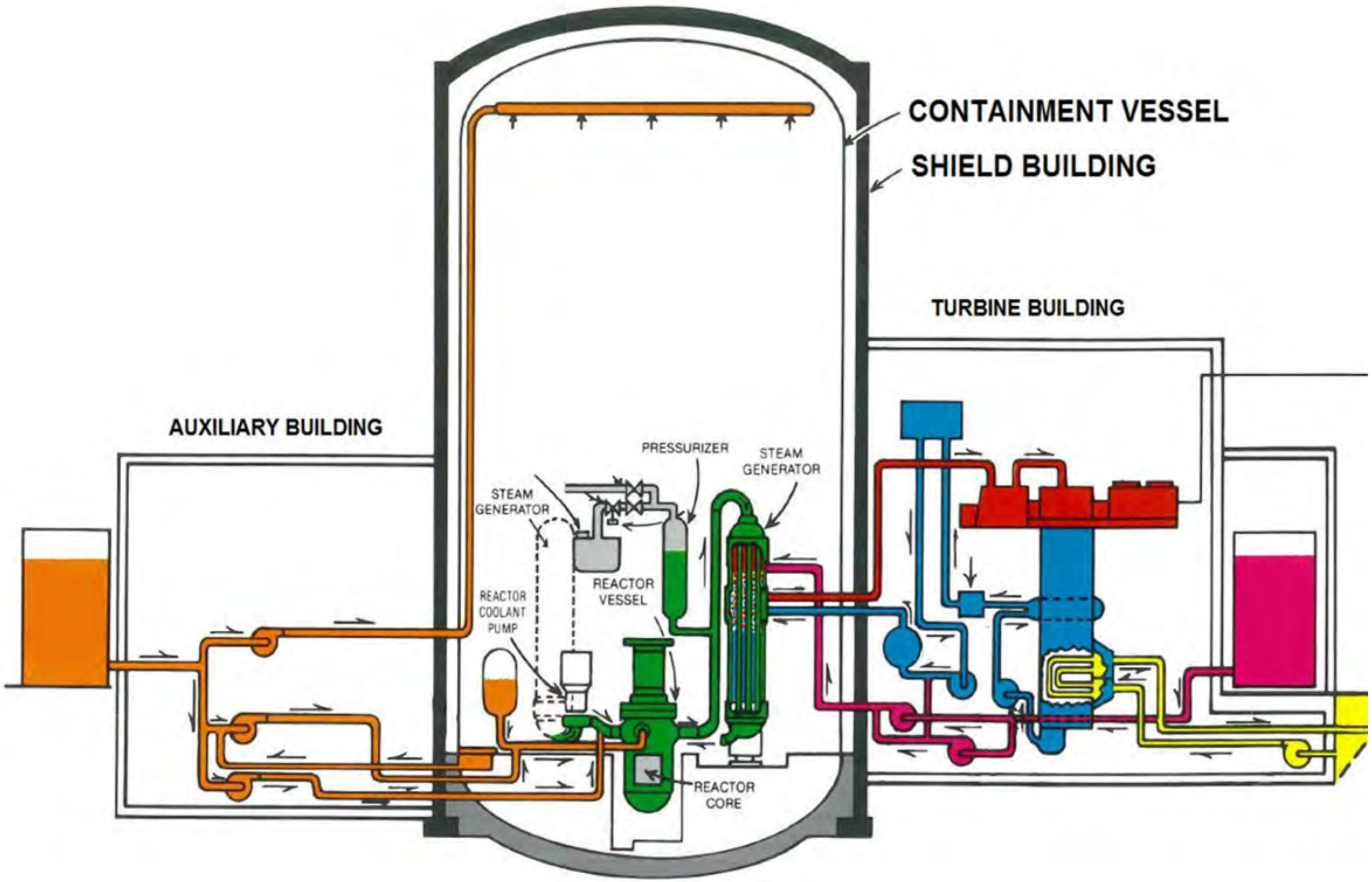
Shield Building

- **Provide a timeline of Shield Building activities**
- **Provide background of investigation**
- **Describe actions taken in response to crack propagation**
- **Provide basis for conclusion that building condition is acceptable with continued monitoring**

Shield Building Timeline

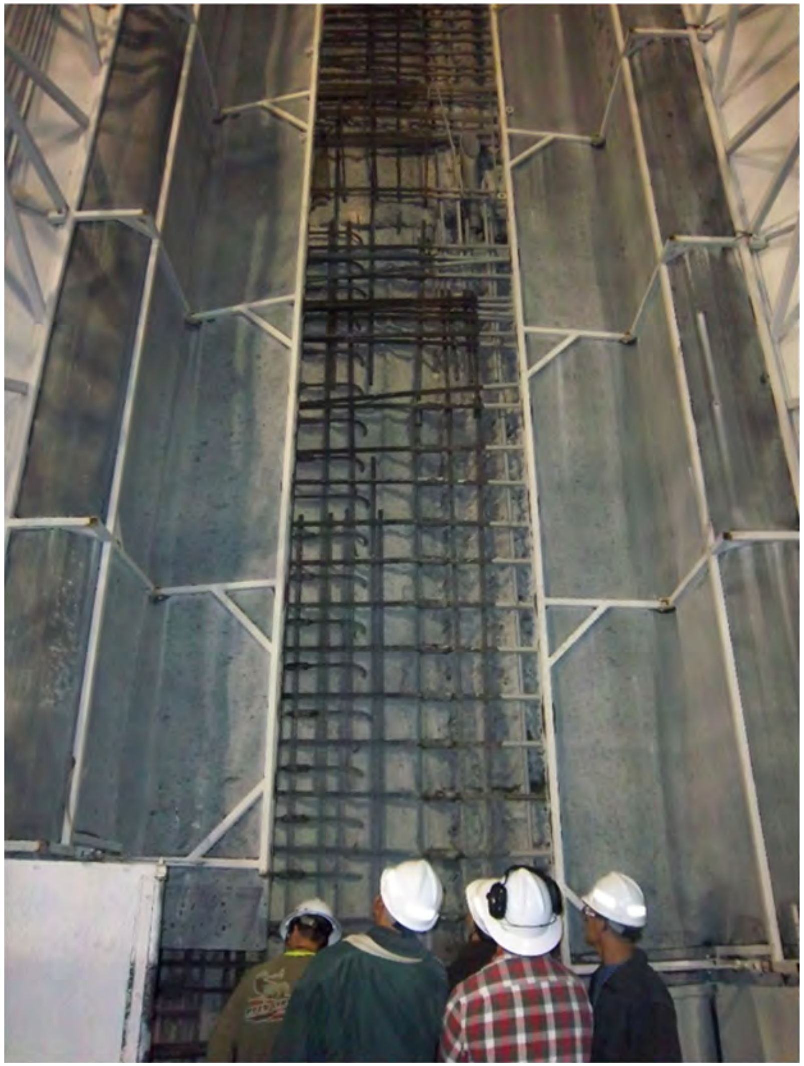
▪ **October 2011**	**Discovery of Laminar cracking**
▪ **May 2012**	**Completed first root cause**
▪ **August 2012**	**Condition monitoring completed with no issues identified**
▪ **October 2012**	**Completed exterior coating of building**
▪ **August 2013**	**Condition monitoring identified crack propagation**
▪ **June 2014**	**Completed root cause of crack propagation**

Shield Building



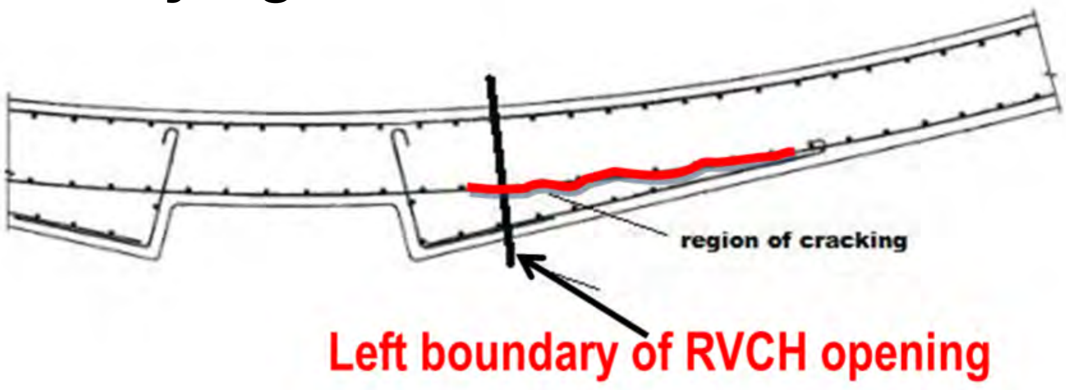
Discovery

- **Cracking found on October 10, 2011, during 17M hydro-demolition**



Shield Building Condition

- **Cracking is mostly restricted to flute shoulder regions**
  - Cracking was observed to be more prevalent on the south side of the building
- **Cracks are located near the outer reinforcing mat; no cracking observed in interior reinforcing mat**
- **Cracks are very tight**



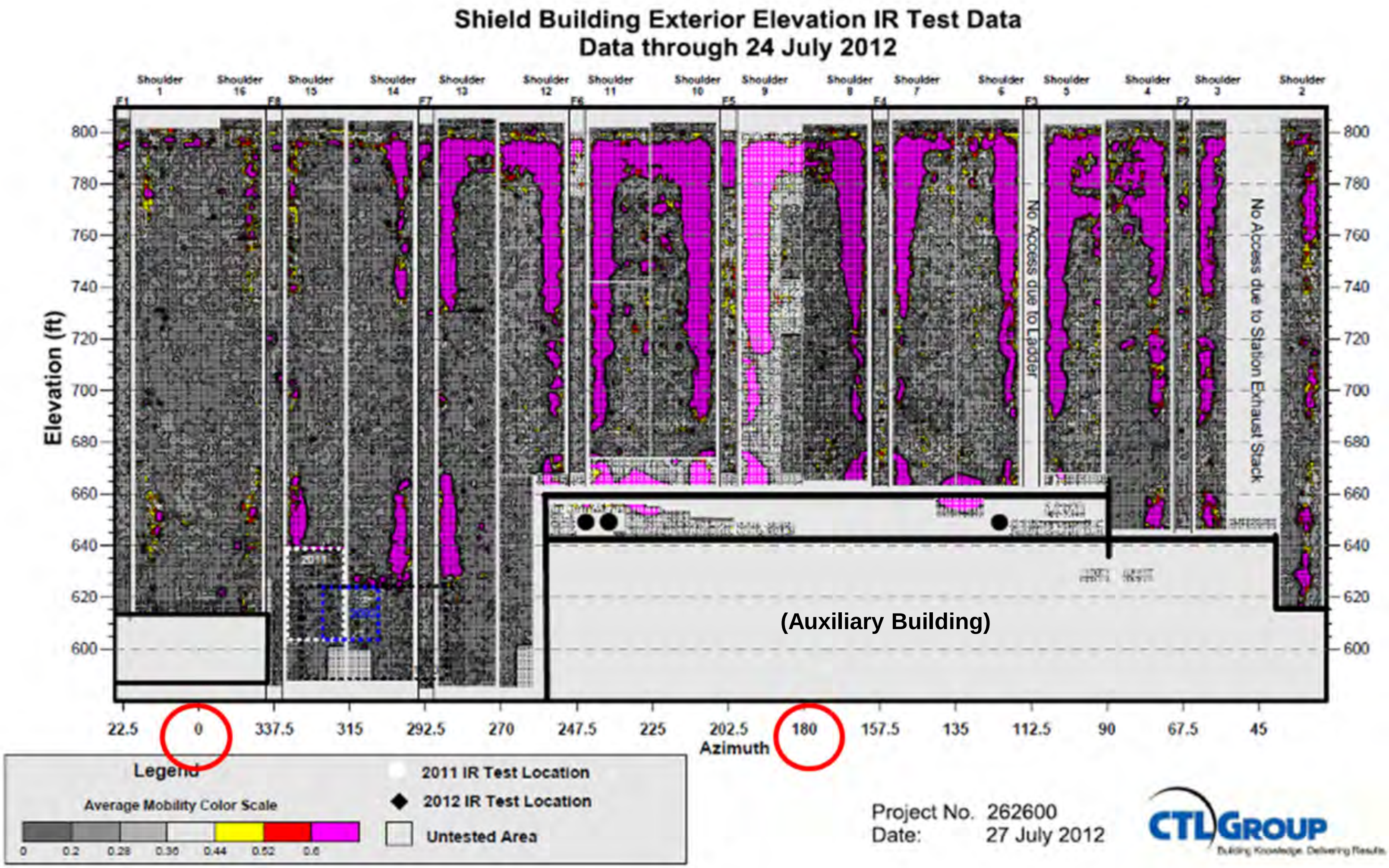
Investigation

- **Impulse Response (IR) testing methodology used to investigate extent of crack**

Investigation

- **Core bores validated IR testing results and determined crack depth and crack width**
- **Cracks are very tight**

Additional Actions - IR Mapping

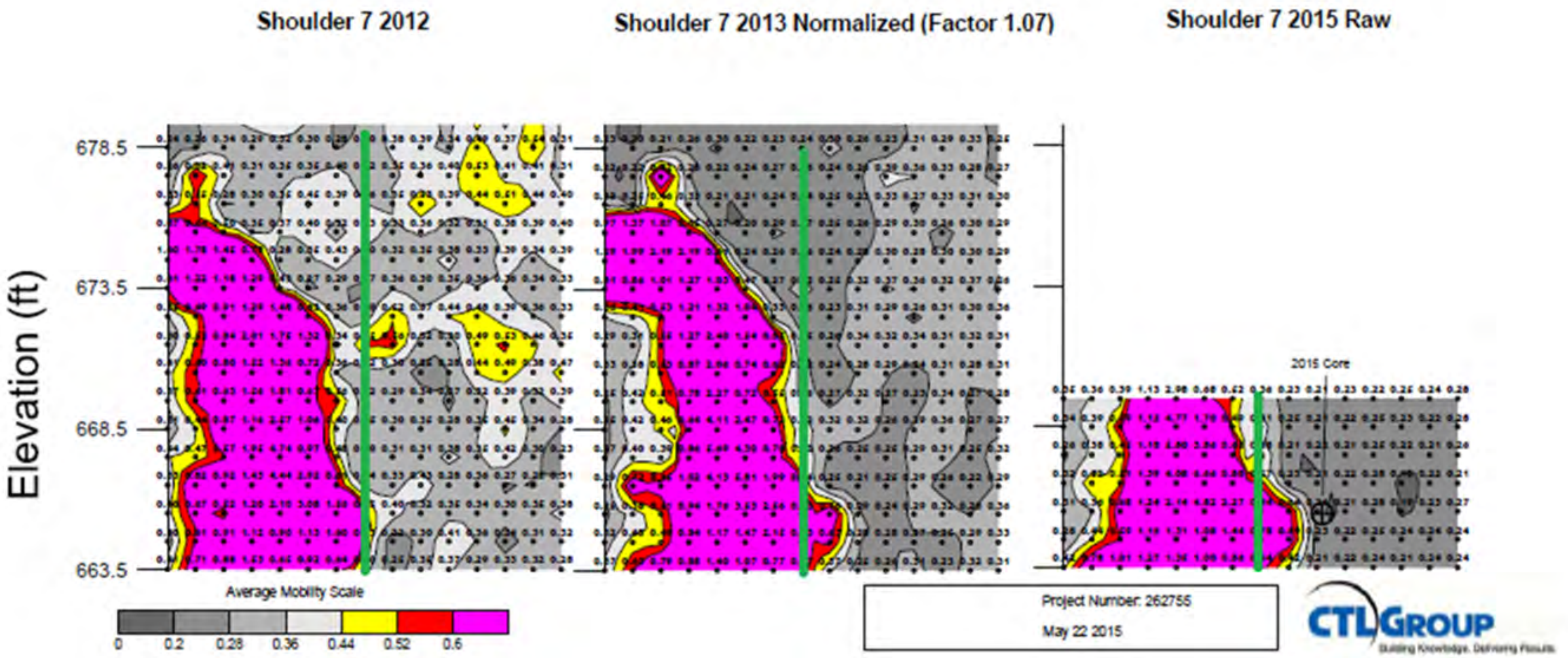


Shield Building Root Cause

- **Cause was identified to be moisture intrusion by wind driven rain followed by extreme cold temperatures**
- **Corrective actions:**
  - **Impulse response mapping conducted on all accessible areas of the Shield Building**
  - **Exposed exterior surfaces of the Shield Building were coated in 2012**
  - **Testing conducted at two Universities to determine steel-to-concrete bond strength in areas of laminar cracking**
  - **A long term monitoring program was established**

Long Term Monitoring

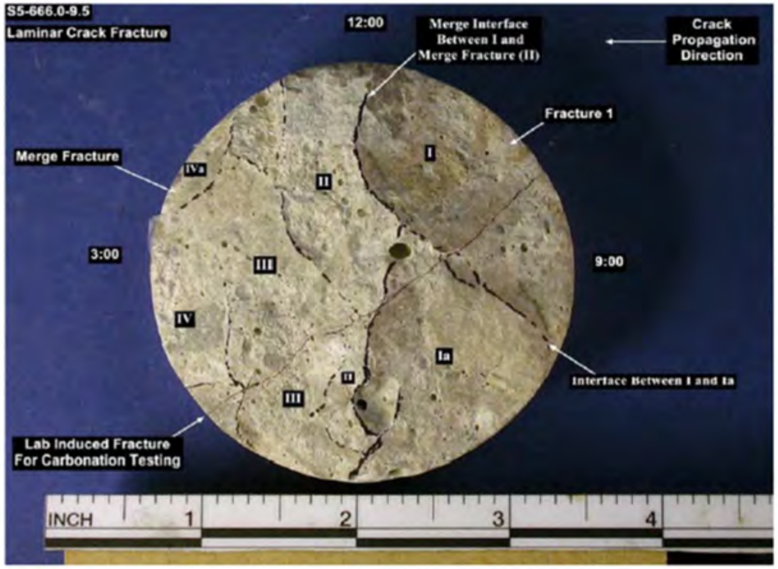
- **Monitoring in 2013 identified changes in eight of eighty core bores inspected**
- **IR also confirmed changes in condition**



Crack Propagation Cause Investigation

- **Core bore extracted from an area of crack propagation**
- **Cracked surface is different from all previous samples**
  - Noticeable ridges – stepped fracture planes

Original crack surface (2011)



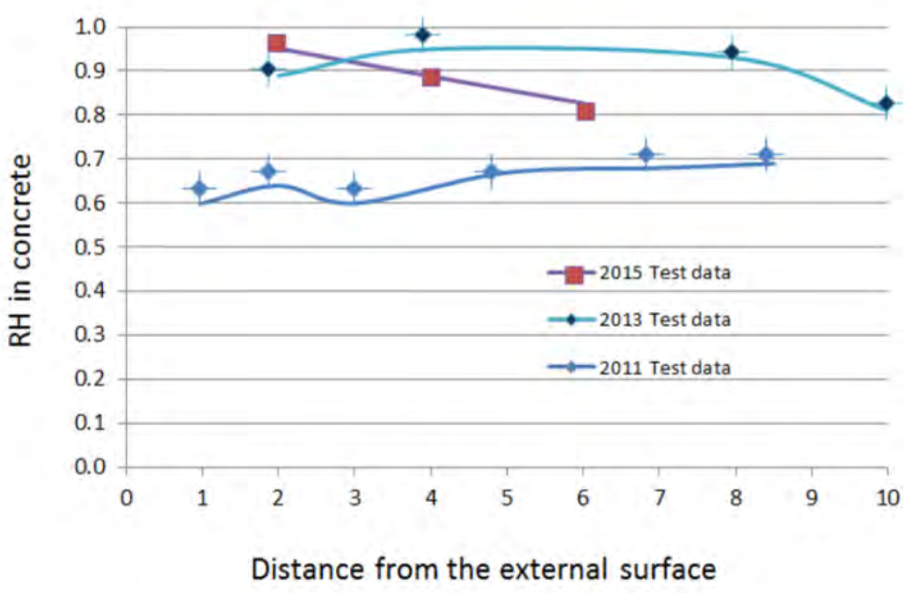
Crack propagation surface 2013

Crack Propagation Cause Investigation

- **Cause determined to be Ice-Wedging**
- **Ice-Wedging requires three conditions**
  1. Pre-existing crack
     - 2011 identified condition
  2. Freezing Temperatures
     - In-situ bore measurements determine that freezing temperatures have occurred.
     - Freeze damage evident in extracted samples
  3. Water accumulation at the crack location
     - Increase in relative humidity of the concrete

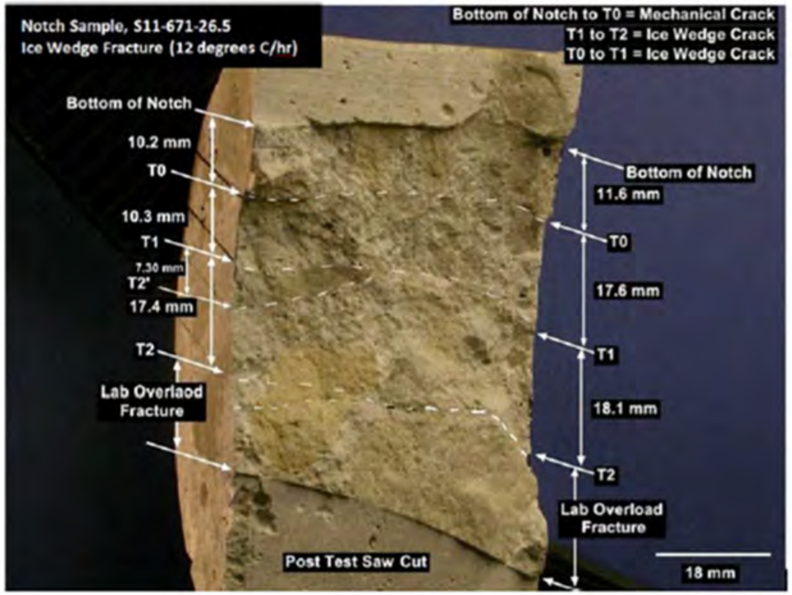
Crack Propagation Cause Investigation

- **Relative Humidity accumulation increase in the near surface and crack locations between samples collected in 2011, 2013 and 2015**
- **Building was coated in summer of 2012**



Crack Propagation Cause Investigation

- **Ice-Wedging – Laboratory Simulation**
  - Used existing core from the Shield Building
  - Replicates failure surface & crack growth
  - Identifies crack growth at approximately ½ inch / freeze cycle



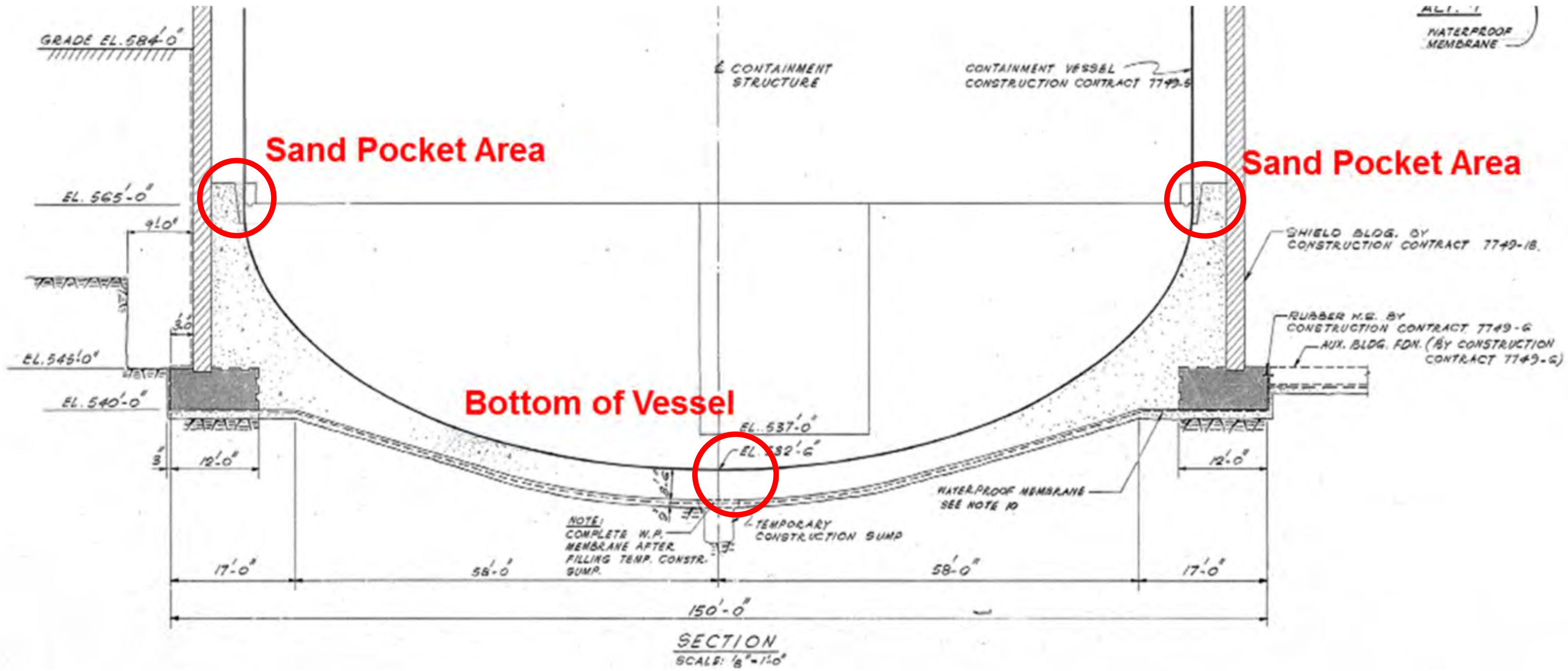
Crack Propagation Actions

- **Monitoring plan was modified to increase number of bores inspected and inspection frequency**
  - Sample size increased from 12 to 23 bores
  - Inspections yearly through 2018 and will continue yearly if changes are noted
- **Structural calculation margin quantified**
- **Periodic testing and analysis of building relative humidity conducted to determine trend**
- **Additional mitigation methods considered**

Conclusions

- **Test Results & Evaluation suggest crack propagation will decrease as Shield Building dries out**
- **Margin in the Structural Calculation is sufficient to allow continued monitoring during time building is drying**
- **Margin in the structural calculation provides sufficient time to develop additional actions if required**
- **Monitoring scope and frequency is appropriate**

Shield Building / Containment Vessel Foundation



Ground Water Intrusion in Sand Pocket

- **Containment Vessel 1.5” carbon steel plate**
- **5 representative locations were investigated**
- **45 Total UT readings**
- **All UT readings at or below the grout interface were above the required mill tolerance thickness**
- **Therefore, sand pocket seepage has negligible affect on the Containment Vessel**

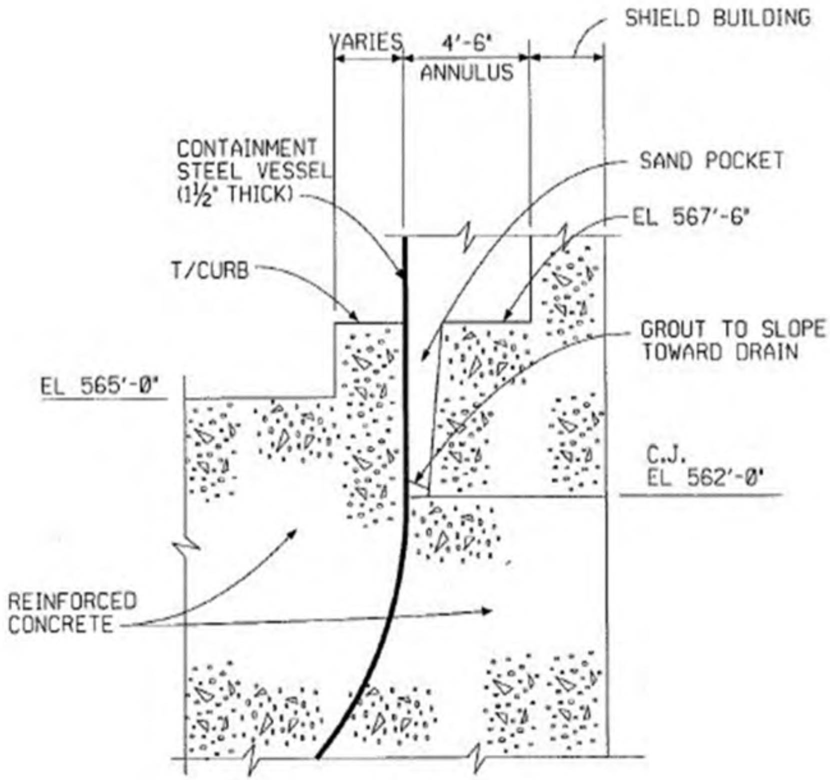
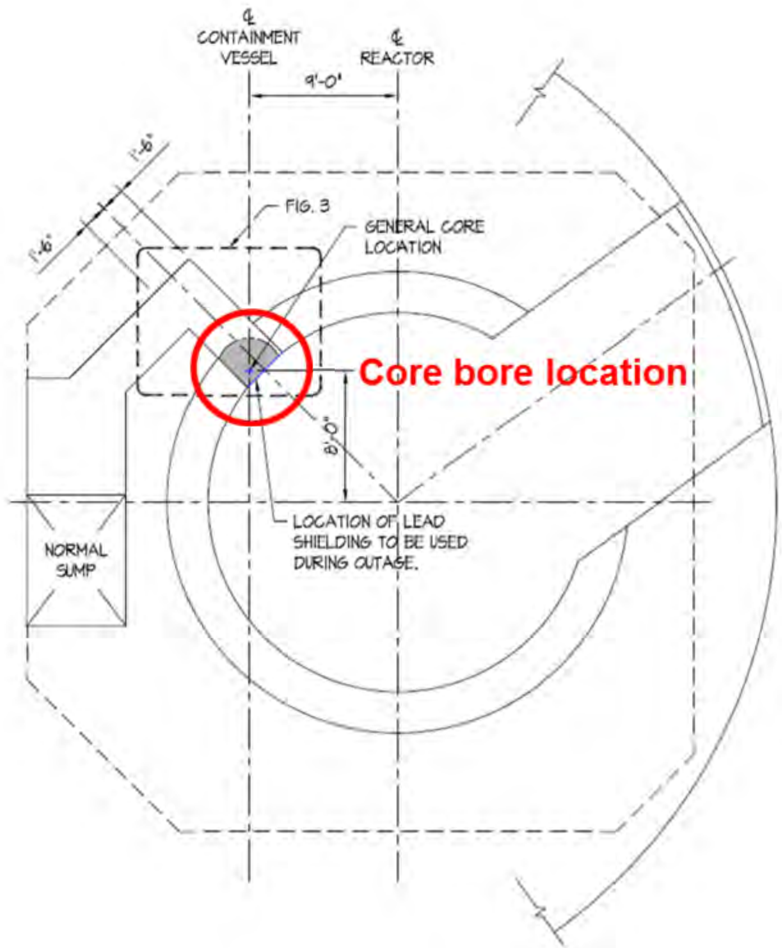
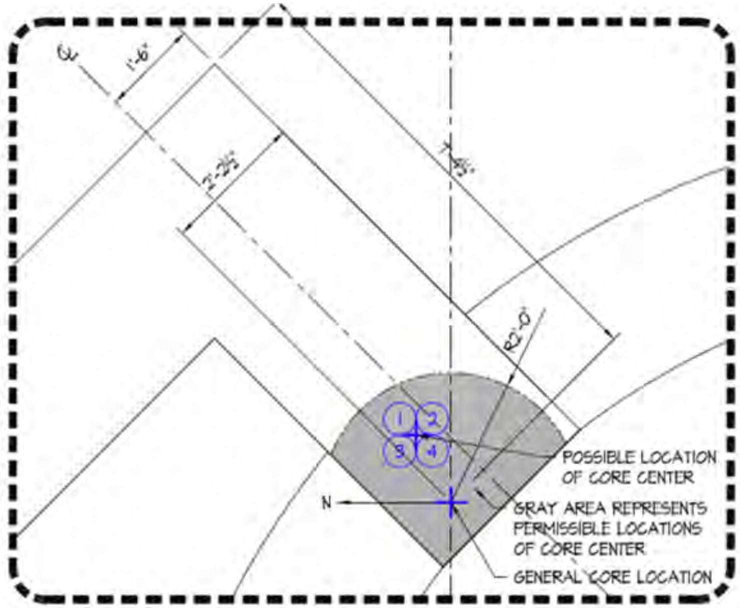


Figure 1. Sand Pocket Area

Refueling Canal Leakage – Effect on Containment Vessel





Conclusions

- ✓ **No signs of water**
- ✓ **UT reading > 1.5"**

Closing Remarks

- **Application has received a thorough staff review**
- **Current with Interim Staff Guidance expectations**
- **Implementation efforts are in progress**

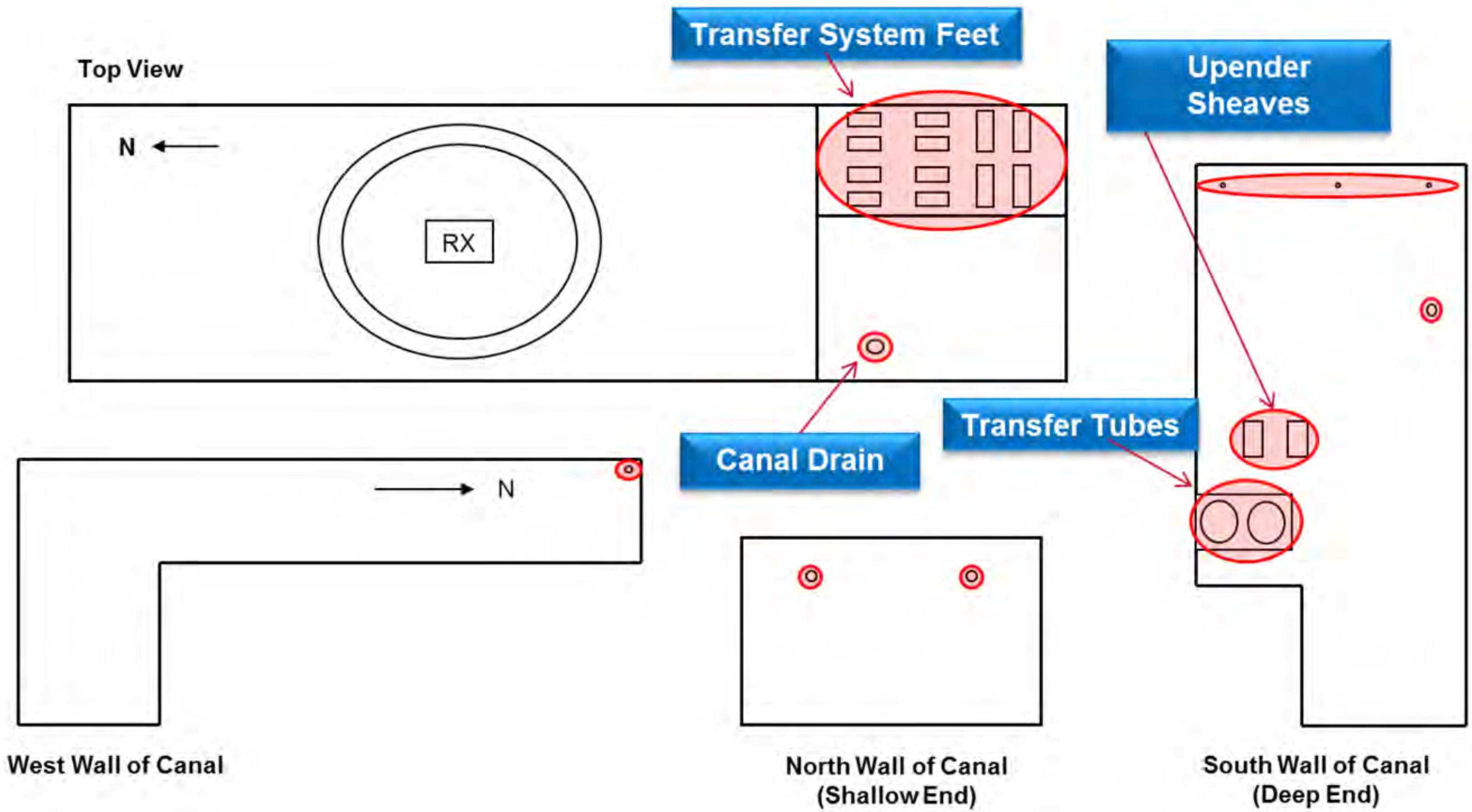
Questions?

Backup Information

Refuel Canal Leakage Mitigation

Refuel Canal Leakage Mitigation

Repair Options



Driving Forces for Moisture Transfer in Concrete

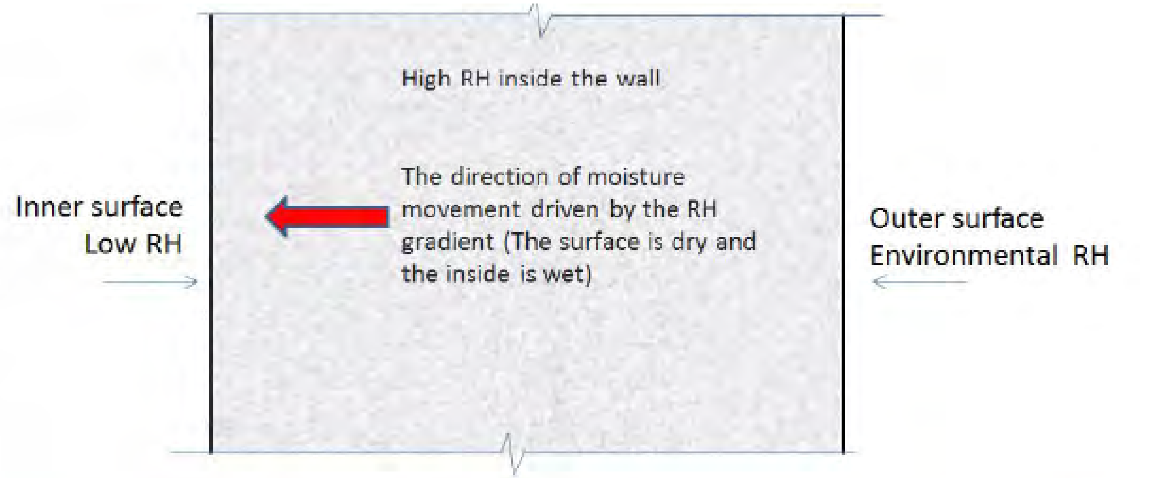


Figure 1- Moisture movement considering RH gradient as the driving force for moisture transfer in the concrete wall. T = Constant

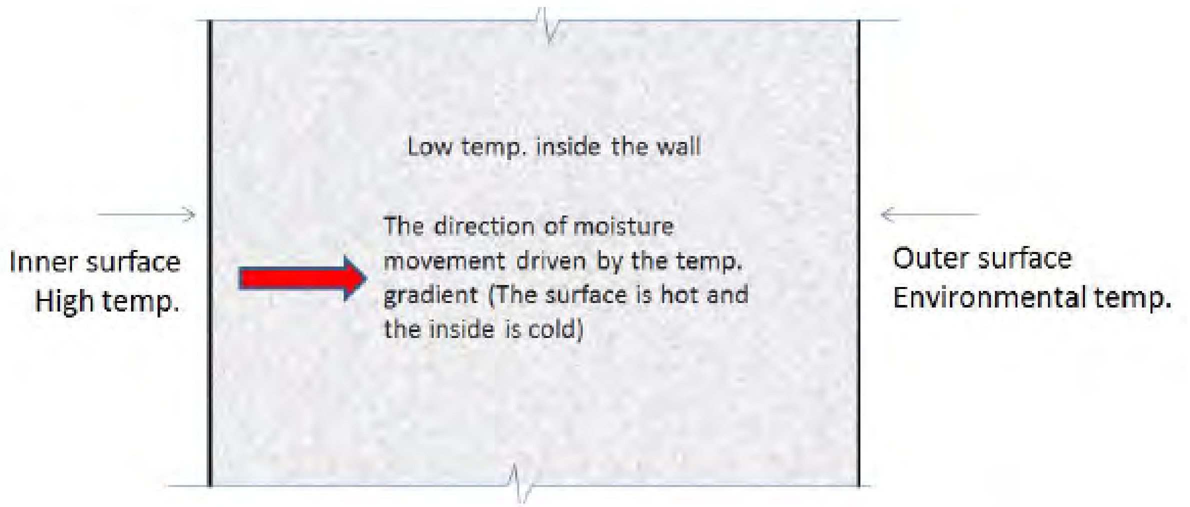
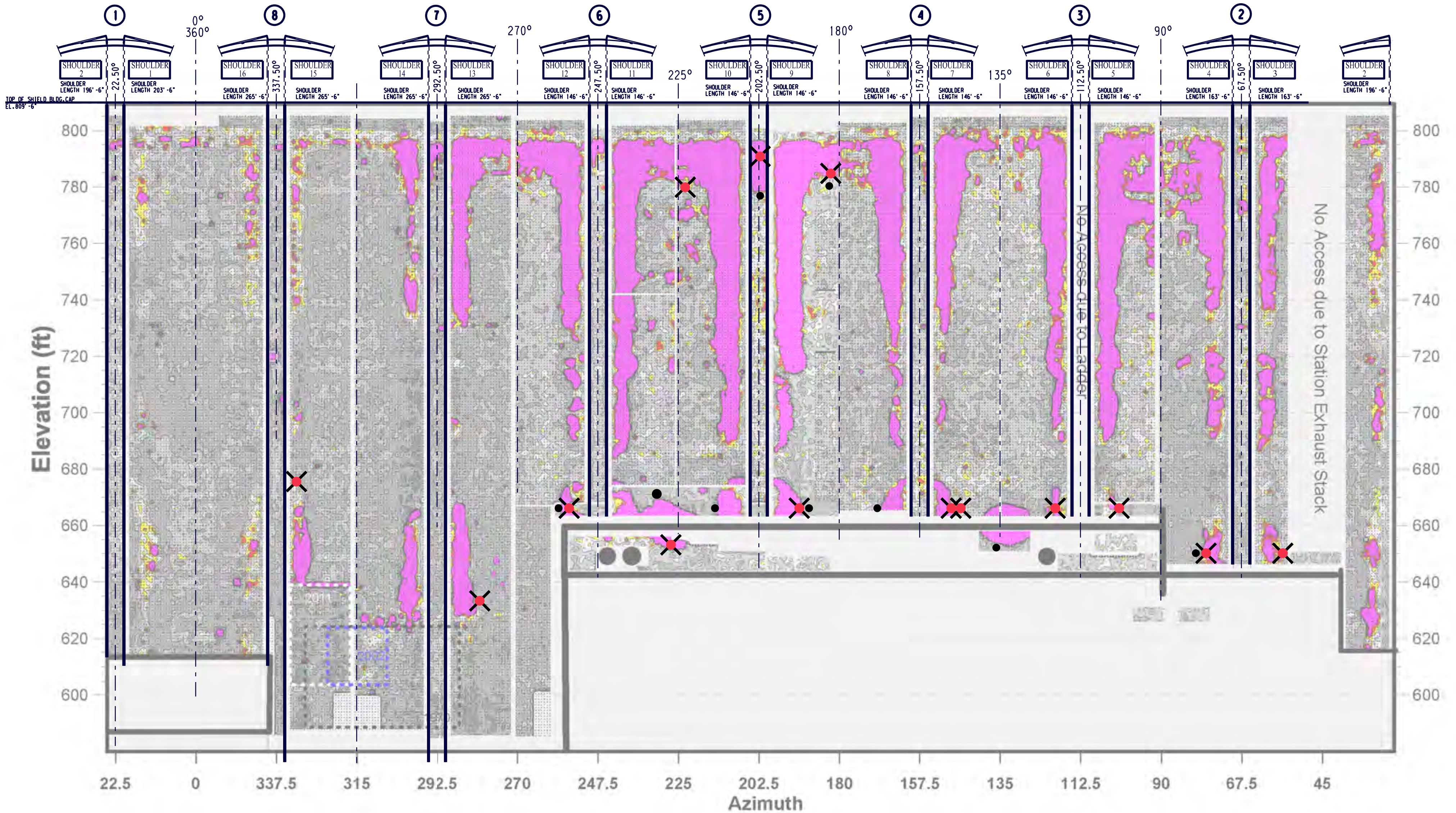


Figure 2- Moisture movement considering the temperature gradient as the driving force in the wall. T ≠ Constant



SHIELD BUILDING - EXTERIOR DEVELOPED ELEVATION
WITH TABLE 1 - REQUIRED BORE INSPECTION LOCATIONS PAGE 35 EN-DP-01511
N.T.S.

DB 09-21-15

DFN=F/SCHED/SKZ904.DGN

Advisory Committee on Reactor Safeguards License Renewal Subcommittee

Davis-Besse Nuclear Power Station

Final & Supplemental Safety Evaluation Report

September 23, 2015

Rick Plasse, Project Manager
Office of Nuclear Reactor Regulation

Overview

- LRA Submitted by letter dated August 27, 2010
- Pressurized Water Reactor (PWR), Babcock & Wilcox Nuclear Steam Supply System
- Operating license for NPF-3 expires April 22, 2017
- Located approximately 20 miles east of Toledo, OH

Safety Review Results

- Safety Evaluation Report (SER) with Open Items was issued July 2012
- ACRS License Renewal Subcommittee Meeting held September 19, 2012
- Final SER was issued September 2013
- Supplement to SER was issued August 2015

Safety Review Results

- SER with Open Items was issued
  July 2012
- 4 Open Items

  OI-3.0.3.2.15-1 Shield Building Laminar Cracks

  OI-B.1.4-1 Operating Experience

  OI-4.2-1 Upper Shelf Energy

  OI-4.2.4-1 Pressure-Temperature Limits

Safety Review Results

- Final SER issued September 2013 (all open items were closed): 44 AMPs total

Staff Disposition of Program	Existing AMPs	New AMPs
Consistent with the GALL Report	9	5
Consistent with enhancements	11	2
Consistent with exceptions	2	-
Consistent with both enhancements and exceptions	5	-
Plant specific	4	6
Subtotals:	31	13

Open Item B.1.4-1: Closed

OI B.1.4-1 Operating Experience

- **<u>Issue</u>:** During review, LR-ISG-2011-05, "Ongoing Review of Operating Experience," was issued

- **<u>Basis for closure</u>**: Applicant provided additional information that addressed the guidance in LR-ISG-2011-05

Open Item 4.2-1: Closed

OI 4.2-1 Reactor Vessel Neutron Embrittlement (SER Section 4.2.2):

- **Issue**: Reactor vessel welds with unknown initial upper shelf energies (USE) require an equivalent margins analysis (EMA), per §Part 50, App G, requirements

- **Basis for closure**: EMA submitted and approved to demonstrate that the welds will have adequate margins of safety on USE, as required by §Part 50, App. G

- EMA provides an acceptable basis to accept the USE TLAA under §54.21(c)(1)(ii).

Open Item 4.2.4-1: Closed

OI 4.2.4-1 Pressure-Temperature (P-T) Limits:

- **Issue:** Methodology (Report BAW-10046-A, Rev. 2) invoked by Tech. Spec. 5.6.4 for calculating P-T limits may not assess potentially limiting reactor vessel non-beltline locations

- **Basis for closure**: Applicant demonstrated Report BAW-10046, Rev. 2, appropriately accounts for potentially limiting reactor vessel non-beltline locations near geometric discontinuities.

- TS basis remains valid to accept under §54.21(c)(1)(iii).

Region III Inspection Results

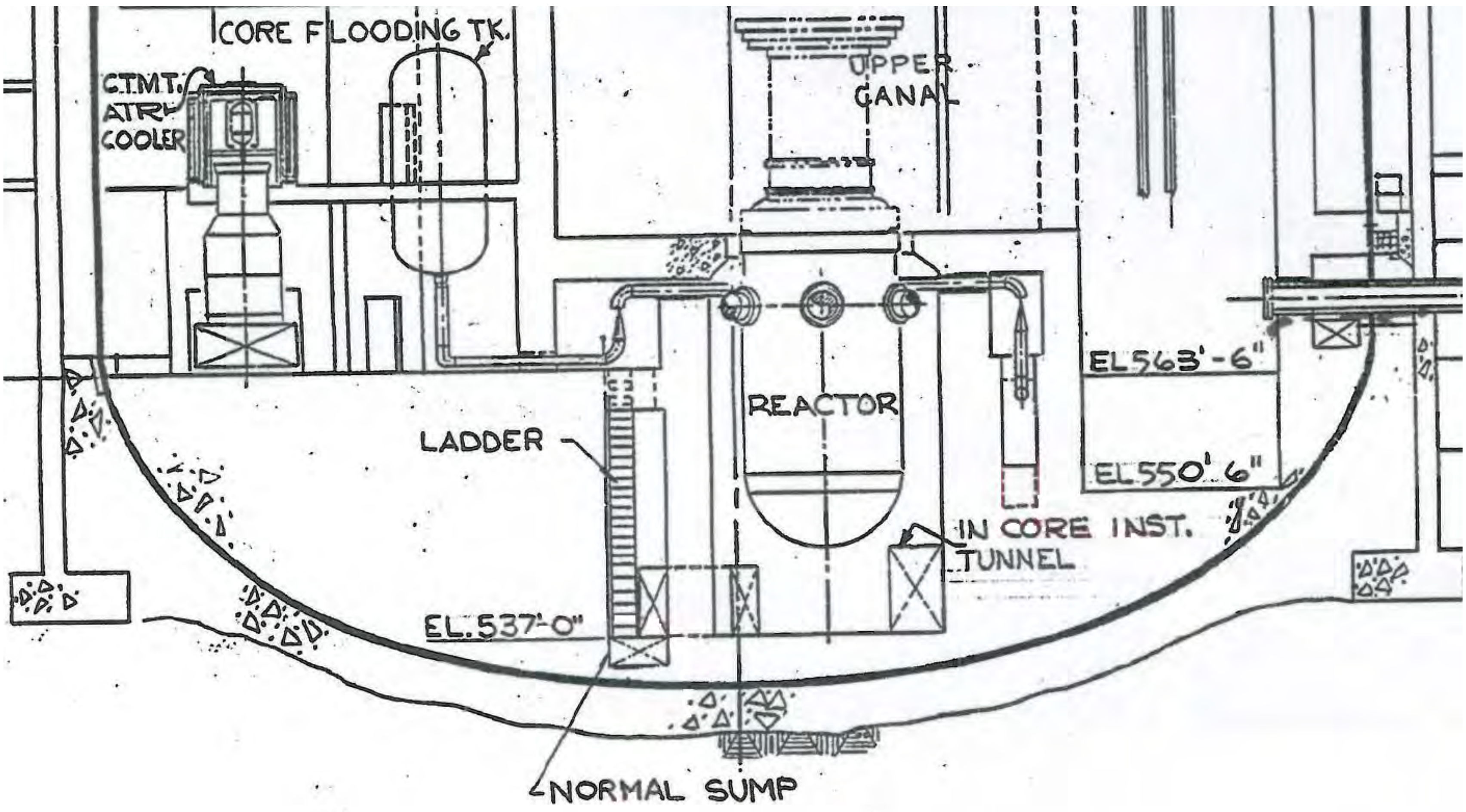
- 71002 Inspection
- Shield Building Laminar Cracking

1. Inspection Report 05000346/2012009 dated June 21, 2012
2. Inspection Report 05000346/2012010 dated October 2, 2012
3. Inspection Report 05000346/2013009 dated May 12, 2014
4. Inspection Report 05000346/2014008 dated May 28, 2015

SER Supplement 1

- Supplement 1 to SER issued August 10, 2015
  - Reactor Vessel Internals Inspection Plan and Program
  - Annual Updates in 2013, 2014, and 2015
  - Updated information and commitments in response to recent industry operating experience
  - New plant specific program Service Level III Coating and Linings Monitoring Program
  - Steam Generator Replacement (Spring 2014)
  - Shield Building Laminar Cracking Propagation
- Conclusion is unchanged
- List of Commitments in Appendix A
  - Several commitments completed and reviewed by NRC staff

Potential for Borated Water Degradation of Steel Containment Vessel (Commitment 39 – Phase 1 Complete)



Steel Containment Vessel Exterior Surface NDE in Sand Pocket Region (Commitment 35, Phase 1 – Complete)

- Perform UT of SCV in the sand pocket region from the outer surface at five areas of previously identified groundwater in-leakage (Phase 1 - 2014, Phase 2 – repeat in 2025)

- Phase 1 Complete (Spring 2014): UT results acceptable
  - Consistent with previous UT examinations
  - Above ASME Code minimum design thickness, with margin

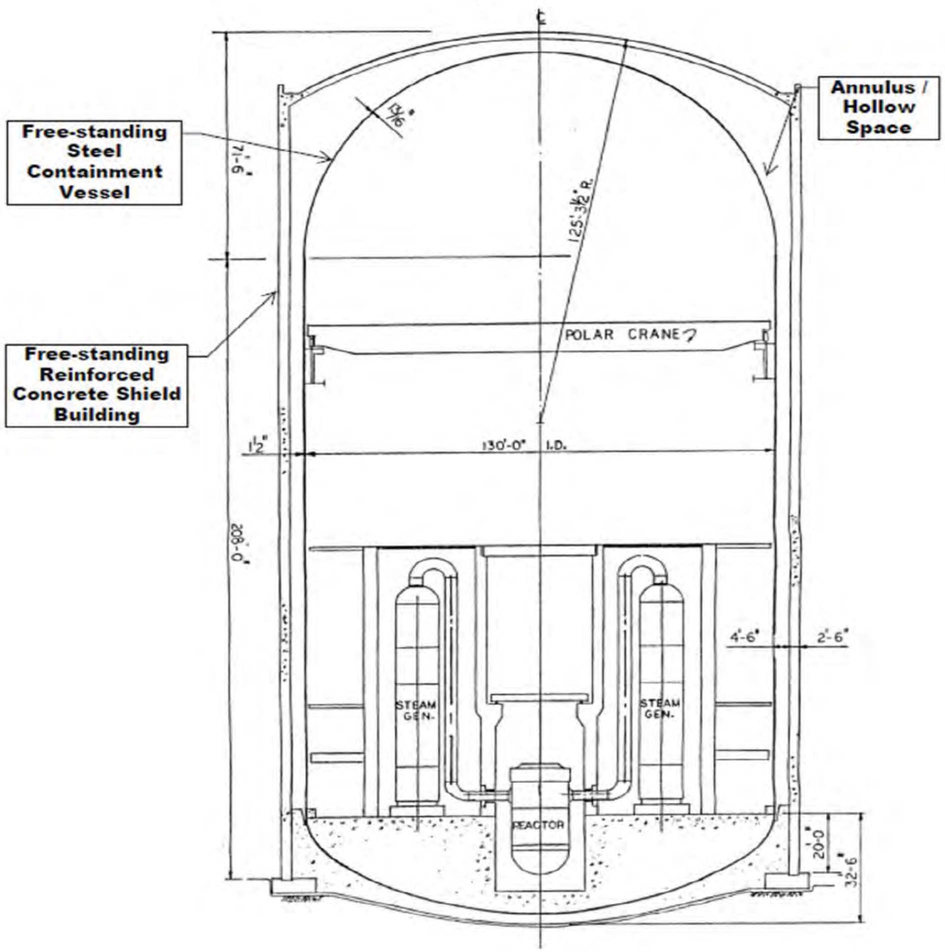
Flow-Accelerated Corrosion Operating Experience

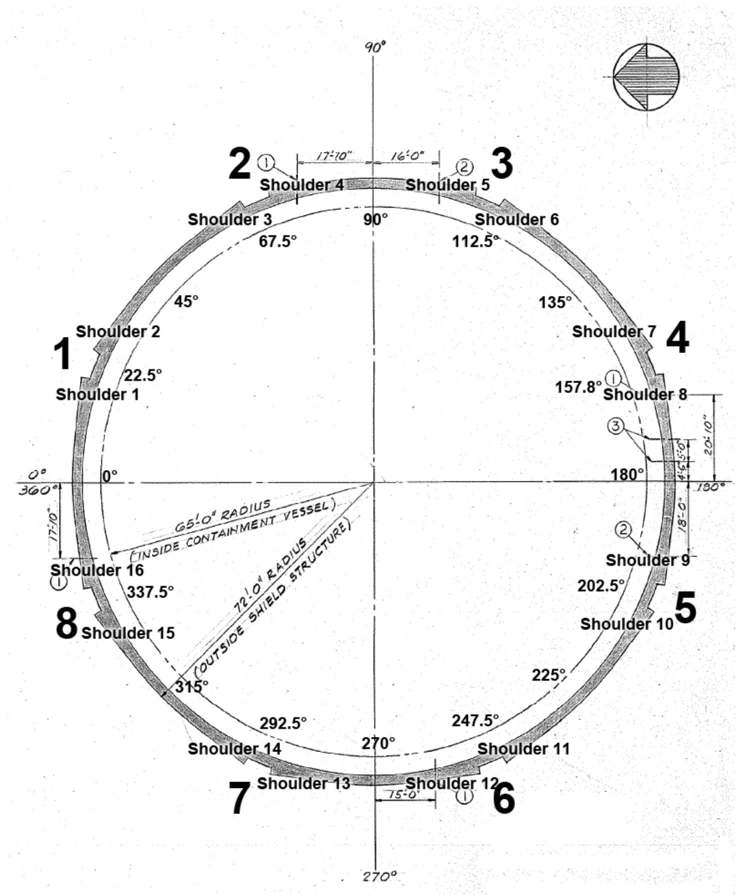
- Failure in 4-inch elbow immediately downstream of restricting orifice.
- Applicant's root cause:
  - Orifice incorrectly modeled
  - Error from original model in 1989
  - Corrective actions from 2006 event did not validate all critical data inputs
- Event led to additional corrective actions and new commitments for FAC program

Shield Building Laminar Cracking (OI 3.0.3.2.15-1) - Background

Shield Building Laminar Cracking - Background

Davis-Besse SB Cross Section

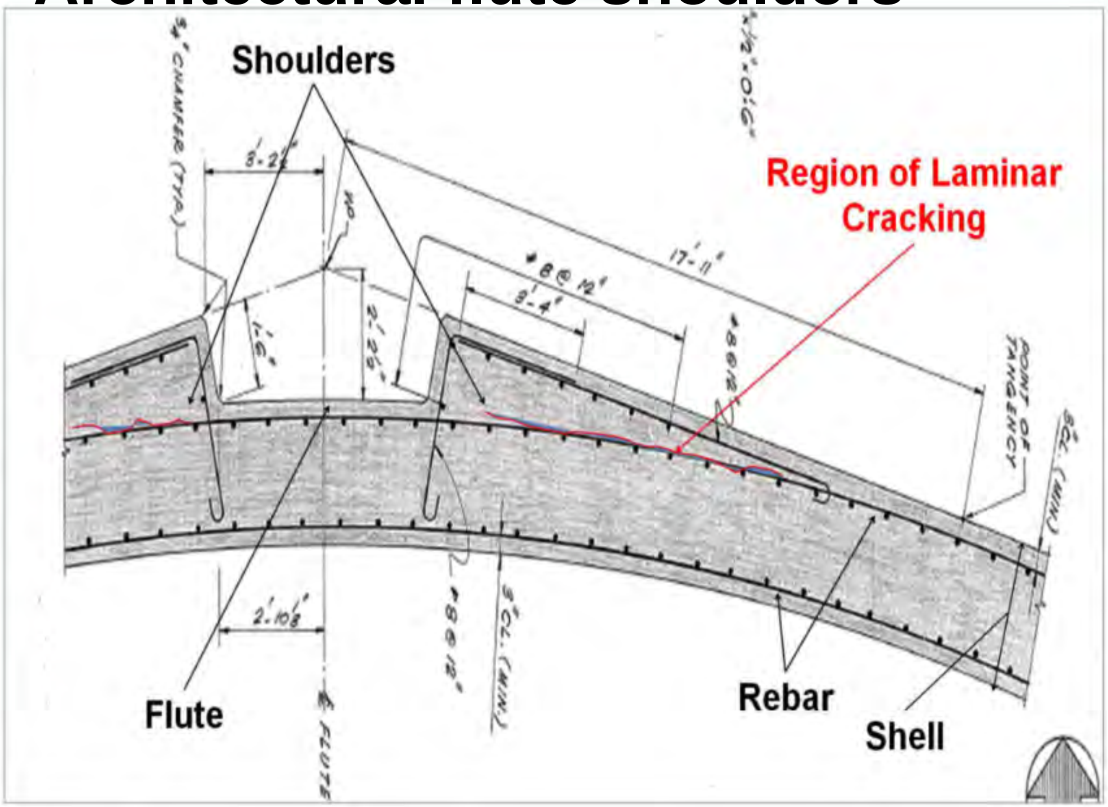


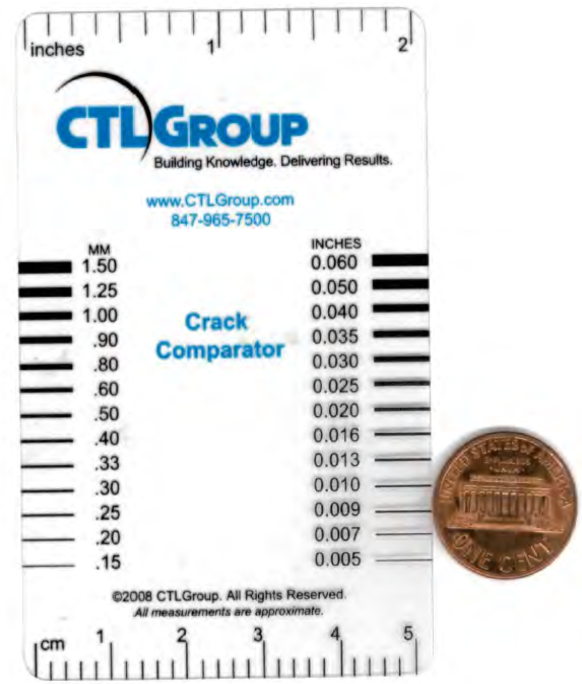


U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

Shield Building Laminar Cracking - Background

Architectural flute shoulders





Shield Building Laminar Cracking (OI 3.0.3.2.15-1) - Background

- Laminar cracks observed in multiple locations of cylindrical wall primarily in flute shoulder regions
- Cracking initiation event driven - 1978 Blizzard (direct cause), no exterior coating (root cause), flute shoulder configuration, rebar arrangement/density: this combination of factors was unique to the SB
- Shield Building Monitoring Program (SBMP) to manage aging effects on laminar cracks; preventive protective coating applied

Shield Building Laminar Cracking – SBMP Chronology

- Jan 1978: Blizzard initiated laminar cracking
- Oct 2011: Laminar crack discovered in access opening & other areas
- Feb & May 2012: Root Cause Analysis Report (Rev. 0 & Rev. 1)
- Feb 2012: Borescope inspection identified no new or changes in existing cracking in core holes
- Apr, Aug, Nov 2012: SBMP proposed & revised
- July 2012: SER w/Open Items issued
- Aug–Oct 2012: Exterior coating applied on SB
- Sep 2013: Final SER issued
- Aug–Sep 2013: Baseline borescope inspection found previously unidentified cracking / indications of crack propagation
- April 15, 2014: Staff RAI on new OpE of SB crack propagation
- July 8, 2014: Apparent Cause Evaluation Report for propagation
- July 2014–Jan 2015: RAI followups, Revised SBMP incorporated OpE
- Aug 2015: Supplemental SER issued

Shield Building (SB) Laminar Cracking - SBMP

- Plant-specific prevention & condition monitoring AMP, supplements Structures Monitoring AMP
- Scope includes SB Wall Concrete & Reinforcing Steel; SB exterior concrete coatings
- Periodic visual inspections of representative sample of core holes; opportunistic visual inspections of rebar near laminar cracking in wall; periodic inspections of exterior coating every 5 years & coating reapplied every 15 years
- Inspector qualifications per ACI Report 349.3R Ch. 7

Shield Building Laminar Cracking – SBMP contd…

Operating experience of crack propagation:

- AMP considers and incorporates future operating experience, as necessary

- Accordingly, the applicant revised AMP to incorporate plant-specific OpE of laminar crack propagation discovered in Fall 2013, attributed to “ice-wedging” phenomenon.

- Revised AMP increased inspection sample size of core holes, increased inspection frequency, and strategy for monitoring crack propagation

Shield Building Laminar Cracking – SBMP contd..

Adequacy of sample size and distribution:

- Representative sample for inspection consists of a minimum of 23 strategically located core holes, with provisions for expanding inspection sample

- 14 are cracked covering the spectrum of locations with highest prevalence of cracking and a range of observed crack widths including the maximum observed crack width, including 3 leading edge bores to monitor planar limit of observed propagation.

- 9 are uncracked but located near areas of known cracking providing ability to monitor propagation

Shield Building Laminar Cracking – SBMP contd..

Acceptance Criteria:

- **Coatings** – Criteria from ACI 349.3R Chapter 5
- **Core Hole Inspection Findings**: Evaluated in Corrective Action Program for conformance with design and licensing basis documentation, previously determined propagation rates, and evaluation hierarchy in Figure 5.1 of ACI 349.3R, if there is
  - Discernible change in existing cracks (width, planar size)
  - Indication of new cracking
  - Crack width greater than 0.013 inch
  - Current extent of circumferential planar crack limit exceeded (SSER Table 3.0.3.3.9-2)

Shield Building Laminar Cracking – Conclusion

- Staff concludes that there is reasonable assurance that aging effects on the shield building laminar cracking will be adequately managed by the Shield Building Monitoring Program, such that intended functions will be maintained during the period of extended operation.

- OI 3.0.3.2.15-1 is closed and staff evaluation is documented in SER Section 3.0.3.3.9.

Conclusion

On the basis of its review, the staff determines that the requirements of 10 CFR 54.29(a) have been met for the license renewal of Davis-Besse Nuclear Power Station

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Shield Building Laminar Cracking

Back-up Slides

ACI 349.3R Evaluation Heirarchy

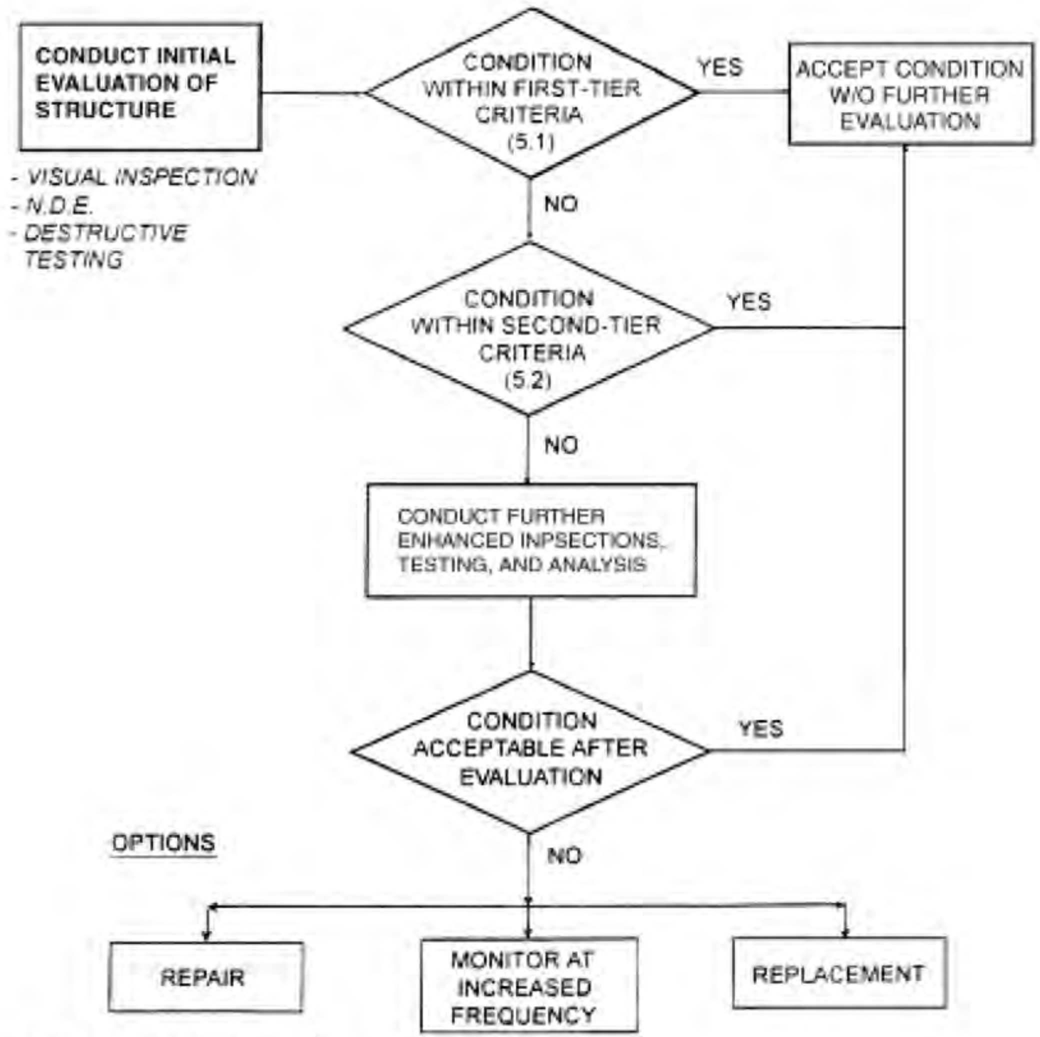

Fig. 5.1—Evaluation criteria hierarchy.