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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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LICENSE RENEWAL SUBCOMMITTEE

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OPEN SESSION

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WEDNESDAY

OCTOBER 31, 2018

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ROCKVILLE, MARYLAND

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The Subcommittee met at the Nuclear Regulatory Commission, Three White Flint North, Room 1C3 & 1C5, 11601 Landsdown Street, at 8:30 a.m., Gordon R. Skillman, Chairman, presiding.

COMMITTEE MEMBERS:

GORDON R. SKILLMAN, Chairman

MICHAEL L. CORRADINI, Member

RONALD G. BALLINGER, Member

DENNIS C. BLEY, Member*

CHARLES H. BROWN, JR., Member

VESNA B. DIMITRIJEVIC, Member

WALTER KIRCHNER, Member

JOSE MARCH-LEUBA, Member

JOY L. REMPE, Member

PETER RICCARDELLA, Member

ACRS CONSULTANT:

STEPHEN SCHULTZ

DESIGNATED FEDERAL OFFICIAL:

KENT HOWARD

*Present via telephone

AGENDA

P R O C E E D I N G S

8:30 a.m.

CHAIRMAN SKILLMAN: Ladies and gentlemen, good morning. This meeting will now come to order. This is a meeting of the ACRS's Plant License Renewal Subcommittee. I am Gordon Skillman. I'm Chairman of the ACRS License Renewal Subcommittee.

ACRS members in attendance are Dr. Ronald Ballinger, Dr. Peter Riccardella, Dr. Walter Kirchner, Dr. Joy Rempe, Dr. Michael Corradini, Dr. Jose March-Leuba, Dr. Vesna Dimitrijevic, and Dr. Dennis Bley by phone.

Our colleague, Mr. Charlie Brown, will attend later. We welcome Dr. Stephen Schultz as our consultant on this topic, and Mr. Kent Howard of the ACRS staff is the designated federal official for this meeting.

NextEra, the licensee for Seabrook station, is following the required protocol for requesting a license renewal for 20 years for the Seabrook Station.

This special meeting is convened to provide focus on one unique topic effecting license renewal of this nuclear power plant, and that topic is alkali-silica reaction on structures, systems, and components within the scope of the license renewal at the Seabrook Station.

Because of the critical nature of this topic, the ACRS considered this independent meeting appropriate and important to enable stakeholder, licensee, and staff participation.

In this Subcommittee meeting, we expect the staff and NextEra to brief the Subcommittee on the status of the alkali-silica reaction issue at Seabrook. The Subcommittee will gather information, analyze relevant issues, formulate a proposed position for deliberation for deliberation for the full committee if needed.

As we begin, I would like to emphasize several points relating to this specific meeting. One of Seabrook Station's required aging management programs addresses structures, systems, and components.

The AMP, Aging Management Program, that addresses SSCs, structures, systems, and components, must address the suitability of the SSC for the mechanical loading for the period of extended operation.

The alkali-silica reaction discovered at Seabrook obligates determining its impact on those SSCs within the scope of license renewal Seabrook.

The ASR imposes structural loadings that are different than those originally addressed in Seabrook's operating license. NextEra is required to formally address those different structural loadings through a license amendment request.

NextEra has submitted a license amendment request to address the different loadings. The license amendment request is based on research and analysis and data intended to demonstrate the acceptability of ASR in those SSCs that are required both for present and for future plant operation.

This meeting is focused on determining whether the SSCs affected by ASR and addressed by the AMP and the license amendment request are acceptable for the requested period of extended operation that NextEra has requested in their license renewal application for Seabrook.

The ACRS was established by statute and is governed by the Federal Advisory Committee Act, FACA. That means that the committee can only speak through its published letter reports. Let me say that again so that it's clear in everyone's mind. That means that the committee can only speak through its published letter reports.

This meeting, a Subcommittee meeting, enables the members to express their comments and concerns, and those comments may or may not find their way into the final letter of report. That means we speak as individuals.

The ACRS reviews and advises the Commission with regard to licensing and operation of production and utilization facilities and related safety issues, the adequacy of proposed reactor safety standards, technical and policy issues related to the licensing of evolutionary and passive plant designs, and other matters referred to it by the Commission.

The ACRS section of the U.S. NRC public website provides our charter, bylaws, letter reports, and full transcripts of all Subcommittee meetings, including slides presented at the meetings.

The rules for participation in today's meeting were announced in the Federal Register. The meeting was announced as open, but here it is. Portions may be closed as needed to protect information proprietary to NextEra or its vendors pursuant to 5 USC 552BC4.

We have, I repeat, we have received written comments and requests for time to make oral statements from members of the public during today's meeting.

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

Participants are requested for first identify themselves and speak with clarity and volume so that they can be readily heard.

A telephone bridge line has been established for this meeting. We have several members of the public, one ACRS member, and perhaps others from the public listening in on the public bridge line.

This public line will be closed during the closed section of the meeting and will be reopened during the open session. We will close the public line as necessary if that is required.

To preclude interruption of the meeting, we ask that you please mute your individual lines during the presentations, and for those in the room, we request that you please silence all your phones and electronic devices.

Before turning the meeting over to Joe Donoghue of DMLR, and this is different for ACRS, I want to provide opportunity for ACRS members to express their expectations for this meeting. We don't normally do this.

My concern is very often the ACRS is seen as a group of individuals who are perhaps not too willing to engage or perhaps not express their thoughts. Since this meeting is different, I want to give the members an opportunity to provide comment before we begin so that NextEra and the staff can hear, if you will, how the ACRS thinks.

I will begin by stating that I am interested in both the staff's and licensee's clear statements that communicates their understanding of the seriousness of the ASR issue at Seabrook, clarity regarding the scope of the structures, systems, and components affected by ASR, clarity regarding the extent of condition resolution and research of this phenomenon, demonstration of the discipline related to understanding the as-found state and of the progression of the ASR phenomenon, and the thoroughness of the licensee's plans, actions, commitments, and programs to fully and comprehensively address ASR.

I invite my colleagues to offer their opening comments. I will begin by asking Dr. Dimitrijevic.

MEMBER DIMITRIJEVIC: So this is my first meeting on this issue, so my goal of this thing is to see that we have a full understanding of the issue and status. So I have a very small expectation just to get completely familiar and understanding of the issue, okay.

CHAIRMAN SKILLMAN: Thank you, Vesna. Dr. Corradini?

MEMBER CORRADINI: I also am trying to learn about the issue, so my only comment is I think the background information we've gotten is quite comprehensive, so I think that will help.

CHAIRMAN SKILLMAN: Thank you, Mike. Dr. Rempe?

MEMBER REMPE: Thank you, Dick. I, in reading through the material, was very interested in why there was such a long time between the 2010, 2009 initial observation of ASR and then the time frame before another indication of it was identified in 2014.

ASR is a known phenomena in other industries and applications, and I am interested in that lag because I want to understand that you're not only monitoring the ASR identified structures, but other structures that might be susceptible, okay? Thanks.

CHAIRMAN SKILLMAN: Thank you, Joy. Dr. Riccardella?

MEMBER RICCARDELLA: Yes, thank you, Dick. I'm a mechanical engineer with a background in structure strength and materials, structural analysis, and probably the closest thing we have on this committee to a structural engineer. I've spent a lot of times in the last couple of weeks reviewing the background information, which I found to be a very, very impressive program and comprehensive.

I have some questions, and I guess my goal for this meeting is to get those questions answered and get all of the information we need for our full committee deliberations.

CHAIRMAN SKILLMAN: Thank you, Pete. Dr. Kirchner?

MEMBER KIRCHNER: Thank you, Dick. My particular interest in this meeting is to see how the test program that was conducted bounds the problem based on the condition assessment and project impact of this ASR over the applicant's, you know, the extended license period. Thank you.

CHAIRMAN SKILLMAN: Thank you, Walt. Dr. March-Leuba?

MEMBER MARCH-LEUBA: As opposed to my

members, I want to start by apologizing for two things. First, it will take a little while to understand my accent, so I will try to speak slowly into the microphone, and second, I am not an expert on this whatsoever.

I mean, ASR, my extent of ASR knowledge is wherever there's a snow forecast, I put the snow on my driveway, and when the snow is away, the driveway's kind of chipped, so that's what I know.

So considering the questions, I wanted to apologize, but the questions I will ask you during the presentation, consider me an uninformed member of the public and I will try to kind of inform the public through my questions.

CHAIRMAN SKILLMAN: Thank you, Jose. Dr. Ballinger?

MEMBER BALLINGER: Thank you, Dick. I really can't add anything to what everybody else has said except for the fact that I live in the EPZ for Seabrook. More importantly, the Airfield Café and the Max BMW motorcycle place is in the EPZ, so I have a very keen interest in what's going on.

My area is corrosion and materials, and I've actually done work related to ASR, so my expectation is to understand that you folks understand the process and what's going on, and in particular, what Walt has to say, how the testing has bounded the conditions at Seabrook.

CHAIRMAN SKILLMAN: Thank you, Ron. Dr. Schultz?

MR. SCHULTZ: My experience is in technical support for supporting operating reactors as a licensee, and I'm sure the Committee wants to develop today a full understanding of the requirements of the ongoing and forward-looking plan and program for addressing ASR.

How has it been implemented for the current operation of the plant? What modifications are required in the near term as a result of the license amendment commitments by the licensee? What if anything in the current program is still in flux?

And I want to, we want to assure that the applicant, the Committee, and the staff will be certain that the program for addressing ASR is fully in place to support the application for license renewal.

CHAIRMAN SKILLMAN: Thank you, Steve. Dr. Bley, may I ask you, please, to offer any comment or expectation you might have, sir?

MEMBER BLEY: No, thank you, Dick. I have nothing additional to add, but I am interested in how the test results have proceeded. Thanks.

CHAIRMAN SKILLMAN: Thank you, Dennis. With that, I'm going to turn the meeting over to Joe Donoghue, the Deputy Director of the Division of Material and License Renewal. Joe, welcome, and thank you. Please proceed.

MR. DONOGHUE: Good morning. Thank you, Chairman Skillman, members of the ACRS License Renewal Subcommittee, and other ACRS members in attendance. Yes, I'm Joe Donoghue. I'm the Deputy Director of the Division of Materials and License Renewal.

We thank the Subcommittee for the opportunity to present an overview of the NRC's activities associated with the review of the alkali-silica reaction or ASR effecting concrete structures at Seabrook Station Unit 1, as well as the results of the staff's review of the applicant's methodology for assessing structures impacted by ASR that was submitted in a license amendment request, and the staff's review of the aging management programs that are credited for addressing ASR in their license renewal application.

I'll just add that there's two separate actions that are affected by this, the license amendment request as well as the license renewal. They depend on the same methodology and the license renewal depends on, it involves a program that's going to, the aging management program that's going to address it.

The NRC has spent considerable time and effort on the ASR issue to ensure that it was appropriately addressed for operability as part of the current licensing basis and in the aging management program's credit for the license renewal.

Just to highlight the extent of the effort, we had site resident inspectors performing regular inspections to assess operability. We had Region I inspection staff who were supported by headquarters' technical staff conducting problem identification and resolution inspections onsite, and we did inspections at the testing site.

We had senior structural engineers from the Division of Engineering assessing the aging management programs for ASR, the structural assessment methodology, and the large-scale testing that was conducted at Ferguson Structural Engineering Lab at the University of Texas. They were also supported by structural engineers from Brookhaven National Lab.

The staff also had a team of reviewers and experts that we established back in 2012 to coordinate all of our activities.

In July 2012, the staff presented the safety evaluation report with open items to the ACRS License Renewal Subcommittee, and of those open items that existed at the time, the one associated with aging management for ASR dominated the discussion.

Today, the staff will present its review of the enhanced and newly developed aging management programs that address ASR that are the basis for the SAR, and that we think resolve this open item. We will present the complete SER and address the remaining open items in a meeting in a couple of weeks to the Subcommittee.

The project manager for the Seabrook license renewal safety review and who will lead us through the presentation is Butch Burton seated opposite me in the room.

Part of the management team that are here with me today are Eric Oesterle next to me, Chief of the Projects Branch in our division, Kamal Manoly who is Senior Level Advisor for Structural Mechanics from the Division of Engineering, and other division and NRR office technical experts and managers.

We also have in the audience and on the phone other staff who supported the review, as well as Region I staff who performed the facility inspections and supported the license renewal reviews, and you'll be hearing from one of them in the presentations later today.

We look forward to a productive discussion with the ACRS Subcommittee, and as always, we will address any questions on this review that you may have. And at this time, I'd like to turn the presentation to NextEra and their Regional Vice President for the Northern Region, Mr. Eric McCartney, to introduce his team.

MR. McCARTNEY: Thank you, Mr. Donoghue. As he said, my name is Eric McCartney and I've been the Regional Vice President for NextEra Energy responsible for the Seabrook Station, Point B Station, and Duane Arnold Station for the past year.

I've been in the commercial industry for 33 years now. I started my career as an unlicensed operator and I have served as the plant manager or site vice president at five different stations in the course of that career. I was a senior reactor operator, licensed operator at the Harris Nuclear Plant outside of Raleigh, North Carolina.

We're pleased to have the opportunity to discuss our structures monitoring program specifically as it relates to alkali-silica reaction with the

Committee today.

NextEra has expended a tremendous amount of time and resources to develop a clear understanding of this issue and develop a comprehensive structures monitoring program that provides us assurance that we can operate the plant safely and reliably not only for the current license, but for the extended license that we are requesting.

We recognize that this condition is a life of the plant condition, and as a corporation, we remain committed to engage in anything and all activities we need to do to ensure that we operate this plant with the safety margins that it's designed to operate with.

We have worked diligently with industry leaders to ensure that we gain any expertise that we may lack at our facility. We have engaged with the folks that we need to, to make sure that we clearly understanding this. Many of them are here today that will help in the discussion.

We also recognize the obligation that we have to the industry to share what we've learned as we go forward with this process. We remain engaged with INPO through our membership.

We continue to work with NEI, and EPRI, and other industry groups to share everything that we learned to ensure that the industry and other facilities in other industries can gain the knowledge that we've gained as we've worked through this process.

Today, we'll talk about our large-scale testing program. We'll talk about the development of the methodologies to monitor the loads, and we'll talk about our structures monitoring program, and provide a comprehensive discussion of both of those, and I believe we'll answer all of the questions and concerns that you articulated as you went through your questions. If we could go to our slide?

MR. BURTON: Good morning. As Joe said, my name is Butch Burton. I'm the project manager for the NRC staff safety review of the license renewal application for Seabrook station Unit 1.

As was already mentioned, we're here today to discuss the staff's closure of the open item related to the alkali-silica reaction known as ASR related to the Seabrook license renewal application.

The closure of this open item is documented in the staff's safety evaluation report for the license renewal application and is supported by the staff's safety evaluation on a related license amendment request. Both of these documents were issued on September 18, 2018, and provided to the Subcommittee.

We'd like to begin this meeting by providing you with an overview and timeline of the NRC's activities related to ASR at Seabrook. We'll then turn the meeting over to representatives from NextEra Energy Seabrook, which is the licensee for Seabrook, who will discuss their activities on this project.

Following the NextEra presentation, the staff will discuss its review, audit, and inspection activities associated with ASR at Seabrook, and we'll discuss the basis for its closure of the ASR open item in the SER.

As we stated, portions of this meeting will be closed to the public. The staff has not prepared presentations for the closed portion of the meeting, but will be available to answer any questions from the Subcommittee during the closed portion of the meeting.

Seabrook is a single-unit Westinghouse four-loop pressurized water reactor located just south of Portsmouth, New Hampshire. Its 40-year operating licensed was issued on March 15, 1990, and the unit began commercial operation on August 19, 1990. NextEra is the principal owner and operator of the unit.

On May 25, 2010, NextEra submitted a license renewal application requesting renewal of its operating license to allow operation for 20 years beyond the expiration date of its current license. Issuing a renewed license would allow the plant to operate through March 15, 2050.

In 2009, NextEra identified pattern cracking in sections of walls and certain below grade structures at Seabrook. In 2010, NextEra confirmed that this cracking was due to ASR. In order to address this ASR issue, NextEra pursued two licensing actions.

It amended its existing license renewal application to include activities to manage aging resulting from ASR and it submitted a license amendment request to address the nonconforming condition with its current license resulting from the effects of ASR.

As you can see, these actions were addressed along two parallel tracks. The upper track shows that NextEra submitted an amendment to its license renewal application and shows the staff's review and the issuance of its review findings in the safety evaluation report.

The lower track shows that NextEra submitted a license amendment request to address ASR in current licensing space, and shows the staff's review and the issuance of its review findings as the final safety evaluation.

As shown, the identification of ASR at Seabrook led to an immediate impact on the license renewal application review schedule and a prolonged time period of NRC oversight activities to fully understand the issue. The NRC's activities will be discussed in more detail during our presentation this afternoon.

Before I turn it over to NextEra, I did want to reemphasize what Chairman Skillman mentioned before, that portion of NextEra's presentation will be closed. During that time, we will ask members of the public to leave the room and we will also close the public bridge line. After the closed portion of the meeting is completed, we'll bring members of the public back in and reopen the public bridge line, and they'll let us know when it's appropriate to do that.

Now I'll ask representatives from NextEra to discuss their activities to address ASR at Seabrook.

MEMBER MARCH-LEUBA: Just a question and first I'd like to inform you that we, the members, we ask a lot of questions and we interrupt a lot, so you know that. So I'm not sure if you are the correct person to ask this, but is this a program which is specific to Seabrook or is this a more generic issue? Is the staff considering it in other plants?

And I'm thinking the ASR, the S stands for silica, and most concrete is done with limestone. Is that the answer? Is Seabrook the only plant that used silica hydrates?

MR. BURTON: I can say that as far as the nuclear industry, I believe, and correct me if I'm wrong, I believe that Seabrook is the only nuclear plant that has found this problem, although my understanding is that it is an issue in other areas such as, I guess, transportation, but we do have some of our technical folks here. I don't know the extent to which it applies to other things beyond what we're seen. I don't know if -

MEMBER MARCH-LEUBA: So the other question is you don't believe it's a generic issue, but was there a generic letter issued to make sure that every other plant was aware of the problem?

MR. DONOGHUE: No, this is Joe Donoghue. No, we didn't issue a generic letter on this, and this is a plant specific program that was put together. There is continuing research that I think you're going to hear about today. I think in his opening remarks, Mr. McCartney mentioned their connection with INPO, so the industry is aware of the issue, but this is -

My understanding, and I think you're going to hear this from the staff's presentation, this is the first plant that observed ASR and this is the only plant that I know of that has experienced it to the extent that it could affect operability, and that's what we're addressing here, so other plants have not experienced it to that extent.

MEMBER MARCH-LEUBA: I'm thinking from the point of view of physics, not - I mean, you need two things for this to happen. You need to be close to the sea to have salty water in your basement and have used concrete that is segregated with granite.

MR. DONOGHUE: So Angie, one of our experts who you're going to hear from later today, can add to my, to our answers.

MS. BUFORD: Sure, when the ASR issue was discovered at Seabrook, the NRC staff did issue an information notice which didn't require licensees to provide the NRC with written feedback, but it did require that licensees consider the potential for ASR, and so per the process for dispositioning information notices, that goes into the corrective action program, and then our resident inspectors inspect to make sure that the licensees have adequately considered it.

MEMBER MARCH-LEUBA: Excellent, so you would have held the ball and considered it on a generic basis and discounted it. Thank you.

CHAIRMAN SKILLMAN: So NextEra is up. Yes, sir?

MR. McCARTNEY: Thank you, Mr. Chairman. So I have with me today Mr. Mike Collins. He's our engineering director at the Seabrook Station. Mr. Ken Brown is our licensing manager. Mr. Ed Carley, Ed is our program manager for license renewal. And behind you is Ms. Jackie Hulbert, and Jackie is our program engineer for the ASR program.

Before I turn it over to the team for some technical discussion, I'd like to bring your attention to a little about the nuclear excellence model at NextEra Energy.

This is a model of how we use to govern our operation within our fleet. It's been in our protocol since 2008. It's based on a set of core principles and values that have never changed. They've been the same since we introduced the model.

You'll see at the first top value on the left, it's the, we conduct all activities with a deep respect for nuclear safety. This is the foundation of how we operate our fleet and our enterprise.

We also focus very heavily on being a self-improving culture and a learning organization, and you'll see through our discussion, everything that we talk about in our structures monitoring program is subject to our appendix B corrective action program.

It gets audited through our own internal audit program. It's subject to audit by our nuclear oversight committee. It also reports out to our corporate oversight, nuclear oversight committee that reports to our board of directors.

We also focus heavily on prevention and detection, and if we can spend 80 percent of our time in prevention and detection, we can find issues at the early onset and deal with them quickly so that the actions that we have to take at that point are relatively small and manageable and easy.

When we get into correcting space, we're now having to correct a larger issue, so we want to focus heavily, 80 percent of our time, in prevention and detection, and this is the foundation of how we've operated our fleet since 2008 and we'll continue to do so.

CHAIRMAN SKILLMAN: Eric, let me ask this question, and I'm imagining Dr. Rempe's opening question. You're a learning organization. You just communicated that your vision for your company is to jump on issues early and prevent them from becoming worse. Why then did it take from 2010 to 2014 to really get a grip?

MEMBER REMPE: And could I even go a bit further? Wasn't it because of an NRC inspection that the next indicator in 2014 was identified? And the reason that I'm again raising this now is because I want to have the concern addressed that you're now looking for other places where something could occur.

It was known that ASR expansion could cause buildings, to place different loads on buildings and have the walls deform, and that was what caused, my understanding is, the seal to quit functioning as it should. Is my question clear what I'm trying to say?

MR. McCARTNEY: I think your question is clear and I think that through the course of the technical discussion today, we'll probably answer a number of those questions.

But one of the things that is a bit unique about the application of ASR at Seabrook is the small growth model. Much of the science involved with ASR was recognizing an early rapid growth period. The testing that we did early on during construction looked for fast growth ASR.

I think the team will speak to that in a lot more detail and a lot more technically than I'm able to, but that, I believe, is the foundation that will speak a bit to that time lag that you asked your question about, Dr. Rempe.

MEMBER REMPE: Thank you.

CHAIRMAN SKILLMAN: Eric, thank you. Please proceed.

MR. McCARTNEY: Okay, thank you, and I'd like now to turn it over to our technical team and Ms. Hulbert will come up and I'll leave back to the back of the room.

MR. BROWNE: Thank you, Eric, and thank you, Mr. Chairman. I'm Ken Browne, licensing manager for Seabrook Station. I've been at Seabrook for 28 years.

I've held positions in operations, including a senior reactor operator's license, varying positions in the control room up through ops director, several years in accredited training, and then the last three years, I've been involved as a regulatory compliance and project management sponsor for the alkali-silica reaction project at Seabrook.

We've prepared a very comprehensive presentation for you today. I believe it will address the Committee's requests and concerns that you articulated at the beginning of the meeting.

Just a bit of background, since Seabrook's last presentation at the ACRS Subcommittee, NextEra and its specialty contractors have been engaged in industry leading research in establishing a safe, reliable method for understanding the effects of ASR and also how it affects concrete and safety-related structures.

CHAIRMAN SKILLMAN: Let the record show that that last interaction with the ACRS was in 2012.

MR. BROWNE: That is correct.

CHAIRMAN SKILLMAN: It's been six years.

MR. BROWNE: That's correct.

CHAIRMAN SKILLMAN: And I'm not assigning any pejorative connotation to that. I'm just saying it's been a while since we've had you here to explain what you're doing.

MR. BROWNE: It has been a while, yes, sir.

CHAIRMAN SKILLMAN: Thank you, okay.

MR. BROWNE: And at the time, we had spoken about our large-scale test program which we had just been initiating at the University of Texas, which was to perform disruptive testing on large-scale beams done with specimens that were representative of Seabrook's structures.

Instead of tests on small sample cores,

the large-scale testing would provide data about the structural capacity of ASR-affected structures at Seabrook, which as we all know, has significant reinforcement.

We had since completed that large-scale testing and it has demonstrated that there is no loss of structural capacity for levels of ASR expansion beyond that presently observed at Seabrook. The results of the large-scale programs have been incorporated into our structures monitoring program and into evaluations of ASR-affected structures, and as part of today's presentation, we will discuss in detail how we determined that ASR conditions at Seabrook are within the bounds of the Texas program.

Another change since our presentation is that we've expanded the ASR project to include the monitoring of building displacement and deformation caused for ASR-related expansion.

As noted, over the past few years, we began to recognize that certain susceptible areas in the plant had shown relative movement due to ASR expansion. This was evident to us in components like seismic gaps, flex conduits, and we do have some photographs of that as part of our presentation, and in some cases, instrument tubing which had become misaligned.

At that point, we enlisted the services of Simpson, Gumpertz, and Heger out of Boston, who performed inspection and analysis of these effected buildings to ensure that the ASR-affected displacement would not alter Seabrook's compliance with its design code margins.

As data is integrated and continues to be integrated from monitoring these buildings, we will continue to update these evaluations throughout the period of extended operation.

MEMBER REMPE: So this is, I guess, a good place. You clearly have identified some buildings. Are you looking for other locations that you have not yet identified? I think there's feedback.

Okay, that's what I was concerned about because, you know, what's happened in the past has happened, but I want to make sure you're looking at other locations that have not been identified. Thank you.

MR. BROWNE: Yes, Doctor, we do have the extensive walk down program that's been in place for several years, and we have that as built into our presentation, our extended condition, the structural analysis, and where we stand currently for evaluation of those structures.

MEMBER REMPE: Thank you.

CHAIRMAN SKILLMAN: If I can ask, what is the connection between that walk down program and the entry of data into your corrective action program?

MR. BROWNE: Maybe Jackie Hulbert may be better to answer that one, but right now, the walk down data is entered into the CAP as part of the program and we'll demonstrate. We have a couple of slides later on that talks about our structures monitoring program and just some of the tooling we use to make sure that we've captured that by building and we're able to have it all in one place so we understand what's going on in the building.

CHAIRMAN SKILLMAN: Okay, thank you.

MR. SCHULTZ: Just a question, there is some impression that the NRC's audits have found the structural deformation in certain locations in the plant. Is that the case or is it just an instance where it's an area of the plant once identified in the NRC audit and what is the circumstance there?

I'm talking about 2014, the audits that were performed then. It appeared from the audit report that the NRC found elements of structural deformation before the licensee did.

MR. BROWNE: The deformation that I think you're talking about, Dr. Schultz, is our, and you'll hear about it here, is the containment enclosure building.

It was noted by a junior resident at the time that there was, from memory, there was a fire seal or a seismic gap seal that had pulled away from the structure and it was recognized, you know, credit given to the inspector that brought that to our attention, and that is really what led us down the road to understanding more about how ASR was affecting deformation on the structures, so, yes, it was identified by the NRC at that point.

MR. SCHULTZ: And that lesson has affected your program that you have in place today?

MR. BROWNE: Absolutely, and we'll talk more about that in subsequent material. Regarding regulatory transmittal over the last several years, we have used the information from the Texas test programs to also prepare two important licensing actions for Seabrook.

We've submitted a license amendment request, as Mr. Burton has noted, since relevant design codes that Seabrook was built with did not consider the loads resulting from alkali-silica reaction, and we'll talk about that extensively in our presentation, and that amendment covers the methodology for evaluating ASR-affected seismic CAT 1 structures at Seabrook.

This methodology uses the results of the large-scale testing program to determine the structural capacity of concrete structures at Seabrook and defines the analytical methodology used to evaluate these structures.

The methodology also includes monitoring to ensure that structures remain within limits of the large-scale testing program and within its design margins as established in the structures analysis.

We have also enhanced our license renewal aging management program for alkali-silica reaction, which was the program we first presented back in 2012, to account for the results of the large-scale testing program.

I'm going to move to introduce our team on the next several slides. We've brought a number of NextEra individuals and also our specialty engineering firms that have assisted us over the years with getting to this point.

I won't go into specific details of introductions on our contractors, but I will just go through the highlight, the slides, and the team leads just to move us into the presentation, Mr. Chairman.

The NextEra representatives are, as Eric has mentioned, here, and all of these will be speaking at some point during today's presentation.

We also have, excuse me, we also have MPR Associates who is a well-known industry expert. They are a multidisciplinary specialty firm with roots in the nuclear power industry, and John Simons is here leading that team from MPR.

We have Simpson, Gumpertz and Heger, which we're lucky to have, out of the Boston office, which is in close proximity to Seabrook, and they're a national engineering firm that designs, investigates, and rehabilitates structures, and Dr. Said Bolourchi is here leading that team and he'll be making a large part of our presentation today.

And lastly, we have some distinguished technical consultants, notably Dr. Bayrak, who ran our program at the University of Texas at Austin, and Dr. Bruce Ellingwood of Colorado State University.

I'm going to turn the presentation over to Mike Collins, our engineering director, to walk us through the background and introduction to ASR from an engineering perspective.

MR. COLLINS: Good morning, my name is

Michael Collins and I'm the Director of Engineering at Seabrook Station. I have 37 years' experience in the nuclear industry, 17 years with Stone and Webster Engineering, with new build construction, and also continuing services at operating facilities, and 20 years at Seabrook Station, the last four-and-a-half years in which I functioned as the Director of Engineering.

So my part of the presentation here will be the background of our station and also lay out how we're going to proceed today with our discussions and presentations.

Seabrook Station is a single unit Westinghouse four-loop pressurized water reactor with a General Electric turbine -

OPERATOR: The conference is now in silent mode.

MR. COLLINS: We're located in the town of Seabrook, New Hampshire, two miles west of the Atlantic Ocean, approximately two miles north of the Massachusetts state line, and 15 miles south of the Maine state line.

Our reactor is housed in a steel-lined reinforced concrete containment structure which is enclosed by a reinforced concrete containment enclosure structure. This containment enclosure building, otherwise known at the station as the CEB, is a structure that actually encapsulates our containment building.

So if you're onsite and you look at the rounded structures at many facilities, it is in fact a containment building. That's not the case at Seabrook Station. That's our containment enclosure building.

MEMBER RICCARDELLA: Excuse me, is that building also the missile shield for the containment?

MR. COLLINS: The containment still has its analysis for missile shields, and we do have protection of missile shields that we'll discuss in one aspect of the presentation, to protect penetrations going through that area from the containment enclosure structure to containment itself.

MEMBER RICCARDELLA: But does the CEB also function as a missile shield?

MR. COLLINS: That is correct.

MEMBER RICCARDELLA: Okay, thank you.

MR. COLLINS: We're at 3648 megawatt thermal power and 1250 net megawatts electric. The Atlantic Ocean is our ultimate heat sink. The seismic category one mechanical draft cooling tower provides additional safe shutdown capability for the ultimate heat sink. Next slide, please.

This is an aerial view of our station, both the unit controlled area and our protected area. Again, we're two miles inland west of the open Atlantic Ocean. Next slide, please.

And this is the - as originally designed, this station was to be a two unit site. It's broken down, which we call the 50-yard line, down the middle of the station. This side of the station is Unit 2, which construction on that Unit 2 was terminated in 1984. The construction permit expired in 1988. That is outside our protected area as it stands.

Some of our major buildings that can be seen is our containment structure, our fuel storage building, our service water pump house, our primary auxiliary building, the seismic cat one safety-related cooling, mechanical draft cooling tower that was just mentioned, our residual heat sink removal vaults, and our controlled building which houses our emergency diesel generators.

So just quickly going through our licensing timeline, construction permit July 1986, zero power operating license October 1986, low power operating license in 1989, our full power operating license March

1990, and as was stated earlier, our commercial operation August 1990, operating license transfer to Florida Power and Light, now NextEra energy November 2002.

Our stretch power operate the 3587 megawatts was in February 2005. We went through a zero power recapture which the NRC then issued amendment 105 to the Seabrook facility operating license extending the expiration date from October 17, 2026 to March 15, 2030.

CHAIRMAN SKILLMAN: Michael, what was the action undertaken for the stretch power upgrade? What did you do there?

MR. COLLINS: It certainly wasn't the magnitude of the large station's extended power to operate. We placed some rotating elements in our condensate pumps. We didn't replace any feedwater heaters.

We didn't replace any feedwater pumps. Rather minimal, we fit our MSRs from a two pass to a four pass. It wasn't as large, again, as our facilities down south such as St. Lucie and Turkey Point encountered.

CHAIRMAN SKILLMAN: Did you change your fuel or did you change your operating cycle length?

MR. COLLINS: Yes, fuel design was changed through an 18-month design of our fuel cycle.

CHAIRMAN SKILLMAN: Okay, thank you.

MEMBER RICCARDELLA: What was the prior thermal power limit?

MR. BROWNE: The original licensed thermal power was 3411 megawatts.

MR. COLLINS: Again, we had a slight more increase in power with a two percent uncertainty up rate with instrument uncertainties we took advantage of. Our license reapplication was submitted in May 2010 and our present operating license expires March 15, 2030.

The present status of the ASR effort at Seabrook Station, to date, we've completed a comprehensive effort to conduct large-scale testing to understand the structural implications of ASR. From that, we've developed methodology for evaluation of ASR-affected structures.

We're evaluating, presently evaluating all our seismic category one structures. There's 26 of those structures. And we're developing a monitoring strategy of ASR-affected concrete and associated system structures and components.

We demonstrated compliance evaluated our seismic category structures and comply with the proposed licensing basis as amended in the LAR, and we have identified areas where modifications to structures are underway and required.

And as stated earlier, we're actively engaged with NEI, EPRI, and other working groups to make sure we're actively tracking developments and any other ASR research not conducted by ourselves.

NextEra Energy Seabrook has implemented an effective program for evaluating and managing the impacts of ASR on effected concrete structures and associated system structures and components.

CHAIRMAN SKILLMAN: Michael, you mentioned the numeric 26 structures. Is that 26 that are seismic category one or is 26 the number of the ASR-affected structures?

MR. COLLINS: 26 that are seismically category one, and each one of those are being evaluated via analysis as impacted by ASR as individual structures.

CHAIRMAN SKILLMAN: Is that what the station calls the ASR scope?

MR. COLLINS: That would be fair to say. We are looking at some other structures that aren't considered category one structures, but are part of our license renewal activity, and those will be included in the ASR aging management program.

CHAIRMAN SKILLMAN: Yes, sir, thank you.

MEMBER RICCARDELLA: So I spent some time reviewing the detailed evaluation of the CEB, which was cited as an example of a stage three evaluation.

MR. COLLINS: Yes, sir.

MEMBER RICCARDELLA: I'm just curious as to the scheduling of similar evaluations on these other 26 structures. Are any of the others complete? Are they going to be complete prior to the period of extended operation?

MR. COLLINS: Absolutely is the answer to that question, but we'll certainly go into more depth as far as the amount of structures that are evaluated. Presently 19 of those structures have their evaluations completed and eight structures are underway. Approximately half of those are in draft format at this point.

MEMBER RICCARDELLA: Okay, thank you.

MR. SCHULTZ: Will you present more detail, Mike? Will you present more detail on the schedule related to that later today?

MR. COLLINS: Yes, sir.

MR. SCHULTZ: Thank you.

MR. COLLINS: You know, the buildings were prioritized for evaluation with regards to the extent of ASR presently identified in those buildings. The point of discovery would be early for those buildings.

MEMBER KIRCHNER: Michael, could you give us some examples of modifications to structures? How extensive are these modifications and their relative importance?

MR. COLLINS: Yes, sir, one of the modifications that has taken place is there's missile shield blocks that are attached to our containment enclosure building as you go out towards the outside of the containment structure that, with regards to missile analysis, protect some of our very important penetrations that go from the Seabrook into the containment building.

With the relative movement of the containment enclosure building, one of those missile shield blocks actually came in contact with the ID of the containment structure. With that, we remediated that by reestablishing the three-inch gap between that missile shield block and the outside of our containment.

MEMBER KIRCHNER: Thank you.

CHAIRMAN SKILLMAN: Michael, when you mentioned the 26 buildings that are categorized, those are the category one, two, and three in accordance with some of your documentation?

MR. COLLINS: You'll see through our presentation today we have several different means of categorizing the extent of ASR and how we specifically analyzed those buildings, so those 26 structures are broken up into those three categories which we'll present when we do our detailed discussion of our analysis.

CHAIRMAN SKILLMAN: Thank you.

MR. COLLINS: Next slide, please. So the purpose of our presentation today is to describe the comprehensive approach for addressing ASR at Seabrook station, provide an overview of the technical basis for ASR, of the ASR management approach which certainly includes our large-scale testing, and from that, the methodology for evaluating ASR-affected structures, and then most importantly for the long term of our station, summarize implementation of the structures monitoring program for aging management of the ASR-affected structures. Next slide, please.

Our presentation outline will include my present presentation of ASR background, our approach to addressing ASR, our technical basis for our ASR management approach via the large-scale testing programs, and the structural evaluation methodology of ASR-affected structures, and our implementation of the ASR management approach, our structures monitoring program, and present the status of our relevant licensing actions, our license amendment request, and our licensing renewal application. We will then provide conclusions and closing remarks.

The background of ASR at Seabrook Station, in 2009 during the Seabrook license renewal process, it was identified that aggressiveness of groundwater chemistry on concrete structures in contact with groundwater and soil needed to be determined. Testing was performed, and in August 2010, Seabrook confirmed the presence of ASR degradation of concrete in below grade walls of several category one structures.

The identified material properties that were impacts, which again we'll go into detail as we go forward with our presentation, was a loss of compressive strength, loss of tensile strength, and reduction of the modulus of elasticity.

What ASR is, ASR occurs in concrete when reactive silica in the aggregate reacts with hydroxyl ions and alkali ions in the pour solution, the cement. Hydroxyl ions detach the silica anions which then combine with the alkali ions. The reaction produces an alkali-silica gel that expands as it absorbs moisture, exerting tensile stress on the surrounding concrete and results in the cracking that we'll discuss in detail in our presentation today.

What we have behind myself here on the shelf here are several samples of slices of core bores we have taken, you know, to give you a feel for the size of the cracking that we're discussing in the concrete pour.

We also have an example of the extensometer which is the device that we're using to measure through wall expansion, which we'll call the Z direction expansion of our concrete walls, and we have an optical device that we use for our crack mapping, and also finally petrography slides for the thin slices of the material they take for the petrographer to look at to determine what level of ASR we have in that core sample. You're free to look at that during the breaks. If you have any questions, please talk to one of the individuals supporting this presentation.

So these are pictures looking at ASR-affected structures outside of Seabrook Station. These photos will look very familiar to the pattern cracking that has been seen at our station and also through the country's infrastructure. As you will hear today, ASR is an aging effect and has been known in the concrete industry since the 1930s.

CHAIRMAN SKILLMAN: Before you change that image, this is not Seabrook. This is another place.

MR. COLLINS: That is correct.

CHAIRMAN SKILLMAN: What other places are we looking at, please?

MR. COLLINS: These are samples. I don't know if SG&H can help me with that. They're most likely bridge abutments. That's correct, bridge abutments.

CHAIRMAN SKILLMAN: Bridge abutments in Walla Walla, Washington?

MR. CARLEY: Commonwealth of Massachusetts.

CHAIRMAN SKILLMAN: In the Commonwealth of Massachusetts, bridges that do what?

MR. COLLINS: Matt, can you help me with this?

CHAIRMAN SKILLMAN: Do they support automobile traffic? Do they support railroad traffic, both, neither?

MR. SHERMAN: This is Matthew Sherman with Simpson, Gumpertz, and Heger. These were photographs that we've taken on other projects where we were working for the Massachusetts Department of Transportation.

There is retaining walls there that are supporting backfill on the upper right.

There are bridge abutments, I believe, on the lower left and lower right. So we're doing the same types of observations and measurements. So they're carrying traffic. It's well known. ASR is well known in the transportation industry.

CHAIRMAN SKILLMAN: Okay, those white buttons on the lower left image, those are extensometer penetrations out of that monolith?

MR. COLLINS: Matt, I'll take it from here. No, sir, they're not. Those are pins that are used to measure implant expansion in the X and Y direction. Those will be addressed in detail from both the large-scale testing program and also our structures monitoring program.

CHAIRMAN SKILLMAN: So you're using these devices in places other than at Seabrook to determine the extent to which this concrete is expanding?

MR. COLLINS: Yes, sir.

CHAIRMAN SKILLMAN: Okay.

MEMBER RICCARDELLA: Yeah, I have a related question. So you have two pictures of individuals, it looks like, with calipers measuring crack width. Are those the, are they applying like the CI, the crack index method?

MR. COLLINS: Those are the pin to pin measurements that are used in our component cracking.

MEMBER RICCARDELLA: Okay, so that's -

CHAIRMAN SKILLMAN: And the CCI?

MEMBER RICCARDELLA: And the CCI, so that's not something that was just invented for Seabrook. That's something that's fairly well used in the concrete industry?

MR. COLLINS: That's correct, and you'll see how we use that, although we looked at different methods of what we were going to use for instrumentation going forward, and that was developed during the University of Texas large-scale testing. There will be a section in our presentation on how we derived what instrumentation we would use to track our ASR growth.

MEMBER RICCARDELLA: Thank you.

CHAIRMAN SKILLMAN: Were these images taken only in the state of New Hampshire?

MR. COLLINS: Massachusetts, sir.

CHAIRMAN SKILLMAN: Oh, how about Maine?

MR. COLLINS: I don't have any pictures from Maine.

CHAIRMAN SKILLMAN: If I went to Maine, would I find stuff like that?

MR. COLLINS: I would say yes.

CHAIRMAN SKILLMAN: And also in New Hampshire?

MR. COLLINS: We don't want to leave New Hampshire out. Yes, sir, you would find that also.

CHAIRMAN SKILLMAN: Thank you, okay.

MR. COLLINS: Next slide, please. So the ASR background, causes of ASR, original plant construction, preventive measures were taken during plant construction to prevent the development of ASR. We did aggregate, using aggregate reactivity testing and we used low alkali cement.

Where we are today with the knowledge of reactive, slow reactive, slow moving reactive aggregate, the ASTMs that were used during original plant construction were not effective in identifying the aggregate that we had was slow reactive.

Today's dates, we use updated ASTMs that are recommended in a modern test nuclear plants can use for aggregate reactivity test data.

Current state of knowledge on this, ASTM test methods used during plant construction were not reliable as an effective means to identify slow reactive aggregate, and also finally, limiting alkali content of cement alone was not sufficient itself to prevent the ASR phenomenon. Next slide, please.

So it was the visual identification of pattern cracking in the 2009 time frame with the identification of aggressive groundwater, which is about 500 ppm chlorides, that led us to doing the investigation in the walls, which led to the core bores and petrography and the identification of ASR in our walls.

MEMBER MARCH-LEUBA: So, Michael, for my education again, is this an education with a bad concrete mix that you bought 40 years ago, or is this an issue with groundwater, or both?

MR. COLLINS: It's an issue with regards to the aggregate we used in the construction of our station.

MEMBER MARCH-LEUBA: Yeah, but what is the source of the sodium? Is that groundwater or was it in the concrete to start with?

MR. COLLINS: It was not in the concrete to start with. We have not had any above that level since 2011. The source of sodium could be as easy of the rock salt we spread around the station in the winter. It's not tied directly to us being on a marsh or being close to the ocean, and then the issue of groundwater, we'll go into that with a little more detail.

We have buildings above grade subjected to ambient humidity that have the same levels of ASR as we do in the lower elevations that are impacted with true wall groundwater, so we can't tie groundwater, ASR directly to the presence of groundwater. It's evident above grade and also below grade.

Again, we discussed this. This is again one of the mechanisms we use which we'll discuss in detail to monitor X, Y in plane expansion of the cracking concrete.

So implications of ASR at the station, you'll see in the upper right-hand corner, that's just industry literature for expansion effects of ASR on unreinforced concrete, so that data applies to the investigation and the analysis that we've done for unrestrained concrete structures which we'll, unrestrained concrete cores that we'll discuss later in our evaluation.

As I mentioned earlier, ASR impacts the reduction of material properties and their effect on structural capacity, again, compressive strength, tensile strength, and modulus of elasticity.

CHAIRMAN SKILLMAN: Michael, please - excuse me, go ahead.

MEMBER REMPE: In some of the background

information that I have found, I observed that they had a lot of cautions in the industry that just because you don't see cracks, you need to be concerned about structural deformation because it's below grade, and obviously that's proven to have happened at Seabrook.

MR. COLLINS: Yes, it has. So thank you for the lead in on effects of ASR expansion on structural demands. That is being handled by our analysis we're doing, and structural deformation as evident in this station, you can see on the lower left.

That is reflecting relative movement between structures, and then on the right, you'll see those are electrical flex connections that are between structures and reflecting relative movement between the structures.

CHAIRMAN SKILLMAN: Michael, please explain what the lower left image is portraying.

MR. COLLINS: The lower left image is the concrete structure has pulled away from a metal, we call it a kick plate, in that area of the building.

MEMBER MARCH-LEUBA: Sorry, I didn't get that. The part moved a couple of inches to the left. Is that what you're saying?

MR. COLLINS: That's correct.

CHAIRMAN SKILLMAN: Thank you.

MR. SCHULTZ: Michael, the graph information, is that showing Seabrook data, testing data?

MR. COLLINS: It is not. It's just ourselves just reflecting that what we'll present today with regards to unreinforced concrete is in line with industry practices.

MR. SCHULTZ: So we'll see more later?

MR. COLLINS: Yes, you will.

MR. SCHULTZ: Thank you.

MR. COLLINS: So we're going to become very familiar with this slide through the presentations we're going to make today. This flow chart is the layout and explains the integrated approach that NextEra Seabrook has developed in response to the identification of ASR in our concrete structures.

All of the ASR related efforts fit and flow together, and all results, conclusions, lessons learned are incorporated into the structures monitoring program.

Before we go into each section of our detailed discussions today, we'll discuss each one of these blocks shown on this flow diagram, and the respective block will be presented in the front of that discussion, so as you go through, you can piece our process together.

MEMBER BALLINGER: This may not be the right point to ask this question, but in all of the presentations, I don't see explicit comment on any interaction between the Seabrook folks and the other ASR related programs that are undergoing funded by DOE. NIST has a big program that's looking at concrete degradation. Are you guys connected or following those programs?

MR. COLLINS: We are knowledgeable and are following. We haven't been fully engaged in those programs.

MEMBER BALLINGER: Because they're very extensive in terms of full scale testing and a lot of it's being done at the University of Texas. Tennessee? I thought Texas as well, but anyway, okay, so you haven't been?

MR. COLLINS: Well, again, we're knowledgeable of the activities, but we haven't had teams associated with those activities.

So with regards to just a quick overview of each one of the aspects of our overall approach, we have the large-scale testing conclusions, our input into our structures monitoring program. Large-scale testing conclusions are input to our structural evaluations. ASR load factors have been derived for use in our structural analysis.

Our evaluation methodology and guidance was developed out of both the ASR load factor development and also our large-scale testing. Our field data is used to feed into our structural evaluation of our 26 seismic category one buildings, and structural evaluation results then feed into our ongoing monitoring and evaluation effort.

MEMBER RICCARDELLA: Tell me a little bit about the ASR load factors. What are we referring to there, please?

MR. COLLINS: I can't explain that because it's over my head. You will be - I am honest on that. That will be discussed in-depth by SG&H in their presentation.

MEMBER RICCARDELLA: Thank you. I was just trying to understand whether those are safety factors applied to the ASR or factors that are projected or allowing for projection of additional ASR in the future.

MR. COLLINS: Those are derived safety factors for the analysis.

MEMBER RICCARDELLA: Okay, thank you.

MR. COLLINS: I apologize I couldn't

answer that, but I wouldn't do it justice.

MEMBER RICCARDELLA: Okay.

CHAIRMAN SKILLMAN: Michael, let me ask this question. The image that showed the displacement raises in my mind my own years of being involved. Not all buildings' displacements would be of concern, but there are some places where a change, where a displacement could be a very large concern.

For example, up in your spent fuel pool, if you got some walk on your north/south walls, you could take your fuel handling gear out of plumb or out of track and out of trolley.

If you have movement in your primary shield in your reactor cavity, you can offset the points of loading for the reactor coolant systems, support for the reactor vessel for your reactor coolant pumps and for their capability to resist seismic loads or to be aligned properly.

Would you say something, please, about how the plumbers at the site and the operators at the site really viewed differential movement relating to operability and to the integrity of your license?

MR. COLLINS: Absolutely, so via our structures monitoring program, we all monitoring all of the structures at this point. That's fully developed. We actually do our target surveys in the fuel storage building to make sure relative movement isn't impacting any of those structures. There's been no, as you explained, tell-tale signs in that structure of issues.

The containment building, there's been no ASR identified within the containment building. We'll talk a little later. There's been some very small areas on the outside wall of containment that have been addressed with ASR.

We've also, to have more eyes in the field, we have trained both the operators and the engineering staff on the aspects of ASR and what to be looking for so that a daily operator round, he is looking for those, so again, we will identify the issues early and put them into the structures monitoring program.

If they're not conforming and considered degraded, an AR is written and they're put into our corrective action program. That gives the shift manager a look at it right out of the gate to make an initial operability call on that item. So all hands are on deck for the station looking for the impacts of ASR on our structures.

CHAIRMAN SKILLMAN: Will you talk about this later today?

MR. COLLINS: We'll talk about it later today with regards to Jackie Hulbert's presentation of our structures monitoring program.

CHAIRMAN SKILLMAN: Okay, thank you, all right.

MEMBER REMPE: But just to clarify, did you say, "We are now monitoring all structures on the site for deformation and movement," not just the category one or the ASR-affected structures, but all structures? Is that what I heard you say?

MR. COLLINS: I believe we're focusing on the category one structures at this point.

MS. HULBERT: We are, but our structures monitoring program as well encompasses all structures, so we look for that pattern cracking under, like, the maintenance rule portion.

MEMBER REMPE: But deformation, just pattern cracking or -

MS. HULBERT: So deformation, we're monitoring seismic category one structures.

MEMBER REMPE: Just the category one, okay. Thank you.

MEMBER MARCH-LEUBA: For my own education, this expansion, is it overnight or is it, I mean, is it a meter a year, or you go home on a Friday and Monday you show up and it's moved two inches?

MR. COLLINS: No, sir, the progression of ASR is very slow moving.

MEMBER MARCH-LEUBA: Okay, so if you have a decent -

MR. COLLINS: Years.

MEMBER MARCH-LEUBA: - program to look for it, you will see it?

MR. COLLINS: Yes, sir.

MEMBER MARCH-LEUBA: Okay.

MR. BROWNE: And Mr. Chairman, if I could revisit your question, as a result of our root cause for the containment enclosure building deformation that we discuss, one of the actions coming out of that corrective action was to, we had a multi-discipline team which also had operators in it that did a, I think the number was plant engineering guideline 98, which is the comprehensive multidisciplinary walk down of the site, to identify things like you're mentioning, like conduit deformation, pipes that may be offset in their support, safety loaded structures. So that was all captured out of the initial root cause coming out of CEB and then dispositioned, and it's also a two-year requirement coming out of tech 98 as well, but we'll talk about that as well.

CHAIRMAN SKILLMAN: Thank you.

MR. SCHULTZ: Mike, you've had almost 10 years of experience with this now. When you say slow moving, are we talking weeks, months, years, or does that vary?

MR. COLLINS: We're talking decades.

MR. SCHULTZ: Thank you.

MEMBER DIMITRIJEVIC: But you have identified, according to this, all of the potential impact on plant systems and factors, right? So, and you know what was potentially impacted on the safety of the plant due to this, right? And did you use that in prioritizing some of the problems?

MR. COLLINS: So we have used our walk down data to prioritize the first buildings that went into analysis. That's correct, and then again, the daily walk downs of the building structures monitoring program, if anything is new or identified as moving, it goes into our corrective action system.

MEMBER DIMITRIJEVIC: Okay, but you're having a comprehensive release of all the systems and components that could be impacted?

MR. COLLINS: Ms. Hulbert will show the comprehensive database that we maintain for all buildings and building areas and the observations in those areas.

MEMBER DIMITRIJEVIC: And you have comprehensive risk assessment as I am familiar that Seabrook has, and I know you have a daily observation too on the daily activities, so did this in any, did you do any risk analysis on this potential impact on the systems and components?

MR. COLLINS: As far, I mean, certainly if we find something that is impacting a system structure or component in a degraded way, that risk analysis happens at what we call T-zero, right away for its impact on the station.

MEMBER DIMITRIJEVIC: Okay, so there is nothing that you can say is in progress that can potentially damage this pipe, or these cable trays, or whatever connections or anything?

MR. COLLINS: So, you know, to be honest, we have observed items that aren't perfectly straight in a pipe sleeve that have pulled away from walls, but those are being evaluated on a case by case basis and included in the overall program. Next slide please.

So just in conclusion before I turn it over for the full presentations that are going to be made today, the large-scale test program, we have determined that there is no adverse impact on ASR on structural capacity within the test limits identified via the University of Texas Program. Limits have been established for monitoring of plant structures. Our evaluation methodology define process that considers the impact on ASR on both structural capacity and structural demands of the respective structures.

Structure evaluations demonstrate the seismic category one structures comply with the licensing basis as amended by the LAR, and then structures monitoring comprehensive program addresses ASR expansion, building deformation, and impact on system structures and components.

NextEra Energy has implemented an effective program for evaluating and maintaining the impacts of ASR on effected concrete structures and associated system structures and components. I'll now turn over the program back to Mr. Browne.

MR. BROWNE: Thank you, Mike. Mr. Chairman, that concludes our opening remarks and initial presentation for NextEra, and at this point, the next section is a closed section, so that concludes our remarks.

CHAIRMAN SKILLMAN: Kenneth, thank you very much. Ladies and gentlemen, we are going to take a 10-minute break. We will return at four minutes to

10:00 on that clock. We are going to stay on schedule and we are in recess for 10 minutes.

(Whereupon, the above-entitled matter went off the record at 9:46 a.m. and resumed at 1:17 p.m.)

CHAIRMAN SKILLMAN: Ladies and gentlemen, let's restart our meeting. We are back in session. We are in the open session and we turn the meeting over to SGH. Gentlemen, please proceed.

MR. BROWNE: Thank you, Mr. Chairman. I'm going to turn it over to Dr. Said Bolourchi who is going to lead us through the SGH portion of the presentation.

CHAIRMAN SKILLMAN: Yes, sir, thank you.

DR. BOLOURCHI: Thank you very much. I'm Said Bolourchi. I'm the senior principle at Simpson Gumpertz & Heger in Boston.

I have worked in the nuclear industry since the very early 1980s and I started my work with John Bloom and Associates and work on many of the, started at Diablo Canyon and then continue with many of the other plant.

I will be representing the methodology for the ASR affected structure. And in this presentation Mr. Glenn Bell and Matt Sherman, both senior principals from Simpson Gumpertz & Heger, will be helping me along with Bruce Ellingwood that will be introduced.

Each person when they come in they will introduce their background for your information. Next slide. The goal is to present the consistent and repeatable methodology that can be applied to all Category 1 structures at Seabrook.

And, but the basic principle in structural engineering, I'm sorry that many of you may not be in structural engineering. But the basic premise is the equation I put on the slide.

The structural capacity is the strength of the number that it can resist the load should be greater than total load. That is the concept.

In the morning session it was discussed that the effect of ASR will not reduce the code capacities and therefore, we can apply the code equation for calculating the capacity. And in doing that we will keep having reliability of the code into the evaluation.

There also, they discussed about the change in the stiffness because of the pre-stressing. Therefore, now on the right hand side in the load that was originally designed for this structure, for all the structures at Seabrook the ASR was not part of a load that was listed in the UFSAR.

Therefore, as part of this part we will define the load associated with ASR and the load factor associated with that. And then also we will discuss the field data to identify what is the status of the ASR for each individual building.

And that we will discuss as part of this methodology. And then we will discuss the modeling procedure to make sure that we will capture what was observed in larger scale testing which includes the pre-stressing effect.

Next slide. In the morning some of the questions was answered. But why are we calculating the demand in the structure.

If you start with the unreinforced concrete and you expose it to ASR the number will expand but it will not produce any measurable load that will affect the structure.

But if the structure is restrained, such as this structure, all the structures in Seabrook, then when it wants to expand the resistance to that expansion will produce imposed load on that structure and that load has to be accounted.

And that resistance can come from a number of places. It can come from reinforcement, doesn't let it grow therefore it is internal balance between the concrete and steel but the steel, it will produce its loads.

Other segment of a structure if there is one part of the structure is expanded and the other part is not the transition between that will see a lot of load in the ASR portion and in the area which is not in the ASR portion where you see all this load or if it's adjacent structures or a part that they are holding.

Therefore, as a whole if you have, if you are resisting this expansion then you will produce load. And this load can be significant therefore it should be considered in total evaluation on the right hand side of the equation that we said it needs to be done.

Therefore, ASR affected structure must be evaluated even if you don't see deformation as such. But it needs to be evaluated. Go ahead, next.

Under methodology again we wanted to make sure we calculated all Category 1 structures to make sure that they will meet the UFSAR as amended by LAR. And in the structural evaluation methodology there are two basic segments that we need to discuss.

One is the ASR loading and loads factor to make sure that we maintain the code reliability that it was intended. The other is a document that can be applied to all structures uniformly for all of that.

And this methodology will provide detailed collection of the data and also evaluation of all seismic Category 1 structures. Go ahead. And then now I want to introduce Glenn Bell for discussing the ASR load factors.

MR. BELL: Good afternoon, everyone. My name is Glenn Bell. I am senior principal and chairman of Simpson Gumpertz & Heger. I have 43 years' experience in the design, evaluation and rehabilitation of structures of all types.

I'm going to address the preparation of the load factors for ASR loading, which as the graphic on the screen shows is input into the structural evaluation methodology. To my right is Professor, Dr. Bruce Ellingwood.

Dr. Ellingwood was our independent reviewer for this portion of the work. He is an eminent authority on the theory of structural safety and reliability and has done groundbreaking work in that area not only in the nuclear industry but in structural engineering in general.

And he'll have some comments at the end of my presentation. But he reviewed and validated this part of our work.

As Dr. Bolourchi mentioned, the overall objective of our methodology is to supplement the design loads used in the original plant design with new ASR loads. And the objective is to do that in a way that maintains that level of structural performance implicit in the original design criteria codes and standards.

So we are maintaining all of the loads and load combinations of the original Seabrook design but introducing new ASR loads into those load combinations. Next slide, please.

The containment building at Seabrook was designed to the ASME Boil and Pressure Vessel Code, Section 3, Division 2, 1975. All of the other seismic Category 1 structures at the plant were designed to ACI standard 318-71 version.

The ASME and ACI documents are based on different design philosophies. ASME is based on so-called allowable stress design which I will describe while the ACI standard is based on so-called strength design.

Why were different codes and criteria used for different structures? The answer is that ACI 318-71 is principally concerned with strength, assuring that the structure's strength is adequate which is appropriate for all of the Category 1 structures at

Seabrook but the containment building.

The containment building on the other hand serves the dual purpose not only of structural containment but also containing the radiological consequences of a loss on cooling accident. So the ASME code requires loading capacity criteria that assure these dual purposes through provisions not contained in the ACI standard.

In particular, the ASME code limits stresses in concrete and steel reinforcing to ensure the containment buildings function as a pressure vessel. I go into this detail because the approaches for the design standards and approaches to load factors are different because of these dual purposes.

So I'm going to take these one at a time. Next slide, please. So let's start with the ASME code, again applied to the containment building. For the containment building the program --

CHAIRMAN SKILLMAN: Glenn, let me jump in here just for a second.

MR. BELL: Yes, sure.

CHAIRMAN SKILLMAN: And let me address my question to Kenneth please. So I'm going to go back to being a landowner within three or four miles of this site.

And I am witnessing NextEra building a varsity team of extraordinarily qualified professionals to defend ASR. The question is, why did NextEra not specifically choose this team but why did NextEra go to a strong outside consulting firm, if you will, as opposed to using a group that might be located in Portsmouth, New Hampshire or Manchester, New Hampshire or someone real, real close to the farms and to the land near the plant?

MR. BROWNE: Yes, I'll try to answer your question. Obviously it's a complex issue. We were first in the industry in needing to deal with this.

SGH is, I would say they are somewhat close because they are out of Boston and I mentioned that earlier that we are fortunate that we have the access to this expertise, you know, literally an hour away.

We've had virtually a constant presence from them on site since we started addressing the issue. I'm not sure if that answers your question. But I do respect that it's certainly bringing that type of technology home to New Hampshire and having that locally is certainly an advantage.

But in this case the, just the level of expertise we needed in order to understand a very complex problem, first in the industry really drove us to reach out for this kind of expertise.

CHAIRMAN SKILLMAN: Fair enough. I just wanted to explore for those who might say why did you find it necessary to go and get a varsity team from over there versus next door.

I think you're saying they're really not that far away. They're just down in Boston and they bring an expertise that is essential for this unique phenomenon that this facility is experiencing.

MR. BROWNE: That's well characterized. I agree.

CHAIRMAN SKILLMAN: Thank you, please proceed.

MR. SCHULTZ: Ken, you mentioned that they've been on site since the problem began. Can you characterize that more deeply?

MR. BROWNE: Yes, Matt Sherman will talk here shortly after Glenn Bell and Liying who is one of our inspectors who is in the audience with us virtually is on site most days and she's been performing virtually all of our surface inspections for the plant.

She does all of our CCI measurements. And so that takes several days per week of, you know, of her time. So they have really helped us develop the program to where it is right now.

DR. BOLOURCHI: We already have seven batch inspector in the field and almost there is no week that we don't have people there since 2010.

CHAIRMAN SKILLMAN: Glenn, I interrupted you and I apologize. Let's proceed.

MR. BELL: No apology necessary, sir. So we're starting with the containment building under the ASME code. For the containment building Matt Sherman is going to describe our field program in some detail following me.

Our work there included crack index measurements at four grids but very extensive visual survey employing rope access. That field survey showed that in the containment building there was only limited localized ASR locations on the exterior surface of the containment building.

And I'll show you a graphic in a few slides from now of the location and the extent of that. So we started with a very conservative initial screening approach in our view of the CB, the containment building.

The intent was to do this initial conservative screening and if the analysis did not demonstrate the structure's adequacy according to the criteria that we would conduct further field measurements, reduce the uncertainty and rerun the analysis.

Fortunately, the structure passed the initial conservative screening. Next slide, please. As I mentioned earlier, the ASME code is based on allowable stress design.

So it's primary objective is to limit stresses in the concrete and steel reinforcement. And the ASME code requires code checking under so-called service and load conditions and factored load conditions.

Service load conditions are those that apply to scenarios of normal operation of the plant which are expected to occur frequently over the life of the structure. Concrete stresses under these scenarios are kept well below the concrete's ultimate compressive strength and well below the yield strength of the reinforcement.

Factored load conditions, however, apply to more severe scenarios that include extreme conditions that could include failure of the reactor cooling system and/or environmental conditions that are considered to be upper bound for the site.

In this case the permitted stresses are higher than they are for service load conditions. But they are still below the concrete compressive strength and below the steel yield strength.

There is one exception to the statement that I just made is that some local steel yielding is permitted under factor load conditions when temperature gradients are considered in the analysis. Next slide, please.

So the question was asked earlier exactly what load factors are. And this slide describes that. Load factors along with partial safety factors are key to assuring the intended structural performance.

As Dr. Bolourchi mentioned earlier, our primary objective in structural engineering is to assure that the structure has adequate capacity to the load effects imposed on it. That is the capacity must equal or exceed the load effects.

That capacity we are concerned with in allowable stress design is assured through limitations on stresses. The effects of the loads represented on the right hand side of the equation are typically from multiple sources that can include dead load, live load, wind, earthquake, temperature, et cetera.

These multiple sources are represented by the S subscript I terms on the right hand side of the equation. And in the case of our present exercise we are also introducing ASR as a new loading condition.

The terms alpha I in front of the SI load effects are the load factors. These are the load factors. There are different load factors for various types of loads in combinations of loads that codes prescribe.

The purpose of the load factors is to account for the variability of the actual loads from the values used in design and to assure that the overall required reliability, r margin of the safety of the structure is achieved.

In allowable stress design the capacity side of the equation on the left is determined by an allowable stress f sub a which cannot be exceeded. The allowable stress is held below a certain critical stress, F sub cr, by applying a partial factor of safety K to the critical stress and K is less than one.

So in terms of overall factor safety the K factor and the alpha i's produce an overall factor of safety against exceeding the allowable stresses. The loads and load combinations represented by the ASME code are deterministic.

That is, they are not probabilistically based. They are not based on a quantifiable target reliability level, but rather structural assurance, performance rather is assured under various scenarios of normal and extreme loading that were posited by the code drafters.

In the ASME code most of the load factors are 1.0, although some are 1.25 and 1.5 for severe environmental or abnormal conditions. An example of the application of a load factor higher than one is in the operating basis earthquake when it is applied to extreme and abnormal conditions.

Because the operational basis earthquake is a relatively frequently occurring event it needs to be scaled up by some factor larger than one to represent an extreme condition. On the other hand, the safe shutdown earthquake which posits a very extreme condition of seismicity, seismic accelerations uses a load factor of one. Next slide, please.

MEMBER CORRADINI: So then for ASR, I think Pete had asked that early on or you had asked somebody. So what is alpha, to work your simple equation backwards is alpha set to essentially make the allowable force equal to the load?

MR. BELL: No.

MEMBER CORRADINI: Or you're looking for a margin given in alpha?

MR. BELL: Yes, you're looking for a

margin.

MEMBER CORRADINI: So in ASR's case you're going to use some additional larger than one value with the ASR loading?

MR. BELL: There's a linkage between the severity of the loading and the alpha factor that you use. The more extreme the loading the lower the load factor needs to be to give you the margin that you need.

And, excuse me, and in most cases, in almost all cases in the ASME code the load factors are 1.0 along with an approach that targets an extreme value of loading.

MEMBER CORRADINI: Okay.

MR. BELL: Okay. Which is actually a segue to the next slide. So consistent with this, next slide, please. Consistent with this our approach is to develop ASR loads that have a very small likelihood of exceedance and to use an ASR load factor of one.

Next slide, please. This describes how we developed the ASR loads. In our structural methodology we applied ASR loading to structures by defining four zones of ASR severity according to this graphic.

And this is similar but not, this is similar both in the ASME application and the ACI application.

Zone 1 which is the lowest level of ASR expansion is from a cracking index of near zero to .5 millimeters per meter.

Zone 2 is from .5 to one. Zone 3, one to two and Zone 4 over two. In the case of the containment building, as I mentioned earlier, we have only a limited amount of ASR and that all falls within Zone 1 where it does occur.

And so I've only highlighted with a picture the box showing Zone 1 here. So our methodology for an extreme and conservative application of ASR is to apply to the entirety of the entire zone an ASR strain corresponding to the upper limit of that zone.

And in the stage one analyses we increase that upper limit by another factor of 1.25. So the practice of applying 1.25 times the maximum limit to the entire zone is conservative.

In this case with Zone 1 ranging from CI to .1 to .5, we apply a value of .6 across the entire zone.

CHAIRMAN SKILLMAN: Glenn, that is, at least it seems to me to be a decision that's driven by an assumption of the thoroughness of the inspection of the containment building. You've said there is little or no cracking or very little limited cracking.

MR. BELL: Correct.

CHAIRMAN SKILLMAN: How should we judge, if you will, the thoroughness of that inspection? That's a big building.

MR. BELL: We have done extensive visual survey all over the building that included rope access all the way to the top and found only limited ASR across the containment building. And the next graphic, if I may, help to answer that question will illustrate that.

CHAIRMAN SKILLMAN: I'll be happy to wait until the next slide.

MEMBER RICCARDELLA: First is why are we using the term CI here rather than CCI?

MR. BELL: I should explain that CI and CCI we're using interchangeably with respect to the application of the ASR loads.

MEMBER RICCARDELLA: Okay. And also I did, I haven't seen the containment building analysis. But I have reviewed the CEB analysis.

And I thought I saw in that you are averaging the CI readings over regions, that you weren't just picking the maximum individual value.

MR. BELL: You are correction application to the CEB. And I'm going to go on, that's the different approach that I was talking about in the ACI code and I'll explain how we dealt with that there.

MEMBER RICCARDELLA: So for the containment you're using the absolute --

MR. BELL: Maximum in the zone.

MEMBER RICCARDELLA: -- that you found?

MR. BELL: Maximum in the zone augmented by 25 percent.

MEMBER RICCARDELLA: Okay. There were zones and regions though in the CEB.

MR. BELL: We simply worked with zones in the CEB.

MEMBER RICCARDELLA: So the containment was all one region you're saying?

MR. BELL: If I could go to the next slide that might help clarify both questions, okay. This is a schematic illustration of the extent of ASR from the extensive visual surveys in the containment building.

You see a band of Zone 1 ASR that runs around the base of the cylinder just above the foundation level for a height of about six feet. There is also a band below the equipment hatch shown schematically there.

And one other patch that is not shown because it occurs on the back side is a three foot by eight foot section of, I'm going to call it suspected ASR because we were conservative in our interpretation of the cracking in that particular area.

And that occurs at an elevation of 68 feet which is higher than the level in the equipment hatch that you see here roughly on the far side. So you can see the vast majority of the CEB has no ASR and even where it occurs it's only within Zone 1.

CHAIRMAN SKILLMAN: How is that captured in your documentation so that a generation to come can review this documentation and have a strong starting point?

MR. BELL: We have an extensive log of all of the field work and the photographs associated with that tagged to particular locations over the building. All of that is summarized in all of our reports running all the way down to the application of loads in our finite element analysis for the containment building.

So it's very thoroughly documented, the dates, the locations, photographic documentation, et cetera.

CHAIRMAN SKILLMAN: Thank you.

MR. BELL: Yes.

MEMBER REMPE: So I have a question that will show my ignorance in this methodology. But from the material I read they emphasized the point that a lot of times there's below grade cracking that imposes a load.

And yet your presentation emphasized that you used this cracking measurement to base your load on. How do you account for these loads that you can't see?

MR. BELL: In this particular case if there was, and we looked at this case, if there was expansion to the foundation that would actually alleviate the loads on the cylinder. We ran the analysis both ways.

MEMBER REMPE: Okay, good.

MR. BELL: And we only reported the worst case which was the assumption of no ASR or no cracking, no expansion in the foundation. But that's a more severe condition because the foundation if it doesn't expand tends to restrain the expansion in the cylinder from the ASR.

MEMBER REMPE: Okay, thank you.

MR. BELL: Sure.

MEMBER BROWN: For the uninitiated again, another one of my dumb questions. Why is it so local as opposed to more, sorry about that. Why is it so locally located as opposed to more uniformly distributed?

I mean it seems to be these very unique bands over this entire thing it's all concrete.

MR. BELL: As others have said today and I think will continue to say over the course of the day the presence of ASR has some drivers. But there's a lot of randomness to the process.

But one of the many drivers is humidity, high humidity. There was a point in time when there was a wet zone on top of the foundation near the base of the cylinder.

That's been dried out now but our presumption is that the humidity associated with that drove that band of ASR down at the foundation level. We also know at one point in time there was some leakage in the equipment hatch tunnel between the CEB and the equipment hatch that probably drove that band of ASR down that you see just below the equipment hatch.

MEMBER BROWN: Okay, thank you very much.

MR. BELL: Sure.

MEMBER RICCARDELLA: Where is grade on this?

MR. BELL: I'm sorry.

MEMBER RICCARDELLA: Where is grade, what level is grade, right at the foundation?

MR. BELL: Grade is, help me, Said. It's

near the equipment hatch.

DR. BOLOURCHI: Equipment hatch.

MR. BELL: Any other questions before we --

MEMBER CORRADINI: Yes, just so we're all on the same page. This is the containment --

MR. BELL: Correct.

MEMBER CORRADINI: -- which is inside the CEB.

MR. BELL: Right.

MEMBER CORRADINI: And the difference in distance between the two that have allowed the visual inspection is about two or three feet?

DR. BOLOURCHI: Four and a half feet.

MR. BELL: Four and a half feet.

MEMBER CORRADINI: Okay.

MEMBER RICCARDELLA: What was the three inch clearance that I read?

MR. BELL: I think that was reference to a seismic expansion joint earlier.

MEMBER RICCARDELLA: Okay.

PARTICIPANT: That was actually the missile shield.

MEMBER RICCARDELLA: There's three feet between.

MR. BELL: There's three feet, four and a half feet, I think, annulus between the CB and the CEB.

MEMBER RICCARDELLA: Thank you.

MR. BELL: So next slide, please, summarizes the approach to load factors in the containment building. And next slide, please, Ken, thank you.

We selected a conservative approach to loads and load combinations by taking the highest level of strain in each zone and applying it to the entire zone and augmenting that by another 25 percent margin.

Also we know that the large-scale testing program that was described earlier demonstrated on average the cracking index measurements conservatively predict ASR strain and furthermore the literature shows that ASR strains measured at the surface of the concrete significantly overpredict the strains at the reinforcement depth which is the depth that we're most concerned with when it comes to detecting stresses and reinforcement and so forth.

So for each load combination for the CB by the ASME code we have applied a conservative value of ASR strain in combination with a load factor of one. Next I will go on to the seismic Category 1 structures other than the containment building, ACI 318-71.

This, as I said earlier, uses a different approach to assuring structural performance than the ASME code and that impacts the methodology that we use for determining load factors. Next slide, please.

These structures, as I mentioned, were designed to the ACI standard 318-71 which takes the ultimate strength design approach where the primary objective is to assure adequate strength.

We check that strength through the code equations which were mentioned earlier with respect to the large-scale testing program.

MEMBER CORRADINI: May I just back you up?

MR. BELL: Absolutely.

MEMBER CORRADINI: Is the CEB this or ASME?

MR. BELL: This. Only the CB uses ASME. All of the other Category 1 structures --

MEMBER CORRADINI: Only the containment uses ASME?

MR. BELL: Did I misspeak? Only the containment, excuse me.

MEMBER CORRADINI: The CEB uses this?

MR. BELL: The CEB uses this, yes.

MEMBER CORRADINI: Thank you.

MR. BELL: Thank you. So we check

strength with the code equations that were described earlier. The ACI code also includes secondary, so-called serviceability checks that are made under less extreme loading conditions.

But we're primarily concerned here with assuring adequate strength. Next slide, please. This graphic is very similar to the one that I showed for the ASME code where we are looking to assure that capacity exceeds the load effects.

The general construct of the right hand side of the equation the load effect side is similar to the application of the ASME code. The capacity is determined a bit differently again, because we're looking to assure adequate strength rather than limiting stresses.

So the factor R, is the nominal strength capacity determined by code equations and it is modified by a partial safety factor fee which is less than one. Now contrary to the ASME code where most of the load factors are 1.0, in the ACI code they generally fall between 1.4 and 1.7.

In the case of the UFSAR the application of the operating basis earthquake goes up to 1.9 and there are some numbers smaller than 1.4 for different load combinations. But the point here is that most of them fall in the range of 1.4 to 1.7 significantly higher than the 1.0 in the ASME code.

MEMBER CORRADINI: I'm sorry that I keep on asking this stuff. So if I made a plot of this phi R is always larger than F sub a?

In other words, there's got to be equivalence in terms of the loading. So the way I think of it is your phi R capacity term is higher than F sub a.

MR. BELL: As a general prospect we're looking at a more extreme condition of structural loading, exactly, yes.

MEMBER CORRADINI: Okay, all right, thank you.

MR. BELL: Yes. Next slide, please.

CHAIRMAN SKILLMAN: Before you change. From where do you chose the phi?

MR. BELL: I'm going to come to that. But actually if you could bear with me for one more slide or a couple more slides I think that will answer your question. Next slide, please.

So since the 1980s the underlying approach to design of concrete structures to the ACI standards and many others has been based on probabilistic concepts of structural reliability. These standards use a quantitative approach to variations in capacity and load effects to achieve a numerical targeted level of reliability.

Reliability here is defined as the probability of not exceeding an acceptable measure of structural performance. While the 1971 version of ACI 318 was not based on probabilistic concepts work was underway in the mid to late 1970s to define a probabilistic approach.

And a key project in laying the groundwork for a probability based structure reliability was undertaken at the Natural Bureau of Standards, now NIST of course. And the leader of that program was Dr. Bruce Ellingwood who was then a research engineer at the NBS.

In their work Ellingwood and his colleagues were able to quantify the levels of reliability inherent in the then existing design methods including ACI 318-71. So they sort of reverse engineered the problem, if you will.

And they laid out an approach for what is called load and resistance factor design going forward, probabilistically based, reliability based engineering. The work evaluated and his colleagues were culminated in a report that is thumbnailed on the left hand side here called Development of a Probability

Based Load Criterion for American National Standard A58.

This report became the seminal document in structural reliability implementation in codes and standards and is a key reference in our approach to developing ASR load factors for the ACI code for this project.

Structural reliability in this context is defined by a term beta reliability index. There's a relationship between the probability of failure and beta. The higher the beta the higher the probability that the structure will remain safe.

The methodology to incorporate ASR effects into this analysis employs the NBS study's findings regarding the reliability inherent in ACI 318-71. The NBS studies show the average reliability or beta for various load combinations to be as shown in the slide here.

That is for load combinations involving static conditions basically gravity loads and lateral earth pressure, a beta of 3.0. For load combinations involving wind a beta of 2.5. For load combinations involving the operating basis earthquake 1.75.

And we used these target reliabilities in our methodology thus maintaining that level of reliability inherent in ACI 318-71. Next slide, please.

So we used a similar zoning approach as I described earlier for the ASME code. But we had very extensive statistical data on cracking index measurements for the plant. We had measurements, 216 measurements and 108 grids which we used for a statistical analysis to feed into beta.

And we grouped those into the four zones of severity shown here. Zone 1 being less than .5. Zone 2, .5 to 1. Zone 3, one to two and Zone 4, anything higher than two.

And for each zone we determined the ASR strains from statistics gathered over the zones for the entire plant. We mapped the four ASR severity zones onto each structure and we applied in our loading an ASR strain corresponding to the mean value of CI measured in each zone with the application of a load factor on top of that.

That addresses the question that I came up earlier I think. And we applied that probabilistically based determined load factor. Next slide, please.

So the calculation to achieve the required beta is a bit involved. But this shows the basic input and the sources of information. The target reliability level of beta.

It is based on the NBS report, as I just mentioned. The probability distribution of structural resistance is based on the NBS report and out of that come statistics about the resistance to answer your question and also the phi factor, to directly answer your question, comes right out of the ACI code.

But that phi factor needs to, the probability distribution of structural resistance needs to be consistent with the NBS report in order for that phi factor to be appropriately applicable. We gained the probability distribution of all of the loads other than ASR based on the methodology of the NBS report.

The probability distribution of the ASR load effects we gained from the statistics measured at the plant. And we also need to know the ratio of ASR load effects to the total load effects, a factor that we call k ASR and we found representative values for each ASR zone in our calculation.

So these input variables go into a calculation that finds the ASR load factor that results in the target reliability level. Next slide, please.

And these are the results of many complex calculations to determine load factors. But for static load factors for Zone 1, the ASR load factor is 2.0.

For Zones 2 to 4 it's 1.6. For wind, 1.7 for Zone 1. For Zones 2 to 4, 1.36. For the operating basis earthquake, 1.3 for Zone 1. 1.04 for Zones 2 through 4.

A couple of comments on this. Number one, these are simply the load factors that apply to the ASR loads. All of the other loads in the combination use the standard code load factors.

And you'll note here that the load factors for Zones 2 through 4 are lower than those for Zone 1. The reason for that is that the coefficient of variation of the CI statistics in Zone 1 is larger than Zones 2 to 4.

And that has to do with the size of the denominator, coefficient of variation being standard deviation divided by the mean. So that's smaller there.

There's two other footnotes. Per ACI 318-71 when you have load factors, load combinations that involve differential settlement, create shrinkage or temperature change these load factors may be reduced by 25 percent, but they may not be less than one.

And finally, for an unusual, very unusual load combinations involving very extreme values of say shut down earthquake and tornado these are not determined deterministically. They are, they are not determined probabilistically.

They are determined deterministically with a load factor of 1.0. I have a concluding slide that perhaps I should pause here for questions before we go to that.

MEMBER RICCARDELLA: You need to help me with this table. Are you saying you used different load factors on the ASR load when you combined them with these other loads? Is that why there is a whole table here?

MR. BELL: We used these load factors in any of the equations that involve loads with ASR loading. So these are the load factors applied to ASR.

A typical load combination will include many factors, dead load, live load, possibly wind or earthquake, et cetera. And now they always include ASR load as well.

Each of those loads, individual loads has its own load factor. These are the load factors that we applied to the ASR loads in every combination.

MEMBER RICCARDELLA: In that specific equation, in those specific loads?

MR. BELL: Yes, that's correct.

MEMBER RICCARDELLA: But what about, I mean, but don't you have combinations that would include static plus wind?

MR. BELL: We do. And we included all of those in the calculations that lead to the ultimate reliability level data using the code prescribed load factors for those loads that are code prescribed.

So we're adding here ASR loading to all of those load combinations. A load that I have described along with specific load factors just for the ASR load. We don't change anything else.

MR. SCHULTZ: Glenn, could you walk through one more time why the load factors for Zones 2 through 4 are lower than for Zone 1? These are, Zones 2 through 4, are those where the cracking index is larger than in Zone 1.

MR. BELL: Right. So coefficient of variation is standard deviation divided by the mean. If you go to the next slide the mean in Zone 1 is very small.

It ranges between zero and .1. The means of all of the other zones are significantly larger. That's the main driver.

Another possible contributor is that the precision in the optical measurements in the very fine cracks is probably not as high as it is, the wider the crack the more precision that we have in the optical measurements. So those two factors account for that.

MR. SCHULTZ: Okay. It's the level of variation divided by --

MR. BELL: Yes, it's all in the variation, yes.

MR. SCHULTZ: I can see that. Thank you.

MEMBER RICCARDELLA: The level of variation in the measurements that you've made in the field in a specific zone. Is that what you're, that's what you're referring to, right?

MR. BELL: That and the fact that in computing COV we're using a very small denominator for Zone 1. But I have one more slide if --

MEMBER RICCARDELLA: I am still struggling --

MR. BELL: Go ahead.

MEMBER RICCARDELLA: -- a little with this. I mean, should the second row really be static plus wind and the third row should be static plus wind and also be --

MR. BELL: These are load combinations that are principally static. They don't include wind.

They can include dead load and by static we mean dead load, live load, lateral earth pressure. The second row are load combinations that involve wind, et cetera.

MEMBER RICCARDELLA: I understand now. Okay, thank you.

MR. BELL: So our last slide, please. Oops, no, that's correct, sorry. In conclusion, we developed ASR load factors for both the ASME and the ACI 318 approaches.

We used methods that are consistent with the underlying philosophy of the original design criteria. We used methods that are consistent with the level of safety and reliability inherent in those codes and standards.

And we took a comprehensive and conservative approach at various decision points. And with that I will turn it over to Dr. Ellingwood who has some comments based on his review of the work that I just presented.

CHAIRMAN SKILLMAN: Before you do that let me ask a question to NextEra, to Kenneth. Kenneth, if I'm, again I'm a citizen of New Hampshire, I live six miles from this place, will the documentation that defends this be available to me in a publicly releasable form so I can take my calculator and my pencil and do some calculating?

In other words, will there be a version of this that is available to the citizens that are living a couple miles from this facility?

MR. BROWNE: The license amendment request and also the AMP are also, are submitted on the docket for review. So, I guess, simplistically, yes.

CHAIRMAN SKILLMAN: Simplistically. Does that mean --

MR. BROWNE: The proprietary version is obviously redacted for --

CHAIRMAN SKILLMAN: I understand that. Now is the not proprietary version of sufficient detail that an interested and curious person could pretty much come to the same conclusion that your consultant has come to?

MR. BROWNE: The methodology document and also the remaining calculations would need to be married up with the license amendment request in order to come to the same conclusions.

CHAIRMAN SKILLMAN: I would like you to think about that just some lessons from what it took to take a plant from not operable to being fully operable given a local next door. We've also seen this, for instance, at Davis-Besse, which was another 350 plant.

And the question was can the public really find a way to come to the same conclusion without going through extraordinary efforts.

MR. BROWNE: No, I understand your comment and several of your questions have been focused around the fact that when you have difficult problems in our industry they're often very difficult to, we obviously, we work in a complex industry.

And it's a technology that sometimes can be difficult to understand. And then when people don't understand our industry due to the complexity they reach a conclusion that's often adverse to safety.

So I understand your comment and we'll work to --

CHAIRMAN SKILLMAN: You know, I'm a 50 year veteran in this, actually a little bit more than that. And what I've learned is the public is mighty smart.

MR. BROWNE: Absolutely.

CHAIRMAN SKILLMAN: And they are owed good answers because one of the most important features we have in nuclear is that we're open to the community. And if the community can find their way to come to almost the same conclusion without a lot of smoke and mirrors the public gains a lot of confidence very quickly.

MR. BROWNE: No, I understand your comment, we understand your comment at NextEra.

CHAIRMAN SKILLMAN: Okay, thank you. Please proceed.

DR. ELLINGWOOD: Thank you, Glenn. I was asked to perform an independent evaluation of the calculations that the SGH team had made in support of the load combinations and the load factors applied to alkali silica reaction structural actions.

And in my judgment the conclusions that they arrived at for the containment building and the methods employed are consistent with, you know, the load combinations that appear in Section 3, Division 2 of the ASME Boiler and Pressure Code which are in fact deterministically based and historically done that way.

For the Category 1 structures other than containment, the procedures that they followed were consistent with the procedures that we adopted in developing the probability based load resistance factors for American National Standard A58 which subsequently have been adopted by all the model codes in the United States material specifications and I might add by some overseas code organizations as well.

And I think that the load combinations that have been proposed for the load factors will achieve the target reliabilities that Glenn had produced in support of his recommendations. Thank you.

DR. BOLOURCHI: I would like to present Matt Sherman to first come and discuss about the field observations before we get to the actual methodology document because we used this data in that.

MR. SHERMAN: Sure. Thank you very much. My name is Matthew Sherman. I'm a senior principal at Simpson Gumpertz & Heger.

As Dr. Bolourchi just mentioned we're going to do a little bit of a jump ahead to the field data. And we're going to talk about that before he comes back and talks about how it all feeds into the structural evaluation methodology.

We're doing that because it's, the methodology document describes how the field data is actually used in the analysis. And when Dr. Bolourchi goes through that document he's going to use some examples of how the field data feeds into the structural evaluation methodology.

So if we tell you right now a little bit ahead of time how we do the field data when it comes along to talk about how it's used you can concentrate on that part and we can keep kind of the simple attainment of the data here first.

All right, so to reboot, I'm Matt Sherman. I have about 25 years of experience in the civil engineering world mostly in civil engineering materials, construction, repair and testing.

I was the supervisor for the field data acquisition portion of the work. Field data is used extensively in the methodology document. It describes very comprehensively how field data works in.

And it's really an integral component of the structural evaluations that were done because it works into an iterative process that lets us interact with information, data and the results of analysis to provide really a robust basis for the calculation.

Next slide, please. So if you think about it the methodology document really describes this evaluation process. It uses field data and provides a framework, the methodology document provides a framework for the overall, for the whole process.

And it really includes a cycle of analysis, field data and an intelligent interpretation. This is not a linear, one time process. It's a cycle where we use the intelligent interpretation.

For example, field testing may include observing crack patterns and measuring expansions.

The analysis may be a finite element model that uses some of that data.

And then the interpretation is an intelligent comparison and backcheck of those, right. So we have to match the models up with the data and observer.

So it's an iterative process. So we start with the observations. We might include measurements and possibly some special testing. And it's done by a team of people who are integrated. The field people are integrated with the analysis team.

Next slide, please. So for this work we can think of the field data as comprising three main groups. There's, the first one is observations which are kind of non-quantifiable information.

They're non-quantifiable. There are measurements that are actually data that feed into the analysis. And then there are sometimes specialty testing that's used to supplement or to answer special questions that arise during it.

All right, all of our work on the field data work was done under full QA, under our full nuclear QA program. All the field teams are two person teams that include different degrees of peer checking to review all the data.

And then it's all evaluated through the structural process. Next slide, please. So the field work really starts with observations, right. This is a walk down that guides and shapes the initial analysis and field data gathering.

These walk downs are done with full plant support and coordination for safety, access and also as a source of historical knowledge for what's happened in the plant and provide any background information that's needed.

So remember that these observations include information but not necessarily data that we use. Next slide, please. So the observations give us information on the extent of apparent ASR cracking and it provides clues about other types of cracking that may be present for other reasons.

Such as on the left here where you can see these diagonal cracks that are highlighted in yellow chalk. Those diagonal cracks are indicative of typical shear forces.

You know, so we're using that information and feeding into the overall analysis. The methodology document describes in detail how the observed cracking is incorporated into the analysis using pattern, type, widths, all of that to aid in interpretation.

This observation phase is a thinking observation. It's a thinking operation. It's done by people who are integrated into the overall team.

MEMBER MARCH-LEUBA: Quick question. Is this Seabrook?

MR. SHERMAN: These are both at Seabrook, yes.

MEMBER MARCH-LEUBA: Okay. So it is the famous tunnel?

MR. SHERMAN: This is not the famous tunnel. These are other locations.

MEMBER MARCH-LEUBA: And what, we're talking a maximum of .5 or 5 millimeters per meter expansion. What degree of expansion would say this is?

MR. SHERMAN: This one I'm not sure of the number for sure. I have a better example coming up later on. This is low. This would be, the one on the right hand side is down like what Glenn was talking about.

MEMBER MARCH-LEUBA: I wonder about those long cracks.

MR. SHERMAN: Those aren't ASR cracks. Those are shear cracks, right so that's, the methodology document describes how we do that. For the most part we assume that they're ASR cracks and use that conservatively.

There are occasions where, Said will get into later on where the methodology document lets you work through and understand that better. So sometimes these observations will also include limited measurements.

We'll go to the, there was an earlier question, we go whenever we walk down an individual structure or a room within a structure or a piece of it, we go find the worst area to make measurements on to help us frame what we're going to do there.

Again, it's a thinking operation. So we'll do limited measurements to provide initial assessments of severity and location. Really not as a data source per se but to indicate what types of formal measurements are required underneath the methodology document.

It shows us what's required as follow up work. We also, during these walk downs we also go to areas and sound the representative surfaces to look for any kind of, with hammers or chains to look for drumming sounding areas or any weak sounding areas all in accordance with the ACI 349.3 document which I was just on the committee that revised.

All right, next slide, please. So the observations in walk down really let us incorporate real world data. They let us bring that real world information into our analysis.

This is needed because there is some degree of cracking that is fundamental to reinforced concrete behavior. That's in reinforced concrete 101, you know, you have to crack to some degree to activate the reinforcement.

That's because the concrete works mostly in compression and it has to crack to let that reinforcement work. And remember there are also other sources of expected cracking such as when we do normal pressure testing of the containment building or in shrinkage causes cracking or anybody who walks around who has a concrete basement knows that you have cracks and look at your sidewalk when you're walking down.

So based on during the observations and walk down we outline any cracks with chalk and identify the patterns that may be unrelated to ASR within the concrete. For example, on the left hand side again those are those shear cracks that are highlighted in yellow chalk.

We also document other information that can feed into the analysis such as relative building movement that could be related to expansion. For example, the photo on the right shows the movement of the conduit flex joints.

Movement direction and offset degree can be used to calibrate the structural models, as Said will describe in a minute. Now each one of these structures, an earlier question about how, where the data is available every structure that we go out has a site visit report that's issued that has a full breakdown of it and those are on the docket.

MR. SCHULTZ: Matthew, before you move on.

MR. SHERMAN: Yes, sir.

MR. SCHULTZ: The observations, I know this is the first stage, if you will, of the investigation. But you said that the, I just want to check what you said, what I thought you said.

And that is this is done by a qualified team that knows what they're looking for. It's a two person team so that one is examining, the other is checking that the observations are correct and so forth.

So this is not just an individual that's out there looking to see what might happen. This is all done as part of a documented observation by qualified people.

MR. SHERMAN: Yes. We have an inspection

and testing protocol that we call on for each document plus a test method that we have.

MR. SCHULTZ: And your procedures are causing the team to document this examination in a particular way.

MR. SHERMAN: Yes.

MR. SCHULTZ: So that when we look at the reports or when anyone looks at the reports it was mentioned earlier how do we know if the next generation is going to know what happened when. This is the first stage of that.

MR. SHERMAN: Correct. These will all wrap up into a site visit report that is well documented and the process is described in our test procedure and in the ITP.

And that includes things about how you tier and qualify inspectors. So there is basically a tiered inspection program where you start off as almost as a journeyman and then work your way up, you know, apprentice work your way up to a journeyman to a senior.

MR. SCHULTZ: Appreciate that, thank you.

MEMBER MARCH-LEUBA: On this walk through with procedure is it one time or is it going to be every year?

MR. SHERMAN: These are all integrated.

You'll hear more, these are integrated into the overall structural monitoring program. It's not as simple as just, there's not one answer because it depends on the severity.

There are multiple tracks. There are some tracks that are for the routine observations and measurements and there are other tracks, parallel tracks that relate to building analyses.

After the first time through actually there's two parallel tracks. One that is based on the results of the analysis, Said will tell us later on about what we find, set some thresholds.

And there are other ones that are just part of the overall parallel track that's for overall monitoring. All right, next slide, please.

So the expansion measurements are done when identified according to that methodology document. These expansion measurements provide data that is incorporated into the eventual evaluations.

If you think back to the earlier slides on the overall testing program and Glenn's descriptions of how we develop those load factors, this is the link now. These expansion numbers are the link that connects the actual plant to the results of the research and the work done and to the statistical work that was done to develop the load factors, right.

So the main group of these are direct measures of expansion. Next slide. So we've seen this already before. You've seen a little bit of some background on the cracking index.

This is the most frequently used method at Seabrook Station. Well over 100 locations are currently being monitored with cracking indexes Glenn just discussed in the background for the load factors.

As you previously heard about these are measures of total cracking strain or a good way to estimate total cracking strain to date. And it's obtained from a crack mapping process where we do quantitative measurements at individual cracks and summation of crack widths along a set of lines.

I'll show an example of that in just a moment. As we heard earlier this technique is based on Federal Highway Administration documents that have been developed for monitoring highway structures.

It's based on Institute of Structural Engineer documents from overseas. It's a pretty well established way of estimating crack strains.

These are used to estimate the expansion reached to date by the ASR-affected concrete. And this is the primary data that drives the structural evaluations.

You can see here we have an example of one. We make these, they are an optical measurement with a magnifying loop and with a calibrated, inside there, there is an optical reticle that helps, that lets you measure the crack widths under magnification.

So with this you can measure it out to about two one thousandths of an inch. All right, next slide, please. So just as a quick recap if we imagine how these measurements are done, this is a quick recap if we imagine there are some cracks in a piece of concrete.

Next click. We draw lines. For simplicity I'm going to show you one line. We draw one line on the concrete and we measure where the crack, the width of the crack where it crosses the line.

If you do the one click. And then we sum those numbers together, next click and divide by the length of the line. Gives an indication of total strain, how much that concrete has gotten bigger.

That's very simple. In practice, if you give me a next click, this is what an expansion grid at the station looks like. All right, so it's 20 inches by 30 inches.

So we established that in the area selected during the walk down. And we measure along each one of those reference lines. The 20 by 30 inch grid size is based on the Federal Highway Administration guide document.

It lets us share those corner points to economize the measurements and it balances the directions pretty well. We get eight measurements in one direction, nine in the opposite.

To give you an idea of the effort required each one of those is a measurement of the crack widths there. This type of grid will take somewhere on the order of an hour to an hour and a half for a person to do.

You wanted an example. This cracking level was about 1.2 millimeters per meter.

CHAIRMAN SKILLMAN: Let me ask this on the prior slide, Slide 31. How do you select length, L?

MR. SHERMAN: It actually ends up being ten inches to let us combine it with the mechanical strain gauges. In just a moment I'll show you that. We actually used the same grids to do the expansion, direct expansion measurements and the optical measurements.

So by combining with ten inches it lets us do dual purpose on those grids and leverage the data that we get optically.

MEMBER MARCH-LEUBA: This is just curiosity. Can you go to the next slide? When I look at this picture I don't see cracks. I mean when I look at the sidewalk I see cracks, I see air in between.

This is just filled in with calcium silicate gel. Is that what it is?

MR. SHERMAN: So the dark, those cracks if you could read the pieces most of those are on the order of two thousandths of an inch to maybe five thousandths of an inch, those individual surface opening cracks.

And the dark appearing material is actually the alkali silica gel itself. So that wall is dry. That's not moisture. That's the alkali silica gel.

MEMBER MARCH-LEUBA: I was reading during lunch time. It's not alkali silicate. It's calcium silicate.

MR. SHERMAN: Well it depends on what your alkali is. Calcium is an alkali. That's an alkali. It can be a sodium silicate gel as well. But we don't have to go --

MEMBER MARCH-LEUBA: I read the Wikipedia page. It's very informative. So I know --

MR. SHERMAN: You can get different, the cation can be different. It's the calcium or the sodium which is that alkali Dr. Bayrak talked about.

MEMBER MARCH-LEUBA: I recommend that you read the Wikipedia page. That's the source of my knowledge.

MR. SHERMAN: So if we jump to the next slide please. So this is where the ten inch comes from. So this is the mechanical strain gauges. So it's a demountable mechanical strain gauge.

So we do these in addition to the cracking index measurements. And we use the same monitoring grid and we do this by installing those metal gauge points, each gauge point has a receiver for the pins from the mechanical strain gauge.

And what this lets us do is go to another order of magnitude of accuracy. This lets us go to a ten thousandth of an inch.

MEMBER CORRADINI: So let me stop you here because early I think in when NextEra was doing the initial or maybe the MPR folks were doing the initial thing there was a comment made that the, I'll call it the labor intensiveness is different between these two.

Can you tell me more about this? This one strikes me as something I prefer to the sending a field worker out to look at cracks. Is this just only available in certain areas of, in terms of where you can place the pins?

I'm trying to understand your choices between these two because you made it a point of saying that they kind of intermesh.

MR. SHERMAN: They intermesh. It's a great lead in to where I was, they are very complementary. The cracking index helps us get back to the origin, to when we started, to before there was any cracks, lets us know what's happened to date.

But there's a little bit, it's less precise. Moving forward these provide more information because now we have pins installed and it lets us more precisely monitor expansion moving forward.

And that's actually baked into the structural analysis and into the structural monitoring plan that we use CCI to start, lets us know where we are. And then moving forward we combine it with the enhanced accuracy of the expansion index.

MEMBER REMPE: So earlier I had asked well how do you know where to put these pins in. And so you would look at the prior slide and is it typically where you see the bigger areas or more densely cracked areas and you stick the pin in there or --

MR. SHERMAN: In general, yes, flip

forward one. You'll actually see in general, yes. Remember I told you there's two tracks. You can see here we have instrumented the worst appearing area.

MEMBER REMPE: I can't tell that is, but if it is, okay.

MR. SHERMAN: So that would be --

MEMBER REMPE: I might put it a little more to the right and up a little based on the picture.

MR. SHERMAN: Remember you may not be seeing the entire grid. So it depends. There's two tracks. One track where we do track the worst areas and that's because that lets, you can always find the worst.

And then in some of the analysis, as Glenn was describing we use moderate. So once, in the second track that's the calculations looks for representative areas, not necessarily the worst case because that feeds into the analysis.

So there's two tracks. It's not, there's a lot to it.

MEMBER RICCARDELLA: But if you go back to your previous slide, do I understand that you have put your pins at the intersections of these grid points, right? You put one in the middle --

MR. SHERMAN: Yes.

MEMBER RICCARDELLA: -- because you want to compare them to the CCI. So they can only put them there and there or there and there.

MR. SHERMAN: Right. You can see on the slide it's Level E, across the middle E, F, G, and H. Those are the individual pins. So those are much faster to do.

The expansion index with the mechanical strain gauge is much more, is faster and more accurate.

MEMBER RICCARDELLA: Yes, but you're only looking at the increment which is a much smaller thing that you're trying to measure.

MR. SHERMAN: Correct, right. So they're very complementary.

MEMBER BALLINGER: But there's a temporal nature to this as well. I mean the fact that you put a gauge on something that looks ugly, that could be an area for which you're already on the plateau.

How do you know that, it's kind of a, I won't use the right terminology, crapshoot in terms of how do you know that there isn't an area that's about to become an issue?

MEMBER RICCARDELLA: But as I understand it once you get beyond that plateau you've got to go to the through-thickness measurements. You don't keep doing the in-plane measurements once you're on the plateau, right?

MR. SHERMAN: Again, those are complementary. And where would we, we would see something and that's going to come into where Said talks about how we group the areas.

So what would happen is if cracks started developing in a new area the classification of that area would change. So then we would probably go and have to go look and add monitoring.

The monitoring points are not static. We add them as driven by the structural analysis we add locations to fuel, again it's that cyclic process where the field data feeds into and supports the analysis and the analysis drives the field data.

Right, sometimes they may need an additional data point so we will go and add another data point.

MEMBER BALLINGER: So ten years from now or ten years from x, there may be an additional, there will likely be additional places where you start doing measurements?

MR. SHERMAN: Yes. And that's all baked into the structural monitoring program at the plant. All right, next slide then and one more. We'll catch back up.

We also heard earlier about through-thickness measurements. These are also used to measure ongoing changes and to verify that the structure remains within the bounds, within that playground that's established by the large-scale testing program.

Next slide. So deformation measurements. We've talked, we've heard a little bit today about deformation, right. All buildings are designed to move.

If you walk out in this building you'll see joints in the, expansion joints where the buildings are expected to move.

MEMBER RICCARDELLA: You went too fast.

MR. SHERMAN: I'm sorry.

MEMBER RICCARDELLA: So in all the, the previous slide, please. All the slides up to this point were CCI which as I understand it is related to in-plane expansion.

This is the only one where you're looking at the through-thickness which is where you have to get to once you get above that .1 or .2 percent threshold, right. We talked earlier.

You said there are 26 buildings under

evaluation. I'm curious how many of those 26 have forced you into the through-thickness measurement versus still doing the CCI measurements?

MR. SHERMAN: If those are all the buildings that Said will bring up later on that are classified as Stage 3, Tier 3 sorry, I keep using the wrong word.

MEMBER RICCARDELLA: So if you're going to cover it later --

MR. SHERMAN: It's about 40 locations where the through-thickness measurements are done.

MEMBER RICCARDELLA: Thank you.

MEMBER REMPE: So I know there's a license condition for additional data to corroborate what you've seen. But what about this thing about adding additional locations.

Is that something that's covered by one of the regulatory programs that again, it's our job to ask these kinds of questions, but to make sure the licensee continues to be vigilant in looking for new locations and adding additional monitors?

MR. SHERMAN: Yes, yes. That process of adding data is worked into the methodology document and it also comes out as a result of individual structural reports.

So each structural evaluation has requirements that roll out of that, that Said is going to talk about that say how often you have to go back and measure and where you have to do that.

MEMBER REMPE: Okay, thanks.

MEMBER RICCARDELLA: So continuing along those lines. As I understand it your load factors, your ASR load factors were based on measurements taken so far and consider the scatter and, you know, the standard deviation of those measurements.

It's possible that going forward in the future that you might get some measurements that change those distributions and result in a need to go back and relook at your load factors.

MR. SHERMAN: Yes.

MEMBER RICCARDELLA: Is that, that's built into the program?

MR. SHERMAN: Yes. Do you want to add anything on that?

DR. BOLOURCHI: Up to now we have not seen anything that changes by adding additional locations that we have done. The distribution of data has not changed.

And when we did those four zones we did multiple distribution and anticipate this kind of affect that three different distribution that if you get more data one of those will cover it and all of those distribution the envelope goes to calculate the zone factor.

Therefore, the possibility is there. But probability is not going to change.

MR. BELL: Without getting into a lot of detail we took a, when we did the curve fitting to the data to determine the load factors we did some conservative adjustments to those data in order to account for the possibility of more numbers and where things might go.

So I think the scenario you pose is possible but highly improbable.

MEMBER BALLINGER: In an earlier part of the presentation somebody mentioned that the degree of volumetric expansion of the components are, consists of near the surface wider cracks, but fewer and as you go into the surface, subsurface smaller cracks but more of them.

I think I recall somebody saying that. Now has the, have the measurements that you've done on the internal part, the through-thickness ones, have they confirmed that contention?

In other words, can you convert the surface to the interior and see if by measuring the interior you're actually adhering to that contention?

MR. SHERMAN: I haven't made the correlation between the two. But I think you might be, we expect the strain to be the same whether we have a lot of little cracks and neither one of these methods will really pick up or the through-thickness measurement will not pick up how many.

It just measures total strain. So I can't tell you if it's a lot of little ones or, you know, one larger crack.

MEMBER BALLINGER: But what you're saying is the strain is about the same?

MR. SHERMAN: I think that was what was postulated earlier.

MEMBER BALLINGER: Postulated. Have these measurements confirmed that?

MR. SHERMAN: I don't think we've done, we have not done it.

MEMBER BALLINGER: Maybe I'm not using the right terms. But that was a contention that the strain was uniform.

MR. BELL: There is actually a lot of literature that says that the strain reduces with depth from surface. So the surface measurements should be conservative.

Do you have anything to add to that, Dr. Bayrak? You have to go up to a microphone if you're going to add.

MEMBER BALLINGER: So I must have misheard.

DR. BAYRAK: So the description that I provided in the morning relates to a study we have done at Ferguson Lab where we sectioned a beam to take a look at what the surface crack patterns look like and what the whole thing looks like through the thickness.

So the strains remaining reasonably uniform within the test specimens was based on that observation.

MEMBER BALLINGER: Okay, but what about here?

DR. BAYRAK: So this particular measurement is intended to measure how much the thickness of a structural wall grows as opposed to how the surface measurements which are in the x and y directions vary as you move inwards into the structural wall.

So this is a z, direction measurement and the cracks that we see on the surface provide an indication for x and y strains.

MEMBER RICCARDELLA: Would the core samples that you take out give you any information regarding that?

MR. BELL: I'd like to make one clarifying point on the statement that I just made. For in-plane strain in a reinforced member, reinforced concrete member generally the strain is reduced with depth because the reinforcement restrains the strain as you go deeper into it.

MR. SHERMAN: Right. We would not actually expect a match between the through-thickness because it's unrestrained and the in-plane surface strain. Those would not be expected to track together because of the effect of restraint.

MEMBER BALLINGER: So there would be a significant difference between the cover, what do you want to call it, the concrete area that has no rebar in it, the cover area, a couple inches or so and once you get into the reinforced area?

MR. SHERMAN: There is a difference. The literature shows there is a difference. It's not giant because the effect of the reinforcement is thrown to a certain degree right.

And we're measuring in the same plane. So everything that's in the same plane is there but it's different than the through-thickness. All right, so we'll jump ahead to the deformation, starting on deformation.

So to restart all buildings are really designed to move, right. We do that intentionally. We put gaps in buildings. We put thermal gaps in buildings. We put seismic gaps in buildings.

So we do that to accommodate thermal movement, earthquake and other such loadings, wind movement. As such buildings incorporate specific, back one, please.

We incorporate specific detailing to accommodate that movement, right. So in the field we measure those deformations or movement of those different structural components at those points of movement and at other locations to provide more supporting information for the analysis.

So in addition to that normal seismic or thermal movements the ASR at Seabrook provides another source of deformations, right, as the affected concrete expands. It's just a difference source of movement.

Before going into our deformation movements I want to take a quick detour. We alluded to it this morning. We're going to talk about plant construction for a moment.

Now if we jump to the next, right. So Seabrook construction took place in excavated bedrock which was near, the bedrock was very close to the ground surface.

So after building the structures within the excavated bedrock the remaining space at many locations between the excavation face and the structure was filled with unreinforced structural grade concrete, right, of the same type used in the structures.

And they did it in two foot lifts. They used that rather than a granular engineered fill. Because this concrete is of the same type and composition of the structural concrete that we've been talking about so far there is evidence that it too is undergoing ASR expansion, right.

This expansion creates pressures against the backsides or underside of structures. You can see how the structure is kind of worked into the bedrock causing relative movements.

So we measured indicators of that movement to be able to feed back into the structural analysis that Dr. Bolourchi is going to talk about shortly. Next slide, please.

So we measure the deformations of the structures where applicable to provide information for the analysis. For example, sometimes quantifying the deformation pattern is critical to understanding the performance and is required to support the analysis as you'll hear about later on.

In a case such as this we'll measure the deformed shape of the structure using a variety of techniques. For example, when we were looking at a vertical wall shown on the left we would mount, we put a laser, a self-leveling laser beam on the floor and measure the offset to the wall in prescribed steps as we go up.

Similarly we'll do the same thing on horizontal surfaces with the horizontally projecting laser. And in all those cases we would bring them back, those measurements back to a known reference location.

Next slide, please. So similarly, sometimes we want to know information about the relative position of buildings so that we can understand the performance and to feed into the measurement analysis and interpretation feedback cycle.

For example, we've heard a lot about fire seal or the seals at seismic joints. That's what's shown on the left here. That's a foam seal or a sealant in a seismic joint.

So we measure and those are actually part of the ongoing tracking program at the plant now. We're measuring like 25 locations are routinely monitored plus there's other measurements that are done in support of building specific evaluations.

So we look at those joint sealant movements. Other places, there was a question earlier about the space between the containment building and the containment enclosure building. That's what you see on the right.

I've spent many an hour in that space. So they're measuring the distance between the two. And again, because of the large size of these things some of those, what sounds like a large deflection could actually be a very small strain because they're just large structures overall.

So we measure those spaces in between there with a laser range finder. And next slide.

MEMBER KIRCHNER: Just to make that last picture palpable, how much movement are you measuring?

MR. SHERMAN: In between those?

MEMBER KIRCHNER: Yes, and the annulus, fraction of an inch?

MR. SHERMAN: Since we've started monitoring they're small. This is one of the locations where they had, this was where one of the missile shields was that had to be cut back where a gap had actually closed.

So it had been an initial gap that had come into direct contact. The trick is here, Said is going to show a picture. Remember these are very large structures that are very highly restrained.

So a very small amount of strain can actually, gets kind of amplified by the shape of the structure and where it goes by all the different constraints on it. So we feed that right back into the analysis.

That's why it's important to do these measurements because it feeds into the analysis so we can really understand what it is.

MEMBER RICCARDELLA: That missile shield thing we're talking movements on the order of an inch, inches, right?

MR. SHERMAN: Yes. Provided, again, we don't know where it started. All we know is that it was, it had come into contact, right. So we're assuming that initial gap had been, was properly there which is, I think, a valid assumption.

But again, very large structures, small strains over large structures, yes. Without necessarily a lot of stress associated with that. This is a strain controlled phenomenon.

So you have to get into the strain world in your head rather than stress world and that's hard for a lot of people. Next slide, please. So we will also occasionally undertake specialty testing in the form of petrographic examinations when it's needed to provide specialized information as was described earlier in the large-scale testing program.

This is done only in special cases where we find a difference between the measurements, observations and analysis. For example, this could be a case where an indicated strain by the cracking index really doesn't match with the appearance or the pattern cracking and it doesn't match with what we see in the results of the analysis.

There's a disconnect in our data. And we, we're curious if that cracking is actually due to ASR. So in that case we'll use petrography to see if the source of that cracking is ASR or if another cause is likely.

Next slide, please. So an example of the process in this case, this is where the cracking index suggests that actually a high degree of ASR. But that was inconsistent with the overall pattern with what we saw on the surface.

You know, we didn't see any of that ASR gel. And it was inconsistent with the results of the analysis. If we really had that much strain the analysis showed us that other things should be happening that weren't.

So we went back and this is actually in the pre-action valve structure. So we went in and removed a core to test that assumption that all the cracking was caused by ASR.

So we took a core centered at a surface crack. Next slide, please. Then we take that core out, cut it, polish it and perform a petrographic examination on the core.

Petrographer is really a geologist who studies concrete. They're specialist geologists who, because concrete is just an artificial rock. So we do that with two petrographers on site still under a full QA program.

We set up a temporary lab on site to do that. And in this case we did the petrography and found that the near surface cracking that was visible was actually not due to ASR.

It's pretty clear the overall picture is on the left. But on the right, it's hard in this room to see, but it does not exhibit any of the typical characteristics of ASR and the petrographers confirmed there is no ASR in this core.

We don't see ASR gel formed. Usually you would see it filling air voids and other cracks within the concrete. We don't see that. The cracks do not start in the aggregate and extend outward. They actually run around the outside edge of the aggregates.

The aggregates themselves don't show signs of reaction. We don't see any alteration rings. So in this case we are able to find that the cracking was not due to ASR. It was attributed to other locations.

So we don't have to account for it as an ASR load. But we do track down where it came from. All right, so next slide. So, I guess, in conclusion, you know, we've gone through how we get the field data and how it's used in support of the methodology document, right.

It provides input data, a feedback loop into the whole analysis cycle and information to support that correlation of the work during the whole evaluation cycle. And as another side, another track that it does is the field data provides a means and is the basis for a lot of the ongoing structural monitoring program that goes on at the plant right.

The readings we're doing now have been

baked into the ongoing structural monitoring plan that you'll hear about later on. All right. So with that I think we turn it back to Said.

DR. BOLOURCHI: Okay, thank you. The goal in here is to describe the structural evaluation methodology to define a procedure which is repeatable and can be applied to all Category 1 structures.

And also there is another terminology we're going to start using establishing a threshold limit for potential future growth of ASR in each building. And I will describe what does this threshold mean.

Is it building specific? And it is a measure that we can expand the ASR still staying within the limit of the defined code. Next slide.

All of you are well aware of where we are. First, we started with the UFSAR and we have defined an LAR. As part of the LAR we have attached to that the load and load factor as a document and that's an attachment to the LAR.

The material properties are per spec defined in the original design per the larger-scale testing that was discussed in the morning. Also LAR defined a creative approach and I will describe that creative approach a little bit further on to that it quite a bit of effort to evaluate all these structures in a timely manner.

Therefore, we tried to do it on graded approach. And also we defined code supplement that we will, the document five supplement to the code for evaluation of this structure.

And we go through those specifically. Then you come, the issue with the LAR is high level and is not a repeatable, although it defined the process but it is not detailed enough that can be defined, can be repeated by sort of any other structural engineer.

Therefore, now we have defined a methodology document and it is very detailed and is, has three big segments. One is the analysis approach. In that it will be, the requirement is to be a repeatable process that can be applied for all Category 1 structures.

And also it defined a graded approach for field data. Therefore, for different graded analysis we will get conservative or more data as is needed. And then the threshold limit is using the design margin for the structure at the -- right now to extend how much more it has, that is still within the code limit.

And that goes through the monitoring as to, as it gets approached to that there will be proper action to take place. And the next one is the finally, structural evaluation.

And structural evaluation is the same equation that you see from the first one. And structural capacity defined by the code for all the, any of the graded approach includes the reliability inherent in the code.

The structural capacity should be greater than all the load included in their structure, the ASR load. When the structure is evaluated based on that then we'll define the parameters that need to be tested and the frequency of the testing and the requirement of the trending.

And that will be defined in each of the calculation packages. If you get any of the calculation, Chapter 8 defined those things very detailed on that, that can be taken directly from there and put into the structural monitoring program which has been in place.

And the last box is the structural monitoring program that it is maintained completely by the Seabrook plant. Next slide. Just to, since the threshold is a new terminology that we are introducing we try to use a similar equation that Glenn discussed earlier.

On the left hand side it is the resistance which we haven't changed. On the right hand side I divided it in two terms. One, all the load effect that is already in the UFSAR.

Therefore, we are not changing those. We are not changing the load factors. All of them is there, therefore, that is the sum of the factor designed basis load that is there.

Then we have a factor of I, which is the load factor for ASR. And then SA which is the load factor load for the ASR. Then the last item which put in green, KT edge, what we call the threshold factor.

Therefore, we go to the field and we measure the ASR and the load by the strain, for example. We put that thing as SA. We multiply it by a factor which is always greater than one.

And it can be very high. In the end I'll give you some summary on that. Therefore, we always grade down one. One is the right at this present time.

If it is 1.5 it is 50 percent more than whatever it is now. That is the only associated with the ASR load because the other load is constant, is not changing. Go ahead.

On the field data already we had a long discussion. We always start with the walk down for the observation. And we also define in detail in the methodology document a graded approach for the field data collection.

The reason that they will see the graded approach if a building has significant margin already in it we try to do much simpler calculation. Keep a lot of the conservatism.

As it is resolved we don't need as much data. We can use more conservative calculations, a lot more conservative for the, that and evaluate the building. And also the typical data is all listed in the methodology.

Therefore, this methodology is designed such that the infrastructure need to reevaluated can be done without any license change requirement. It is all included in that.

Therefore, the in-plane strain we talked about CI, CCI and pin-to-pin or expansion measurement. And also changing in seismic gap, structural deformation and structural distress like crack and crack rate.

All of that has been accurately listed in that on how it can be used. And also in, there is a good section in the methodology that defines how do you adjust what we measured in the field.

Does the table specifically define what

is ASR and what is not ASR? Therefore, you can go and there are five different requirements to be ASR. Therefore, that is defined.

But also there are other cracks that we know that they are not ASR like pressurization. We have data from 1980 that containing -- we have the pictures and the grade of where the crack was under.

The temperature affect differential ASR between these structures have produced a structural crack not an ASR crack and other sorts of structural deformation. And if needed we'll do petrography to identify if it is or is not because usually when we go to a place then we can look at that.

And if it doesn't jive that all the, why should it be ASR and we cannot completely identify it based on the structural primarily on this lab on plate -- lots of times we do petrography to confirm if it is not ASR.

CHAIRMAN SKILLMAN: Dr. Bolourchi, would it be acceptable if we took a 15 minute bio break because the next portion of the presentation will be the graded approach. This might be a clean break, give everybody a few minutes to stretch their legs. Would that be all right?

DR. BOLOURCHI: Absolutely.

CHAIRMAN SKILLMAN: Ladies and gentlemen, we are in recess for 15 minutes. Please come back at quarter past three by that clock.

(Whereupon, the above-entitled matter went off the record at 2:57 p.m. and resumed at 3:14 p.m.)

CHAIRMAN SKILLMAN: Ladies and gentlemen, we are back in session, let's begin. To the presenters, we're late in the day, we're behind schedule, I ask you to take every action that you can to speed up this presentation.

DR. BOLOURCHI: Okay.

CHAIRMAN SKILLMAN: We need time for the staff, we need time for the public. We will go as late as we need to go, but let's proceed forthwith. Thank you.

DR. BOLOURCHI: Thank you. The talk about the graded approach, next two slide, we go a little bit slower, but after that, we'll try to go as fast as we can.

In each of the building we start, we start with the review in the field data and all the document that there are, the original design document, review all the Structures Monitoring Program to date, to figure out if there was any observation over the life of the plant.

And then, we do initial walkdown. And at that point, we'll decide which space under how much margin it is in the original design and what is the status of the ASR and so on.

CHAIRMAN SKILLMAN: For those of you who are on the phone line, please put your phones on mute. Thank you.

DR. BOLOURCHI: Okay. Then, we will start, we can start at any of the three stages of analysis. Within all three stages, the commonality is that all will be evaluated based on the code of record.

Therefore, in any of these three condition, the conservatism inherent in the code will remain intact for all of these stages and type of analysis.

MEMBER MARCH-LEUBA: So, I can understand, you call it the stages. Is that you're doing all three for each component? Or are these options?

DR. BOLOURCHI: These are options and you can start at any of them.

MEMBER MARCH-LEUBA: So, it's an option and you can choose one of the three for a component and stay with it forever?

DR. BOLOURCHI: We can start with Stage One and if you need to reevaluate it, I have a choice of going to Stage Two.

MEMBER MARCH-LEUBA: You do a Stage One, if you don't meet the criteria, you go to Two, if you don't meet the criteria, you go to Three?

DR. BOLOURCHI: But if a structure is already in a more critical or as defined, we can start at Stage Two. You don't need to go One, Two, Three, we can go One, Three, if needed.

So, the Stage One is, obviously, the most conservative calculation. These are usually we use all the original design calculation, we don't do any more recalculation of the demand.

Usually, the original design is done at a part, the design stage very conservatively. And we calculate the ASR in conservative way.

The way we do that, we go to the worse area of the building and we measure that one. We amplify that for the entire area. We expand that, if it can take that load, obviously it can take even if you have more data in that.

We start with the most conservative way of calculation, which is really over-conservative, but saves lots of time and has lots of margin in that. Since it has lots of margin in this calculation, we will mandate every 36 months going back and make sure that nothing is changed in that.

The Stage Two is still very conservative, because we still use all the original design calculation.

All the loads which were calculated with the original design, we don't touch it, we just go back to usually in the old calculation, all that has been done based on the closed form solution, very conservative. They will pick up those very directly.

But usually, then, we will model the ASR using finite element. And generally, that is the case when the differential in the one area versus the other, that difference between that, if you cannot simulate by hand calculation, become more complex.

Or if the geometry is complex. If you have a cylinder and a rectangle next to each other, trying to estimate it by hand become very difficult.

In that case, we go to calculating the ASR demand by the finite element, then we add to original calculation and then, we will monitor it every 18 months after it pass.

The Stage Three, which as I said, retain all the evaluation based on the code, is the more defined. We calculate -- we develop a finite element.

And the first step in that would be to correlate the finite element with the in situ condition, the sustained load at this point. And I have a figure for that.

And then, we calculate all the loads, the dead load, live load, lateral soil pressure, all the load that we need in the original design and the ASR, using that finite element. And then, we will monitor these structure every six months.

If you go to next slide, this is a flowchart for a Stage Three analysis, which is the most refined one. The other one become simpler than that. We started with Stage Three, either because we started at that or it can come from the previous analysis.

Then, we will develop the finite element and we correlate that to the field data that we will talk, and I have a figure to represent that. And then, we use, when the finite element model is validated, then we will use it to calculate all the load, ASR and non-ASR.

And then, we will amplify ASR load with additional load, more with the threshold factor for future growth of ASR. We calculate total load and then, we come to the box at the junction.

The question is, is the capacity still greater than the demand? Capacity, the core capacity still. And the demand is all the load calculated.

If it greater than that, therefore, it meet the licensing basis, as appended by LAR, which obviously including ASR load, we define threshold limit and the reference value for monitoring every six month.

If it doesn't pass, we have two choices. Either we can go back and reevaluate with the same methodology, how can we do it? Because if we can go back and get more field data, we'll observe more variation in the structure.

Or we can do petrography, if you have assumed something is ASR and if it didn't qualify, we can go back and do petrography and confirm it is not ASR. If it is not, then we can go back and reevaluate this structure.

And that can happen if you approach the threshold. Right now, we don't have that condition, but it is anticipated in the methodology to be able to do within that.

Or the other option, we can go and retrofit. And we have already defined some retrofit and some has been completed, that will be discussed by Seabrook. Next slide, okay.

The model evaluation, model correlation, corroboration with the field data is important step. On the left-hand side is the input that will go to the finite element. It is the CCI on the top left.

And as a Stage Three, the dot represent the number of points that we have taken. As you see, there is many points on that. Then, below that is the pressure from the concrete backfill. And then, all the other load.

On the right-hand side, we will get -- we have measure those, the deformation, either through the seal or through the annulus measurement. And then, we have amplified the deformation in order to be visual, otherwise you don't see any deformation. And then, we will try to match the deformation to that.

The only variable in here is the concrete backfill, we can adjust, that we'll discuss, to match that. Or in the other structure, it can be cracking or cracking pattern or strain. And that is the output and that the input.

One the comment that was in the morning about the ASR, the CI value of the containment enclosure to be small. We have the trending analysis with the pin-to-pin measurement and we have looked at the slope of that versus the slope of the CI measurement, starting from the early eighties to that value.

The change in the slope is insignificant, therefore, the measurement that we have is valid for the evaluation of the CI. I mean, for the containment enclosure building. Next slide.

MEMBER RICCARDELLA: You don't have a plot here that shows it, but it's saturated, you're saying? It seems to have reached the level of threshold?

DR. BOLOURCHI: Well, your question, I understood that you were saying that that is in the low level and there may be a difference between the measurement with the strain measurement versus the CI measurement.

And I'm saying that we have, like, eight years of pin-to-pin, which is physical measurement that describe on that, that it account for all the strain.

And when we get the slope of that and we go back to the -- go directly down, compare to the slope if you started the CI all the way to the early eighties, these two slopes are very similar to each other.

Therefore, that CI measurement that we use for the containment enclosure building is representative of the actual value. We have two ways of confirming that value. Okay, next slide. Some of the attribute of the --

MEMBER RICCARDELLA: Can you go back a moment?

DR. BOLOURCHI: Sure.

MEMBER RICCARDELLA: So, the upper right-hand corner, on a bigger version, I was trying to understand you, this is, you're comparing your finite element measure deformations to the actual measured deformations. I had trouble kind of interpreting which --

DR. BOLOURCHI: Oh, okay. The dark black line is the -- which is circular, that's the original shape.

MEMBER RICCARDELLA: Okay.

DR. BOLOURCHI: Then, we put two circle, inner and outer, each of them representing one inch of deformation.

MEMBER RICCARDELLA: Yes.

DR. BOLOURCHI: Obviously, at 180, 160 feet diameters, one inch, you will not see, but for visualization.

Then, the dots are the actual measurements that you see on the dots. And the lighter blue color is the deformation presented by the finite element. This at one section, we have done it at multiple sections, to make sure that the deformation matches the data on that. Okay?

MEMBER RICCARDELLA: Okay.

DR. BOLOURCHI: On the attribute, we are

using general purpose program ANSYS, which we got license under the full QA and we have audited that and we brought it under our QA program.

And that program has been used for multiple other plans that we have used and others have used for the industry. And the internal ASR is the ASR of the reinforced concrete structures.

And for each of the finite element that I showed at the previous slide, each of the element consist of three elements. One representing concrete and two representing rebar in one direction and two orthogonal direction.

We expand the concrete by the CI measurement and then, the reinforcement model will pull it back and produce the pre-stressing that was observed in the testing program. Therefore, in here, we will see the pre-stressing that require to model on that.

And the concrete backfill is, obviously, from the measurement that we have a bigger section, all of which we defined.

MEMBER KIRCHNER: So, may I ask, do you test your -- I'm looking at the sub-bullet there, on -- I'm interested how the nodalization might impact the results. So, I assume you benchmark the code, with the assumptions you just described, against the large-scale test program beams?

Or how did you determine that the nodalization used in the finite element method applied here was actually doing physically what happens in the structural member?

DR. BOLOURCHI: We have some hand calculation that we can simulate that very easily. And we have also used different method of calculation and compared to that.

And the result -- we also simulated some of the testing that was done in response to some of the question that was raised by NRC. We showed that all of them are simulated properly.

MEMBER KIRCHNER: Like this morning, we saw a large beam being flexed quite a bit. Were you able to model that --

DR. BOLOURCHI: We did not --

MEMBER KIRCHNER: -- behavior and failure?

DR. BOLOURCHI: We did not simulate that particular one, but we have done the north wall of Seabrook, for example, which has about one inches of deformation.

We have the CEB, which has plus or minus two inch of deformation. And we have simulated those and we match the actual field measure.

MEMBER KIRCHNER: Yes, but I can adjust a code to get to the field measurements. What I'm thinking more is kind of a blind calculation of the large-scale test program results, to have confidence in the code as applied and that the nodalization is sufficient to capture the effects, because the properties are changing in the concrete mix and not in the steel, other than, obviously, there's stresses induced.

So, I'm just curious if you did some just basic checks of the methodology, using the FEM code against those test specimens from the large-scale test program.

DR. BOLOURCHI: We have not done a validation against the test program. In our QA program, we have done enough to confirm that it is done, but we have not -- if specifically you are saying that, did we validate our program against large-scale test, we have not done that.

MEMBER RICCARDELLA: I thought you said you did one.

DR. BOLOURCHI: Pardon me?

MEMBER RICCARDELLA: I thought you said you did simulate one.

DR. BOLOURCHI: We have simulated some of the values on that --

MEMBER RICCARDELLA: On the large-scale --

DR. BOLOURCHI: -- and we have captured the same delay cracking that was observed. We have simulated that in the analysis. But we did not get exact same dimensions.

MEMBER RICCARDELLA: If your ANSYS analysis, it's a linear analysis?

DR. BOLOURCHI: ANSYS is for the -- what we have use is a linear analysis.

MEMBER RICCARDELLA: Linear, so if you were simulating a test, you could only go up to the point of first cracking?

DR. BOLOURCHI: That's all it is. I mean, we have extended it for ourselves to see with going there.

But in our evaluation and modeling, we have limited to the linear analysis, as required by the -- we did not extend to any nonlinear vein. We are not getting to that range of large reflection that it was tested. Okay.

The other factors, the structure cracking and the cracking is associated -- we have tied the cracking to the strain in the concrete. Therefore, any of the pre-stressing has to be overcome. That simulated delay cracking that was observed in the field. Next slide.

This slide, we have seen before. Basically, growth of concrete backfill can put load on the structure. Let's go to the next slide.

In here, in the Methodology Document, we have quite a bit of extension of discussion and that here are coded basic concept of it. At any depth on the concrete backfill, as it try to grow, will produce a load, we assume a load equal to the overburden, is all the load that is sitting up there.

And since if it want to grow beyond that, it will grow vertically, doesn't need to grow horizontally, is the direction of least resistance. But when we want to simulate the deformation, we can reduce that, like we have simulated in the CEB, we can reduce that in order to match the deformation.

Or if we are not observe a crack on the wall, we can assume that the pressure equal to the crack, which is the conservative value. Therefore, when we come to field observation, we say, go and make sure there is no crack observed in the field. That's how we adjust on that. Next slide.

The supplement on the code, there are five supplement. The first one is, we add ASR load base on the load and load factor, which were discussed, to all the FSAR load. We are not changing FSAR load, we keep all the load, we add the ASR to that.

And the second one is that we are accepting the code calculated values as capacity for the structure. And that is based on the large-scale testing.

The third one is, ASR produces compression in the member and there is a terminology called shear friction, that it is sliding of the concrete over each other.

If you have compression, you have to overcome the sliding friction. ACI 318-71 does not address that. All the other code beyond that, including 83 version and ACI 349, address that consistently. Therefore, we are using 318-83, entire section of that, instead of the original 71.

And the next two is reduction of the structural property, because of the cracking. The number four is full flexure, which ASME 443 and current ACI all recommend that, in lieu of doing a tedious calculation, you can use a 50 percent reduction and that's a conservative.

Because we want to get a higher value, this is a displacement control, more stiff you put, more load you going to get.

And the last one is axial and shear reduction, because of the cracking. Again, the code 71 says, you can reduce it to zero. We gradually reduce it in order to capture more load and that is standard in the industry. Next slide.

The threshold parameters, this is specific for each structure, for structure monitoring, after we evaluate the building. But these parameters is from a set of the well-defined in the methodology.

Therefore, we are not coming up with a new case, because if it come later they want to reevaluate any of these building, the methodology already defined what are the parameters that you can do.

And those are in-plane expansion. As you see, I'm not talking about CI anymore, it's just the expansion. And the preferred method is the pin-to-pin expansion here. We also, we can look at the deformation, seismic joint, or structure deformation as included. Next slide.

In the summary, we have provided a Methodology Document that includes how to include ASR load and load factor to maintain inherent reliability in the code.

And we provided repeatable graded approach for analysis and collecting data, and also, threshold values and limit that need to be monitored in future. Therefore, as taken, is that the repeatable analysis process is for evaluation of all Category I structures has been defined in here.

Next, we go to the next box in the evaluation of the structure. Therefore, now, we use the Methodology Document and apply to each of the Category I structures.

And in here, we going to define established limit for the threshold and how much more these structures have capacity to go. And again, the same thing is, we are giving back to that the structure capacity based on the code, it should be greater than all the loads on that.

We go to next slide. For all Category I structures that are being evaluated for the site, we confirm that the structure meet the code of record and we will determine the threshold for future ASR growth and will define for each of them how often they need to be monitored, based on the stage of the analysis was done.

And we also defined the parameters that need to be monitored. Also, we will identify if there is an area of the structure that require enhanced monitoring, which can be as short as two months interval. And also, if there are some retrofit required for the structure.

And a summary of the structure evaluation is summarized in this table below. Obviously, it doesn't add up to 26, I --

MEMBER RICCARDELLA: That was my question.

DR. BOLOURCHI: -- can tell you right away. Because what we have done is the number of structure evaluation packages.

Some of the structures, we can combine them together and evaluate it together. Some structures, we had to do three or four different evaluations.

Like the example is manholes, there are 16 different manholes, different geometries, trying to put everything in one -- and some of them are Stage One, some of them are Stage Two -- become very difficult, trying to stay with the structure.

Therefore, 19 of them is completed and the threshold is from 1.2 to 3.7 for the ones which is completed.

And out of the eight which is left, four of them, one of them is Stage One, one of them is Stage Two, two of them is Stage Three. We have the draft calculation, but it is going through internal review before we send it to Seabrook for evaluation.

MEMBER MARCH-LEUBA: You might not know the answer to this, order of magnitude, the equation that controls this is capacity greater than the sum of the loads, the load for the ASR, what's the percentage of the total load?

DR. BOLOURCHI: It's very good question.

MEMBER MARCH-LEUBA: And I know it depends on -- each one is different, right?

DR. BOLOURCHI: Yes, each one is different, but there are places that ASR can be small, five-ten percent. There are places that the ASR can be 40 percent of the load.

MEMBER MARCH-LEUBA: You've seen 40 percent increase?

DR. BOLOURCHI: I have seen 40 percent and there can be some structures that, in some direction, there was not -- doesn't produce load, but ASR become primary load on that.

MEMBER MARCH-LEUBA: But as a percentage of the capacity, not a percentage of the total sum?

DR. BOLOURCHI: Oh, it could --

MEMBER MARCH-LEUBA: Because, I mean, if you didn't have any load, then any load is a significant change.

DR. BOLOURCHI: Right. I mean, as a percentage, yes, because we always add up everything to see how much is compared to the load that was design. As a total load, probably about, could be about 30 to 40 percent. I mean, this is just an estimate. I mean --

MEMBER MARCH-LEUBA: Relevant, it was not a wasted exercise, we --

DR. BOLOURCHI: Yes, it is not -- I mean, I cannot say it one or two percent, it a value greater than that.

MEMBER REMPE: I'd like to understand uncertainty and try and get a feel for it. Could you go back to Slide 49, please?

DR. BOLOURCHI: Okay.

MEMBER REMPE: On the lower right, sometimes the data are very -- I assume the data are the little dots or --

DR. BOLOURCHI: That's correct.

MEMBER REMPE: -- diamonds and --

DR. BOLOURCHI: That's correct.

MEMBER REMPE: -- the predictions are the line that are reddish --

DR. BOLOURCHI: Correct.

MEMBER REMPE: -- colored. Some places are matching quite well, but then, if we look at towards the end there, it looks like that it's almost 0.009 versus -- it looks like the data could be off by a factor of two?

DR. BOLOURCHI: Well, okay, that's great question. And if you look at that, in the actual -- on the right-hand side, if you look at the right-hand side on the top, we have different colors.

MEMBER REMPE: Right.

DR. BOLOURCHI: And that area that you are referring to is the right-hand side of that, which is a special area, which is the average of the -- we have actually input the average value between these two locations. And that is the vertical direction that was applied.

And the reason, because that value was very high, either we can go and do a petrography and confirm it's not there, but we will -- at this stage, we say, okay, let's have that, but we have, in that area, we measured about eight or nine values and we put the average of that eight or nine values into the model, as a not constant value.

But when it comes with all the other load combinations and the deformation, then the strain deformation, it doesn't become constant, it become a gradual value.

MEMBER REMPE: Okay.

DR. BOLOURCHI: But it is, as an input, it is --

MEMBER REMPE: Okay. So --

DR. BOLOURCHI: -- average.

MEMBER REMPE: -- my takeaway, since I'm not an expert in this, is if you see something like that, you investigate it and try and understand and get a better feel for what's going on --

DR. BOLOURCHI: Absolutely.

MEMBER REMPE: -- at those locations?

DR. BOLOURCHI: Absolutely. And that is exactly -- that was very important for us to do. For that particular one, I know I spent at least about three months.

MEMBER REMPE: I don't want to know what you did for three months on it, but thank you.

MEMBER RICCARDELLA: Now, is that within the scatter that we talked about from the mean to the -- you talked about how you built the spread in the data into the load factors for ASR.

Now, this one here, does that say that three standard deviations is a factor of two or something like that? Is that what that tells you?

MR. BELL: This is somewhat of an anomaly. We're looking at the differences between an analysis and a measured value.

MEMBER RICCARDELLA: Yes.

MR. BELL: And we often will input a measured strain, under the presumption that it's all ASR. And what Said is saying is, if the model tells us there's a large discrepancy there, then we need to chase down why there's a discrepancy.

So, we'll either refine the analysis or do petrographic analysis to explain the difference, we just don't let it lie.

So, this isn't so much variation in field data as the model not, at first blush, completely describing the structural behavior. And then, we chase that down.

MR. SCHULTZ: Said, your last slide on evaluation packages shows that there are three that are in Analysis Stage, excuse me, nine that are in Analysis Stage Three. And so, they're being monitored on a six-month frequency?

DR. BOLOURCHI: Yes, after -- they are on a six months, after it is completed. The one that --

MR. SCHULTZ: Yes.

DR. BOLOURCHI: -- it is completed, they

will go on a six months monitoring.

MR. SCHULTZ: How long does it take to do these analyses?

DR. BOLOURCHI: Is about --

MR. SCHULTZ: Roughly?

DR. BOLOURCHI: -- five-six months, at least.

MR. SCHULTZ: Are any in the augmented, you mentioned augmented, could be less than six months, are any of the completed package less than six months?

DR. BOLOURCHI: Actually, in the Methodology Document, we have provisions, if there is an area that may require retrofit, then we will put it on a higher monitoring --

MR. SCHULTZ: But you don't have that for these --

DR. BOLOURCHI: -- until we --

MR. SCHULTZ: -- completed packages?

DR. BOLOURCHI: -- it is retrofitted and the issue goes away.

MR. SCHULTZ: I see where that fits, thank you.

MEMBER MARCH-LEUBA: But the monitoring, what you do is, you check the cracks again every six months, to make sure that they're below a threshold?

You don't rerun the analysis?

DR. BOLOURCHI: That's correct. That's correct.

MEMBER MARCH-LEUBA: So, and we were told a single location takes about a couple of hours to perform?

DR. BOLOURCHI: That's correct. And when we get to the monitoring, there's a -- our preferred method is the expansion measurement, which most difficult time is to get to the location. The actual measurement is very fast, usually --

MEMBER MARCH-LEUBA: I have not read that slide yet, but suppose you give the threshold in units of CCI change instead of 1.2, that doesn't mean much to the guy in the field.

DR. BOLOURCHI: Oh, yes. No, no, no, we will define exactly for one --

MEMBER MARCH-LEUBA: The maximum CCI is 4.7?

DR. BOLOURCHI: Right. We will define as one value or at one location or aggregate, depending on the deformation pattern, aggregate of that, and will give them the actual value.

And also, if it is Stage One, we reduce that by 90 percent, and if it is a Stage Two, we reduce it by 95, and so on.

MEMBER MARCH-LEUBA: I'm just thinking, human factors, everybody in that table understands what a load effect S sub A means. The tech you're going to send in the field doesn't know what that is.

DR. BOLOURCHI: No, that --

MEMBER MARCH-LEUBA: They don't know what CCI is.

DR. BOLOURCHI: That's correct. We give the actual value of, this much strain cannot go more than this value. We give the exact value in the table.

MEMBER RICCARDELLA: So, when you say the threshold factor range from 1.2 to 3.7, can I assume that the 1.2 is associated mainly with the ones in Stage Three and the 3.7 would be way down in the Stage One? Is that --

DR. BOLOURCHI: That's usually -- there's one or two building which has 1.2 and is Stage Three. The other one, we have 1.4, 1.7, 2, 2.5, and it can be -- there is one building that is 1.3 and by design, we set it on that.

That it is a Stage One, because doing any higher evaluation doesn't change. But as a part of the methodology, we --

MEMBER RICCARDELLA: But 1.2 means --

DR. BOLOURCHI: -- put that value --

MEMBER RICCARDELLA: -- you're 80 percent of the way there, if you can only take 20 percent more expansion before you hit the limit?

DR. BOLOURCHI: Before you hit the limit and --

MEMBER RICCARDELLA: Have you to do so?

DR. BOLOURCHI: -- you can do the reevaluation or there are specific procedure how to get there. Either you -- because usually not all the structure get effected, there is a small part of the structure that you can either reevaluate or retrofit.

MEMBER RICCARDELLA: Retrofit?

DR. BOLOURCHI: Yes.

MEMBER RICCARDELLA: I see.

DR. BOLOURCHI: It is option that we can -- will be discussed by Seabrook.

MEMBER DIMITRIJEVIC: I have a risk related, I'm risk specialist, so I really appreciate all of this deterministic evaluation. But, from my point, so, you basically prove that they satisfy licensing basis and capacity of the structure.

What I would like to understand is there any, because I know you do this and you will understand it well, is there any risk implication of this?

So, let's say that we have a Seabrook

station, same for Westinghouse, on the same seismic area. I'll just ask about seismic, I will ask when this second group comes about other failure modes.

So, you have same seismic event and you calculate fragility for the components and structures. Would the Seabrook, with this issue, with ASR issue, would the fragility numbers be different?

DR. BOLOURCHI: I haven't calculate the actual fragility calculation for you, but we have --

MEMBER DIMITRIJEVIC: What's your feeling?

DR. BOLOURCHI: No, no, let me --

MEMBER DIMITRIJEVIC: Okay.

DR. BOLOURCHI: -- each of our calculation, I am a seismic engineer --

MEMBER DIMITRIJEVIC: Yes, that's right.

DR. BOLOURCHI: -- by nature, we have calculated all the calculation, original calculation is done by the stick model for the seismic and we review all of that.

The total mass is not changed, obviously. The center of gravity, center of the -- we calculate the center fragility and central mass for each of the structures, to make sure the original stick model still is valid.

Therefore, the original calculation in

which Seabrook, I assume that they have done the PRA work, would not be impacted on that. And --

MEMBER DIMITRIJEVIC: But, for example, you said that there is a change in seismic gap. This can impact the impact of the one structure and that is -- so, you think really that ASR would not impact any risk, seismic risk calculation?

DR. BOLOURCHI: No, no, we calculate actually the maximum calculated value for what is the required seismic gap? And we calculate that, I know, on a very conservative way.

Originally, they did all the seismic gap, they put everything at three inches. And most of the calculations are less than half an inch, that you require.

We are recalculating those to confirm, at an area that was abutting against each other, that was one of our recommendation, because it would impact the seismic, original seismic evaluation.

Therefore, we recommended to cut the missile shield and they did cut it and the requirement was to have at least one inch of gap and to maintain that, to maintain the same code requirement and also, the fragility that would impact on that.

MEMBER DIMITRIJEVIC: Thank you. So, no

risk implication, that's what you're saying, right? This phenomena doesn't have a risk implication whatsoever?

MR. BELL: Maybe a way to address your question at a higher plane, if this is appropriate, we could go through the analysis and all the processes, the structural performance, including fragility, would be in line with a code-compliant structure.

MEMBER DIMITRIJEVIC: All right.

MEMBER RICCARDELLA: I believe you did the analysis using the original design-basis response vector for SSE.

I'm sure you're probably aware that the updated response vector, as part of the Central and Eastern United States Seismic Study, showed a considerably reduced response vector, in the one to ten hertz range. I'm sure you're probably aware of that.

DR. BOLOURCHI: I think Seabrook did the PRA work already?

MR. BROWNE: Yes, I would have to reach out for the PRA work.

MEMBER RICCARDELLA: Well, I'm just saying that might be some additional margin that you could take --

DR. BOLOURCHI: Yes.

MEMBER RICCARDELLA: -- advantage of in --

DR. BOLOURCHI: We have additional margin.

MEMBER RICCARDELLA: -- the event that you have the 1.2, an issue with the 1.2.

MR. BELL: The exercise here was to check conformance to the original design criteria. To the extent that was conservative, that's built into the present exercise.

CHAIRMAN SKILLMAN: Let's move along, folks.

DR. BOLOURCHI: Okay, next slide. Therefore, in conclusion, we have evaluated or we are completing evaluating all seismic Category I structure using the consistent methodology applicable to all of them.

And we provided the threshold for each building that we will complete. Therefore, and defined action require to make sure each structure meet the code of record. And that conclude our part of the evaluation.

CHAIRMAN SKILLMAN: Thank you very much. Members, before we release this team of consultants, have you any questions, please? Hearing none, it's -- Ron, go ahead.

MEMBER BALLINGER: What's the uncertainty on the 1.2?

DR. BOLOURCHI: Generally, the -- I know some of these buildings by heart now. Some of the buildings that is 1.2 is on the conservative side, I can very easily, if I do more evaluation on that, can easily, because the controlling part is low grade and that's why we limited to above grade, and we -- easily, we have more margin. We have tried to be conservative on this evaluation.

MEMBER BALLINGER: So, it's better than 1.2?

DR. BOLOURCHI: It's better than 1.2.

MEMBER BALLINGER: Not lower than 1.2?

DR. BOLOURCHI: No.

CHAIRMAN SKILLMAN: Okay. Where are we on presentations? Do we have another presentation from --

MR. BROWNE: Mr. Chair, we have a short, I'll call it a short presentation on the program, but, I'll talk to Ed, but I think in the -- there's several slides at the backside of this next section that involve the license amendment that I think would be redundant and I think the Subcommittee likely understands the construct of that.

But I'd advocate we at least walk through the program a bit with Mr. Carley and Ms. Hulbert, and then, we'll turn it over.

CHAIRMAN SKILLMAN: Absolutely. Let's do that and let's get moving. Thank you. Please go ahead.

MR. CARLEY: Thank you. I am Edward Carley, the Engineering Supervisor for License Renewal and I was part of the project team for the resolution in the licensing basis for ASR-affected concrete structures.

As our final segment for today, we will discuss the approach for managing the aging effects of ASR-affected concrete structures at Seabrook Station. If we can just go ahead one slide?

Ms. Jackie Hulbert will provide the details of our enhanced Structures Monitoring Program and ASR monitoring implementation. And as we had just discussed, we will probably just skip over the summary of our current licensing actions, as we've discussed those quite a bit today. So, just two more slides ahead.

So, referring back to the graphic you've seen throughout this presentation, the Structures Monitoring Program takes the bounding conditions of the large-scale test program and the threshold monitoring limits from the structural evaluation and implements an overall ASR Aging Management Monitoring Program that is integrated into the site's comprehensive Structures Monitoring Program.

As shown by this graphic, the -- if and when limits are approached or a new condition is identified, there is a feedback loop to update the structural evaluations. And as shown on the graphic, the program currently implemented will continue into and through the period of extended operation.

And on that, I'll turn it over to Ms. Hulbert.

MS. HULBERT: Hi, I'm Jackie Hulbert. I'm the Structures Monitoring Program Engineer at Seabrook.

As Ed had mentioned just a second ago, we have developed a comprehensive Structures Monitoring Program that addresses the typical Maintenance Rule portion, as well as the identification, evaluation, and monitoring of alkali-silica reaction affected concrete structures and associated systems, structures, and components.

Our Structures Monitoring Program incorporates the results and the respective monitoring limits from both the large-scale testing program, as well as the structural evaluations.

In addition, Seabrook Engineering, we have performed both interdisciplinary and cross-disciplinary training on ASR and ASR-induced building deformation to bring awareness to the Station.

We have developed web-based training for all badge personnel onsite, as well as we provide focused training for departments. Next slide.

So, I know this slide's busy, and the next slide will be as well. The intent is not for you to be able to read every word.

So, at Seabrook, we developed a database in which we enter all of the deficiencies, the monitoring results, et cetera, that derive from the inspections performed in accordance with our Structures Monitoring Program.

The database mimics the different sections of our program. As you can see, we have the Maintenance Rule portion, ASR expansion monitoring, the ASR-induced building deformation monitoring, and equipment impacted by building deformation, and groundwater monitoring.

The database we use as a tool or an aid, that we use to track our monitoring results, and in addition, the other departments onsite have access to this, so they can use this for their information. Next slide.

Like I said, this is busy. This just gives you a glimpse of what's included in our database. It's a partial view of all the observations identified under the different sections of our program.

This is particular to our residual heat removal vaults. Examples captured in our program include, like, corrosion of the steel components, concrete cracks, ASR, degraded building seals, coatings, et cetera.

So, the margin parameters in acceptance criteria for ASR-affected concrete structures are driven by the results from the large-scale testing in the structural evaluations, as previously mentioned.

Expansion due to ASR is tracked via in-plane expansion measurements, in the form of either combined cracking index or pin-to-pin.

The through-thickness expansion is tracked via material testing in the installation of the borehole extensometers. And then, we also track volumetric expansion.

The limits for ASR expansion, like I said, were derived from the large-scale testing program. The monitoring frequency is driven by the severity of the in-plane expansion.

In-plant expansion measurements are performed either on a six-month or a 30-month basis. Through-thickness expansion measurements are performed on a six-month basis, as well as the volumetric.

The parameters to be monitored for structural deformation due to ASR are building-specific and their associated thresholds are derived from the structural evaluations.

Examples of parameters in which we monitor can include the measurements of seismic gaps between structures, the annulus width measurement between our containment structure and containment enclosure structure. We do plumbness measurements, in-plane expansion measurements. We sound for drumming areas. And a slew of other things.

The monitoring frequency for the deformation parameter monitoring is based on the stage in which the building was analyzed under.

So, as previously mentioned, Stage One structures are monitored every 36 months. Stage Two structures are monitored every 18 months. And Stage Three are monitored every six months.

Additional conservatism has been implemented by our Structures Monitoring Program, by way of applying what we call an administrative monitoring action limit, and that's applied to the threshold limits that were developed through the structural evaluations.

The admin limit provides time to perform additional inspections, to ensure limits are not to be approached prior to the next inspection interval, and to initiate corrective actions if warranted.

In addition, the Structures Monitoring Program ensures that if a new deficiency is noted or if a deficiency worsens that could potentially have an impact on structural evaluations, that it is entered into our Corrective Action Program and evaluated appropriately.

So, monitoring locations. As previously mentioned, we monitor ASR expansion volumetrically, both in-plane and through-wall.

We currently have a total of 136 locations in which we monitor in-plane expansion, as it relates to the large-scale testing, and we have an additional 21 grids established that derive from the building deformation evaluations.

Through-thickness expansion, like previously mentioned, is determined by establishing what the expansion is to-date and then, using the borehole extensometers to track any potential expansion going forward.

To establish the expansion to-date, we extracted concrete cores, performed material testing, and correlated the results back to the large-scale testing program.

We currently have a total of 48 extensometers installed in various structures and we've taken approximately 200 cores and performed material testing on all of them.

As mentioned before from MPR, we test all cores for compressive strength and for modulus of elasticity.

Actually, Seabrook -- so, for the material testing, Seabrook actually brought the capability to test cores onsite. We set up a lab that mimicked the lab at the Ferguson Structural Engineering Laboratory.

And we developed procedures in accordance with the respective ASTM standards for the obtaining and the performing of the material testing on the concrete cores. Next slide.

The monitoring locations and parameters related to the structural deformation, like I said, are derived from the structural evaluations and are captured in our program.

This slide shows some examples of the monitoring we performed. Top left photograph shows how we perform seismic gap measurements between structures.

Top right is, we have these plastic Avongard crack gauges installed on specific cracks throughout certain structures, to monitor any additional crack width or worsening of said cracks. We also monitor in-plane expansion, like we mentioned, via both CCI and the pin-to-pin.

And we measure, like I said, between structures, like the bottom right, the annulus between the containment enclosure building and the containment structure. Next slide.

With our ongoing monitoring, we have established that the current ASR expansion levels are within the large-scale testing limits and our structures and the associated building deformation monitoring parameters are within threshold limits established from the structural evaluations.

As we had mentioned before, ASR expansion at Seabrook is slow. We have been monitoring expansion since 2011 and our monitoring frequencies are sufficient to ensure that the limits are not approached prior to the next inspection interval.

MR. SCHULTZ: Jaclyn, how much margin do you have on that statement? In other words, you know it's not going to happen before the next inspection, but if it did happen then, I mean, it would be nice if you had two intervals, comfort level for at least two intervals.

Because a reevaluation, for example, could take six months, it was stated. Action take to correct an issue that was identified and then, inspection, could take even longer. So, how --

MS. HULBERT: Correct. With --

MR. SCHULTZ: -- much margin do you have? Do you feel, with the slowness and --

MS. HULBERT: That's a loaded question.

MR. CARLEY: So, not getting back into what we discussed in the closed session, right now, the in-plane limit is at, the highest location is 2.46. So, significantly lower than the overall limits.

Volumetric is at 0.78, so if you can remember the close limits, but significantly lower. So, even in our worst case situations, we still have quite a bit of margin to all areas.

MEMBER RICCARDELLA: That's for the first bullet, relative to the large-scale testing. It seems to me, the second bullet is the more limiting.

MR. CARLEY: The more -- the threshold limits are our limiting case.

MEMBER RICCARDELLA: Like that 1.2, have you had multiple measurements on the one that has the threshold factor of 1.2, to see how that's progressing?

MR. CARLEY: That is the CEB, and that is the one that we have the most data on. And particularly, on seismic gaps, and we see very little to no --

MEMBER RICCARDELLA: Can you --

MR. CARLEY: -- movement on that.

MEMBER RICCARDELLA: Okay.

MR. CARLEY: Liying can probably elaborate on that, because she takes those measurements for us, if you need more detail.

MS. HULBERT: But like I said, we have this admin limit that we apply to it as well, to give us more time to react.

MEMBER MARCH-LEUBA: But I don't know how to compare that 1.2, which is a 20 percent margin on the load factor, which is a threshold, how to compare to how much cracks you can have. Can you double the number of cracks and it still be okay on that?

Twenty percent doesn't seem like that much margin, but it may be more than sufficient, because it's in the wrong units. And I have no idea how to convert it.

MEMBER RICCARDELLA: It depends on how fast it's changing. I mean, if they've taken measurements in the last three six-month intervals and it's only gone from maybe 1.1 to 1.1, then you're not too concerned about reaching 1.2.

MEMBER MARCH-LEUBA: But what I'm hearing on the top bullet units is that for 30 years, it has grown 2.5 millimeters. And it can -- they can tolerate seven.

MEMBER RICCARDELLA: Yes.

MEMBER MARCH-LEUBA: So, that -- over there, you don't have a problem. What I don't know, how to compare 1.2 to something in those units.

MEMBER RICCARDELLA: Yes. It probably depends on the structure.

CHAIRMAN SKILLMAN: Let's move. Something to think about in your program.

MR. SCHULTZ: Another question was, it sounds as if Seabrook has taken over all of the inspection, Seabrook personnel are doing all the inspections that were done by --

MR. COLLINS: No, SGH has continued to --

MR. SCHULTZ: Their work?

MR. COLLINS: -- perform those inspections. We do have a long-range plan, because SGH is not cheap, sorry you guys. So --

MR. SCHULTZ: No, I understand that.

MR. COLLINS: We do have -- we have just opened up three positions in our design group, civil design group, to hire in individuals to -- and SGH has just said they'll help train these individuals to do the work that SGH is now performing. We intend to have a transition to bring all those activities in-house.

MR. SCHULTZ: Is there a clear qualification program that is required to do this kind of inspection?

MR. COLLINS: We'll set up a qualification program. I know SGH has their own qualification program, that's something we're going to have to go through the transition period with.

MR. SCHULTZ: Okay, thank you.

MR. CARLEY: ACI 349-3 --

MR. SCHULTZ: Okay, good.

MR. CARLEY: -- has the requirements.

MR. SCHULTZ: Thank you.

MEMBER REMPE: Remind me, what is the admin limit, what percent of the --

MS. HULBERT: Ninety-seven percent.

MEMBER REMPE: Ninety-seven, so it's only three percent additional margin?

MS. HULBERT: But this is on top of the conservatism that's already built into the model.

MEMBER REMPE: Thank you.

MEMBER DIMITRIJEVIC: May I ask a question? Why do we worry about those small details if there is no risk implication of that? They just told us it doesn't change any risk, so why we are so concerned of is it 1.2 or 0.9? What is going to change from the risk perspective?

MR. SCHULTZ: Maybe if you go to Slide 18, if you're ready to do that. I mean, there are modifications that are happening to the facility because of this program. And they're determined based upon the analyses and the inspections.

CHAIRMAN SKILLMAN: Vesna, it goes back to the design basis. This is an issue where the licensee must demonstrate that the loads imposed by ASR, combined with other loads, do not exceed the licensed load limits.

And so, while there might not be any significant risk implications, there is most certainly a license implication. And this is very much a license demonstration of loading capacity, so that the facility is within the bounds established by its license.

MEMBER KIRCHNER: But, Dick, it's more than that. I mean, if they exceed the limits from the codes, then you can't make assumptions about success of the particular structure to withstand, let me just pick on one of the inputs, seismic loading, if you don't meet code within the margin that's required.

So, it does turn back to a risk impact, because then, when you do your PRA, you pretty much need to assume that with that load and that degradation, that piece of equipment does not meet its function. It becomes very important with seismic Cat I components and structures.

MEMBER DIMITRIJEVIC: I understand this, but what I'm saying, this is just setting limits, triggering limits. We are not anywhere close not to meet -- okay.

MEMBER REMPE: So, earlier --

MEMBER DIMITRIJEVIC: I'm a probabilistic person, I'm staying out of this discussion.

MEMBER REMPE: Well, earlier today, you asked, have they reevaluated fragility? And in my mind, I was wondering, have you gone through and thought about what seals, other seals due to building deformation, might be impacted?

And has a similar type of analysis been

done on that? I mean, it's not just fragility, it's penetration seals, and has that been carefully thought through all the way?

MR. CARLEY: Yes. And seals are inspected as part of our monitoring program, along with seismic gaps, fire seals, we're looking at those and make sure --

MEMBER REMPE: All of them?

MR. CARLEY: Yes, those are all incorporated into our Structures Monitoring Program, as part of structures monitoring, but also as part of the deformation review, to verify that those seals are staying intact through --

MEMBER REMPE: So, you're monitoring the deformation that could impact all those -- these kind of questions are good. I appreciate it, just because it would be hard to divine that from what we were given to read in advance.

MEMBER DIMITRIJEVIC: Well, I was going to go in more details, like the electrical vaults or the pipe vaults and things. But then, I said, if they're not impacted in seismic area, there is nothing else which will impact it.

Not any other challenge, or maybe they will -- so, this was why I concentrate only on the seismic demand versus the others. So, I mean, there is so many different failure modes can be introduced here, but if they are not going to fail under seismic, then --

MR. CARLEY: Yes, and I think the true answer, as Chairman Skillman indicated, as long as we stay in our limits, our licensing limits, there is no increased risk. I mean, that's what we're looking at.

CHAIRMAN SKILLMAN: Let's move on, we're almost there, let's go.

MR. CARLEY: If it's all right with everyone, we'll skip over the review of the license amendment and the license renewal application and move on to Slide 15.

This is just the summary of our closure of the open item from 2012 in the SER, for Structures Monitoring Program.

We've updated to augment the existing Structures Monitoring Program by the addition of plant-specific Alkali-Silica Reaction and Building Deformation Aging Management Programs.

And we've also added a tie in our IWL Program to our Structures Monitoring Program, to address ASR.

CHAIRMAN SKILLMAN: Okay.

MR. CARLEY: And as our conclusion, NextEra has implemented a program that effectively evaluates and manages the aging effects of ASR on affected concrete structures and associated components.

And on that, I'll turn it back over to Mr. Collins for conclusions.

MR. COLLINS: Thanks, Ed. Next slide, please. So, you'll recognize the flowchart from my opening discussion of the background of ASR at Seabrook Station.

We have presented a detailed discussion on each aspect of the graded approach that has been developed in response to the identification of ASR in our seismic Category I concrete structures.

The flowchart explains the integrated approach that NextEra Seabrook has developed. All ASR-related efforts fit together and all results, conclusions, lessons learned, are all incorporated ultimately into our Structures Monitoring Program. Next slide.

And then, these are the 19 structures that we have completed a seismic Category I structural evaluations. Listed under the actions required on the right-hand column are activities moving forth for retrofit for areas that are outside the limits or bounds of the analysis, and we are taking appropriate actions in those cases.

MEMBER MARCH-LEUBA: Before you move to the next one --

MR. COLLINS: Sure.

MEMBER MARCH-LEUBA: -- I understand you will be coming back next month, I believe, for the full Committee, to get our coveted letter. I would ask you a favor.

If you can present this slide to us again and add an extra column, which is the percent contribution to the load by ASR? Because those 1.2s at the bottom look really bad, but maybe the ASR only contributes five percent to it.

If it's not too much work, which I mean, you have the numbers, I would add how much did -- what was the contribution of ASR to that threshold?

MR. COLLINS: I don't see that as being unreasonable, we'll work on that.

MEMBER MARCH-LEUBA: It would help me a lot, understand how relevant ASR is to this problem.

MR. COLLINS: Understood, thank you.

MEMBER MARCH-LEUBA: And if you could send it -- if you have it done three days in advance, don't send it the night before at midnight, so we can read it.

MR. COLLINS: We'll work through it to make sure you have reasonable time to review the information. But next slide, please. Again, this is a conclusion statement, to rack up, close up the discussion for today.

In conclusion, NextEra has completed a comprehensive effort to conduct large-scale testing to understand the structural implications of ASR, developed methodology for evaluation of ASR-affected structures, evaluated ASR-affected structures to the degree I just showed you in the previous slide, and have developed monitoring strategies for ASR-affected concrete and associated systems, structures, and components.

Completed structural evaluations demonstrate seismic Category I structures comply with the licensing basis, as amended by the LAR. We've shown that ASR progression is slow.

Ample margin exists before large-scale expansion limits would be approached. Monitoring frequency are based on relative margin to the limits and thresholds.

And our efforts provide reasonable assurance that the structures will continue to perform their intended function, consistent with the licensing basis, again, as amended by the LAR, through the period of extended operation.

If there's no more questions, this will end our presentation for today.

CHAIRMAN SKILLMAN: Okay. So, colleagues, any question or questions at this point for NextEra or either of their consultant teams?

MEMBER KIRCHNER: What is, I don't see it here in the rack up, in the summary, how does the containment margin, how would you, not demonstrate, in your -- as a result of your program and your analysis, what would you say about the containment?

You've got threshold factors for all these seismic I categories --

MR. COLLINS: That --

MEMBER KIRCHNER: -- that CV, is that the 1.8, there?

MR. COLLINS: Yes.

MEMBER KIRCHNER: Is that it?

MR. COLLINS: That's correct, sir.

MEMBER KIRCHNER: Okay, thank you.

MEMBER RICCARDELLA: And the CV, I don't see in this table.

MR. COLLINS: Sorry?

MEMBER RICCARDELLA: I'm sorry, I don't see the --

MEMBER KIRCHNER: It's down here, I think, there.

CHAIRMAN SKILLMAN: It's about six from the bottom.

MEMBER RICCARDELLA: Okay. All right, thank you.

CHAIRMAN SKILLMAN: Colleagues, any other questions for --

MEMBER MARCH-LEUBA: Yes, to remind me, the containment is the one that almost didn't have any ASR? So, that's where the percentage I'm asking you will help, because you will see no difference before and after. I hope.

MR. COLLINS: We'll apply that to all the items I have listed here.

CHAIRMAN SKILLMAN: Okay. Going once? Going twice? NextEra and MPR, and the team from Boston, thank you very much.

Not being trite, we've saved the best for last. We've got the NRC staff to come up and they've been patient all day long.

We did take a break an hour ago. I'm going to ask that we move into the next phase of the presentation. And if individuals need to disappear for a few minutes, would you please do that, but let's keep this meeting going, because we really would like to wrap up at a reasonable hour. Please.

MR. DONOGHUE: Yes, Chairman Skillman, I'll tell you that the staff, embracing transformation, has looked through its slides -- come on up, come on up -- and will streamline as they can, but we're ready to answer all the Subcommittee's questions.

CHAIRMAN SKILLMAN: Thank you, Joe. So, Angela, are you the leader today?

MS. BUFORD: Yes.

CHAIRMAN SKILLMAN: Thank you. Let's just hold for a minute here. Ladies and gentlemen, let's get started. Angela, are you ready?

MS. BUFORD: Yes.

CHAIRMAN SKILLMAN: Yes, ma'am.

MS. BUFORD: Okay. There we go.

CHAIRMAN SKILLMAN: Let us begin.

MS. BUFORD: Okay, great. My name is Angela Buford. I am a Structural Engineer in the NRC's Office of Nuclear Reactor Regulation. I'm also the technical lead for the Seabrook license renewal ASR issue.

Seated with me at the table are Bryce Lehman, he is another Structural Engineer in NRR. And also, Nik Floyd, who is a Senior Reactor Inspector in

Region I.

Also at the table is actually George Thomas, who won't have a speaking role today, but he participated in the review of the license amendment request.

Like Joe said, in the interest of time, we're going to trying to streamline what we say and not repeat some of the information that was already given to you.

But as it relates to the staff's impressions and our review, some of the information may overlap, just so that you can get a feel for our reactions and our actions.

As you guys know, this issue has definitely evolved over time. I've actually been involved since day one, so that's eight years.

And a lot of iterations of the LRA were not deemed sufficient by the staff, because we weren't able to come to a reasonable assurance conclusion, because there was testing being done, there was not enough information, and we weren't able to have confidence that ASR would be effectively managed.

After extensive work by the licensee and extensive review from the staff, we are now able to have that reasonable assurance conclusion and can now close that open item. Next slide, please.

This slide just presents an overview of what we'll be discussing today. So, I don't need to read it. But I'll just begin with the overview and then, I'll turn it over to my colleagues.

Oh, you know what?, this is Butch's presentation, if you just scroll through? Okay, there we go. Because this is what we'll be covering. And again, we'll try to pare down as necessary. Next slide.

I will just highlight that, because ASR is a complex phenomenon and it's the first identified in the nuclear industry in the U.S., the NRC assembled a large team of individuals to help coordinate and evaluate the issue, and that's including the organizations that are up on that slide.

It's the Seabrook ASR Issue Technical Team, and we've had extensive coordination in assessing and sharing information along the way. Next slide.

So, a lot of this slide is history, so unless you have any questions on it, I will skip through to the next. We know how ASR was found and that operability determinations were developed. Okay.

So, again, on this slide, NextEra covered most of why ASR occurred. But I will highlight the last bullet, that the Seabrook Health Monitoring

Program for Systems and Structures, which was a precursor to the Structures Monitoring Program, which is required by the Maintenance Rule, did not then have a process for periodic reassessment to assure that all failure modes were identified and monitored.

Since then, NextEra has adopted ACI 341.3R, which includes guidance for monitoring all aging effects for concrete, including active cracking, such as ASR.

CHAIRMAN SKILLMAN: I would like to just make an observation, as I've been preparing for this meeting for about six or eight weeks.

What I finally tumbled to, when I was thinking about 50.65, Maintenance Rules, Structures Monitoring, and all of the experience I have had, I was asking myself, how did this slip through the crack?

And the answer that I'm comfortable with, whether it's a good answer or not, is, this is an active element of a passive component.

And we normally don't think about a passive component having an active mechanism that has the potential to degrade that component to the point where it is no longer within its design basis.

So, at least in my own mind, in an attempt to not point fingers or create fault or to suggest anything untoward, this one slipped by a lot of people in the whole industry.

This isn't just something that happened in a little corner of New Hampshire, this could have slipped by anybody. But it does raise the question, are there any other passive components out in our realm that have an active element that we're not looking at?

And I don't know the answer to that question, but -- well, we know about NVT, we know about all kinds of chemical issues, but here's truly one that's a sleeper. It's really under everyone's radar.

But it just strikes me that a unique feature of this is, here is a passive component that has an active mechanism within it, and none of us saw it coming.

MS. BUFORD: Yes.

MR. DONOGHUE: Chairman Skillman, this isn't really an answer to your question, but I'll just emphasize that the staff plays close attention to operating experience. I know the industry does.

And one of our jobs in the Division of Materials and License Renewal, they were put together for a reason, because a lot of those degradation mechanisms are material based, material engineering based.

So, we are paying attention to operating experience, that's how we think we're going to catch them as early as we can.

CHAIRMAN SKILLMAN: Good, thank you, Joe. Not philosophizing, I just -- I found it important to communicate that, because in a way, it tells me, this is how we got here. This really snuck up on everybody.

MS. BUFORD: Yes, and it actually happened during the review for license renewal, so that was a focused review, specific to that application.

Under the reactor oversight process requirements, NextEra performed an extent of condition review and prompt operability determinations and concluded that, from a regulatory standpoint, the affected structures were operable, but degraded, and nonconforming, because ASR was a degradation mechanism that was not taken into account in the then current licensing basis.

The prompt operability determination analyses assumed that the Seabrook design equations remained valid for concrete affected by ASR and used a reduction in capacity for structural limit states such as shear and compressive strength.

Regional inspectors and Headquarters experts reviewed the operability determinations. The

NRC staff concluded that the analyses used conservative load factors to ensure that there was sufficient engineering margin.

Secondly, inspectors and experts from Headquarters performed field walkdowns and confirmed that there were no significant indications of deformation, distortion, or rebar corrosion.

Third, that the ASR was localized and was occurring slowly, based on existing operating experience. And then, finally, the degradation was being monitored.

And those operability determinations are still in place and are being resolved under the license amendment request.

In response, NextEra made commitments to address the issue of ASR-affected concrete and to confirm those commitments, the staff issued a confirmatory action letter, or CAL.

The CAL referenced NextEra's planned large-scale testing program and you heard about that a lot today.

At the time that the applicant was proposing the testing program, they wanted to define crack limits for ASR and to examine ASR behavior in a structural context, as opposed to an unreinforced core bore samples.

Under the license renewal process, in June of 2012, the NRC staff issued its safety evaluation report with open items. The document discussed the Seabrook operating experience related to the impact of ASR and included one open item related to the need for ASR to demonstrate that the aging of structures would be adequately managed during the period of operation, extended operation, despite ASR.

The Region, during its inspection procedure, 71002 Inspection, came to the same conclusion. And such that the NRC staff did not find that the structures could be effectively managed for the aging effect, given the proposed monitoring.

Shortly after the SER with open items was issued, NextEra supplemented it's license renewal application to include a plant-specific ASR monitoring program.

This was also the time frame that the SAITT, the technical team, was formed to allow for effective alignment of Agency positions. Next slide.

As discussed previously, NextEra's prompt operability determination evaluations used a conservative loss of structural capacity.

The NRC, with input from an independent

expert on structural engineering, independently verified that there was reasonable assurance that the ASR-affected structures at Seabrook maintained adequate margin to continue to perform their intended functions.

However, since the prompt operability determination evaluations were based on conservative estimates and literature data, the staff understood that NextEra would be initiating a large-scale testing program to determine the actual impact of ASR on the performance of the structures.

The NRC, as part of its CAL review, reviewed those plans, and also under the license renewal review.

There was a significant amount of back and forth, with the NRC staff asking questions and holding public meetings to understand how the testing program was going to be credited to analyze the structures. Next slide.

So, there was a difference in opinion. NextEra viewed the large-scale testing program as more of a research and development effort, to gain information that would help to inform monitoring programs.

The NRC position, however, was that if the testing would be used to support the position that ASR did not have a structural impact, then this would be a new method of evaluation for the current license that would need to be approved by the NRC.

Similarly, the staff position with respect to license renewal has always been that if the testing program would be the basis for elements of Aging Management, then that would require a detailed review by the NRC.

So, in response, NextEra submitted their license amendment request that included the large-scale testing program and would amend the Seabrook licensing basis to include the findings of that large-scale testing program. Next slide.

So, you already know that during routine walkdowns in 2014 and 2015, it was NRC Resident Inspectors that observed degraded seismic and fire seals that appeared to have been caused by differential movement between adjoining concrete buildings.

It was determined that ASR caused this additional aging effect through cumulative micro-cracking in ASR-affected structures. In addition, there was discrete large cracks and the effects were not anticipated. They were identified by the NRC as a different consequence of ASR.

In addition, the large-scale testing

program did not address specifically how building deformation would affect the ability for structures to perform their intended functions.

Therefore, NextEra subsequently developed an additional plant-specific Aging Management Program called the Building Deformation Monitoring Program, to manage this effect.

I'll just add that, based on your earlier comments, Mr. Chairman and Dr. Corradini --

MEMBER REMPE: I'm short, but I'm right here.

MS. BUFORD: Oh, I'm sorry, Rempe, Joy, excuse me. Okay, yes, right. Yes, I couldn't see you. Sorry about that.

MEMBER REMPE: Otherwise, we look a lot alike.

(Laughter.)

MS. BUFORD: Sorry about that, Ms. Rempe. So, I just wanted to add that, based on your earlier comments about the length of time that it's taken from the initial review to get to this point, part of the reason that the staff was not able to reach a reasonable assurance conclusion was our concern that NextEra did not appear to be addressing the potential for ASR to manifest in other ways.

So, we didn't have confidence, throughout this process, that monitoring plans that were in place would manage the aging effect in a more holistic manner.

MEMBER REMPE: So, that clarifies a question I was going to ask about, this was not anticipated. It sounds like the staff did do some homework and recognized that this could be another effect, because it's in the literature.

MS. BUFORD: I think that it definitely came to -- it was a surprise, I think, even to the staff, although in the literature, it does say that ASR can manifest itself in other ways.

It's just that that particular way of the building deformation hadn't been identified by the licensee. And it was of concern to the NRC that it was the NRC that identified the issue.

CHAIRMAN SKILLMAN: Let me ask this, as I listen to your words and think about what we've learned today, it's logical from my perspective, as a long-term plant person, I'd be looking at buildings, I'd be looking at what the Maintenance Rule would tell me to look at, but the last thing I would be thinking about is that the engineering fill or the concrete that was outside the building was actually imposing a load, causing the building to deform.

That would never have crossed my mind. Is that -- when you say, NextEra really didn't latch on to the fact that the buildings were being deformed, as an individual in PE, I'd say, well, I probably would have missed that too.

I never would have thought that there would be outside forces that were strong enough to shift my building. Is that kind of what's hiding in here?

MS. BUFORD: Well, yes, but I think that our reaction really was that, because if you -- we walked down the plant numerous times. And if you go to the areas, it's clear that something's wrong, right? You've got expanded --

CHAIRMAN SKILLMAN: Something's off?

MS. BUFORD: Right. So, I guess, our concern really was that people -- this has been potentially going on for years and no one noticed it.

So, even if you couldn't predict the backfill to be expanding the structures, it was a little bit just -- it was surprising to us that, walking the plant, no one said, why is that seismic gap smushed?

Or isn't that supposed to be three inches, and that looks like it's actually just hitting the other building? So, those kind of symptoms, we were -- it was surprising that those symptoms weren't identified sooner, really, I think.

CHAIRMAN SKILLMAN: I see. Okay, thank you.

MS. BUFORD: Okay. This is really already -- you can turn to the next slide, please. This information has already been covered, just that in August of 2016, the license amendment request was submitted to resolve the licensing basis.

And also, to provide technical inputs to the license renewal review. The review of the methodology and the large-scale testing was needed in order to come to a reasonable assurance conclusion for license renewal.

And so, the staff's review under the license amendment request provided that technical review.

And now, I will turn the presentation over to Nik Floyd, who will discuss the Regional inspection and oversight.

MR. FLOYD: Thank you, Angie. Good afternoon, everyone. My name is Nik Floyd and I now will discuss the Regional inspection and oversight of ASR at Seabrook, which I have been personally involved with since 2013. Next slide.

The roles of the Regional inspections were initially focused on NextEra's structural assessments of the reinforced concrete buildings affected by ASR.

As you heard in some of the previous slides, NRC performed independent reviews to verify that the affected structures were capable of performing the required safety functions and were properly characterized as operable, but degraded and nonconforming.

We have continued to perform semiannual inspections to review the Structures Monitoring Program implementation and results and to verify the significant changes, if any, are evaluated for impact on the concrete structures.

One of those sensitivities was the fact that this was initially mis-unidentified and then, the identification of building deformation led us to another increased sensitivity, that we need to continue to look at this with a keen eye.

The Resident Inspectors also provide insights on new material conditions in the plant, which I'll describe later.

In addition to the onsite monitoring, the NRC performed inspections of NextEra's large-scale testing program, to ensure that the results were being appropriately reflected in the operability assessments and evaluations of ASR-affected structures.

The Regional Office has lead the Seabrook ASR Issues Technical Team, as the team's chair. Part of that role has been to ensure a coordinated effort between the Regional inspectors and Headquarters technical staff, when conducting inspections, as well as assisting in some of the technical licensing review audits.

We provide insights and observations from each inspection to the NRC inspectors and experts on that team.

The Resident Inspectors, who are also at the plant each workday, also participate in these meetings.

It was really this collegial knowledge sharing that's led to a comprehensive oversight and has aided the staff during the licensing activities related to ASR.

And a lot of that has also included requests for additional information as new issues arise. Next slide.

There have been thousands of direct inspection hours by Regional inspectors and Headquarters structural experts related to ASR at Seabrook since 2010.

In total, the combined number of inspections at Seabrook and the Ferguson Structural Engineering Laboratory, which is the location of the large-scale testing program, is 32 weeks.

Just to note, these figures do not include the separate audits conducted by Headquarters as part of the licensing review activities.

The scope of the Regional inspections consisted of reviewing the operability determinations, the confirmatory action letter team inspections, Resident Inspector samples specifically looking at ASR, as well as the semiannual onsite inspections focused on the ongoing monitoring and corrective actions for ASR. Next slide.

Since 2010, the Regional inspections have focused on NextEra's performance to fully identify the effects of ASR on Seabrook structures, to evaluate the condition with sufficient technical detail, and to resolve the nonconforming condition.

We have closely monitored NextEra's response to ASR, from the initial identification during the petrography of concrete samples to the implementation of ongoing corrective actions, which would include enhancements to the onsite monitoring programs.

I'll now discuss a few of those key observations from this experience.

During the NRC's initial oversight of ASR at Seabrook, the inspectors identified concerns regarding the long-term operability of the structures affected by ASR.

This was understandable, because the various characteristics of concrete affected by ASR and the related effects on other elements of the structure, such as rebar, due to groundwater in-leakage, and also the progression rate of ASR at the site, were not well understood.

Several early inspection findings related to inadequate operability determinations, to fully evaluate the ASR impact with available information.

It was really this long-term impact concern that led to a public meeting with NextEra staff and to the NRC subsequently issuing a confirmatory action letter, with one of NextEra's commitments being a time line of resolution of actions and plans to conduct a large-scale testing program.

Just a quick note, I'll provide --

MR. SCHULTZ: Excuse me, just to clarify, this leads back then to the statement on the previous slide that all of the ten noted shortcomings were all low significance or very low significance, is what you represented there.

And so, that was the earlier finding and then, as time went on, it was determined that this really is a long-term programmatic problem that needs to be seriously considered.

MR. FLOYD: Yes, that would be correct. So, some of our early inspection findings, back in the 2011 time frame, were really the initial identification of ASR and what that impact was to the sites.

Another one would be with the condition monitoring program for the Maintenance Rule. They weren't really evaluating and putting that back into the program for evaluation.

I think part of that was growing pains, trying to understand what the issue was, and that led to additional NRC questions and, inevitably, a public meeting and issuance of the CAL, to fully understand the impacts.

Some of those impacts were completing operability determinations on all the affected structures.

MR. SCHULTZ: Yes, that's to be appreciated. I thank you.

MR. FLOYD: Yes. Just a quick note on the large-scale testing program implementation, Bryce will provide more details on that later and I'll have key observations during that portion.

In 2014, NRC Resident Inspectors identified several instances of large discrete cracks in the Seabrook residual heat removal vaults.

The NRC issued a finding of very low safety significance and inspection report dated August 5, 2014, because NextEra did not perform an adequate technical evaluation when it was determined that the crack sizes exceeded the quantitative limits specified in plant procedures, per the Structures Monitoring Program.

This is actually one indication of Structures Monitoring Program implementation issues and going back from 2011 to 2014, there was a grouping then, and then, in 2014, a separate grouping, all along the implementation of the program.

So, that's what this observation really captures. Also --

MEMBER MARCH-LEUBA: Nik?

MR. FLOYD: -- this was one early indication of -- oh, sorry.

MEMBER MARCH-LEUBA: Those large cracks on the residual heat removal system, were they ASR-induced or were they other type of stress?

MR. FLOYD: Well, that's actually what kind of led to some of the delayed identification. This cracking went along the interior of the vaults and it was in areas that ASR had not been confirmed.

And it didn't make sense why that crack was there. Maybe the thoughts were, was it a cold joint? Was it settlement? And it was the lack of evaluation by NextEra staff that led to it not being evaluated and later being confirmed to be the --

MEMBER MARCH-LEUBA: And what was the evaluation at the end? Was it ASR or not?

MR. FLOYD: It was ASR.

MEMBER MARCH-LEUBA: It was ASR?

MR. FLOYD: Yes.

MEMBER MARCH-LEUBA: So, that's the limiting, not the famous tunnel, but this one?

MR. FLOYD: Yes, this is a separate structure that just kind of slipped under the radar.

MEMBER MARCH-LEUBA: Well, if you look at the list that we saw at the end of the presentation, is the limiting one, is the one that has a threshold of 1.2.

MR. FLOYD: The RHR bolts?

MEMBER MARCH-LEUBA: Yes. That's the

limiting place.

MR. FLOYD: Next slide, please. Later in 2015, during a routine plant tour, NRC Resident Inspectors observed degraded fire seals and changes in seismic gaps that appeared to be caused by differential building movement between the adjoining concrete structures.

An example of a degraded seismic gap is shown in the picture. The concrete structures are separated by a seismic gap, that's what's shown by the two black vertical lines there. And the change in the gap at the seal can be seen by the associated cracking and separation between the seal and the structure on the right.

We have seen instances of both increases and decreases in gaps, due to the differences in building deformation.

As Angie described earlier, NextEra staff initiated a root cause analysis in response to this observation. This confirmed bulk ASR expansion, resulting in building deformation.

This building deformation impacted some systems and components attached to the adjoining structures, as evidenced by deformed flexible conduit couplings, reduced seismic isolation gaps, and concrete spalling. Next slide.

An example of equipment impacted by deformation is shown in these two pictures. On the left, you can see deformed flexible conduit couplings. On the right, you can see deformed instrument air piping.

Building deformation and its impact on equipment was considered a new phenomenon related to the effects of ASR. NextEra subsequently developed an additional plant-specific Aging Management Program to manage this effect, which you heard earlier.

The NRC staff continued to perform inspections and audits at the plant and issued requests for additional information as needed, to determine whether building deformation would be adequately managed during the period of extended operation.

Our inspections have verified that the equipment impacted by building deformation has been documented and evaluated by NextEra.

We've also reviewed the criteria established for acceptability, as detailed in the Building Deformation Monitoring Program, to ensure that the equipment remains functional. Next slide.

Overall, Regional inspections have determined that the Seabrook structures remain capable of performing their safety function. The NRC has observed significant enhancements to the Structures Monitoring Program since the original identification of ASR at Seabrook.

Independent walkdowns by the NRC inspectors have not identified any new undocumented structural deficiencies over the past two years.

Based on inspections conducted to-date, NRC inspectors conclude that the licensee is adequately implementing the Structures Monitoring Program and it is appropriately identifying, evaluating, and correcting issues.

I will now turn the presentation over to Bryce Lehman to discuss the staff's review of the large-scale testing program, absent any additional questions.

MR. LEHMAN: All right, thanks, Nik. I'm going to cover the staff's review of the large-scale testing program and conclusions from the testing program.

Obviously, a lot of this, we covered this morning, so if I think we've already addressed it, I'm going to jump over it. If I'm going too fast, just let me know, stop me and ask questions. All right. Next slide, please.

And in fact, this one, I think we can skip completely, because it kind of just is an overview of the program and how it was developed, and I think we went over that in detail this morning. So, I'll skip right to the staff's review. All right.

The staff reviewed the large-scale testing program, with a focus on the representativeness of the program and the applicability of the program's conclusions to Seabrook structures.

The size of the specimens, the configuration of the reinforcement in the materials used in the specimens, were all much more similar to Seabrook structures than existing literature data.

The reinforcement in the specimens is similar to Seabrook structures and provides a realistic structural context which accounts for the confinement provided by the reinforcement and the interaction between concrete and reinforcement.

The concrete mix design was based on the original Seabrook design specifications. And when practical, materials were obtained from similar sources as the original construction.

Furthermore, the test methods used during the testing program were the same as those methods used to establish the empirical design equations in the

Seabrook codes of record.

Based on these features of the large-scale testing program, especially the structural context that is provided by using large-scale specimens with realistic reinforcement, the staff found that the large-scale testing program is representative of Seabrook structures. Next slide, please.

In order to use the through-wall expansion to monitor ASR at Seabrook, it was necessary for NextEra to determine the through-wall expansion of Seabrook structures that had already occurred prior to instrument installation.

NextEra reviewed the large-scale testing program data and literature data for multiple properties and determined that reduction in modulus of elasticity was the best material parameter to determine ASR expansion to-date.

Using data from the testing program, NextEra developed a correlation between normalized modulus and through-thickness expansion. The staff reviewed the data and noted that the correlation aligns well with the testing data and the available literature data.

In addition, the staff noted that a reduction factor was included in the correlation to account for uncertainty and to provide a conservative expansion value.

The staff found this approach to estimating through-wall expansion reasonable. However, since this approach has not be corroborated on Seabrook structures, the staff determined that a license condition was necessary to require future confirmatory actions related to the correlation.

MR. SCHULTZ: Bryce, this looks -- these future confirmatory actions, they seem like substantial, substantial evaluations that are going to occur for 2025 and then, ten years subsequent. Is that -- am I getting the right impression?

MR. LEHMAN: Yes, I believe that's correct. I mean --

MR. SCHULTZ: In other words --

MR. LEHMAN: -- NextEra kind of went over it this morning, but it's to --

MR. SCHULTZ: Yes.

MR. LEHMAN: -- verify that the behavior is similar to the University of Texas.

MR. SCHULTZ: And that could, in fact, require an additional research program, as well as site characterization and evaluations?

MR. LEHMAN: Well, I think --

MR. SCHULTZ: What -- I'm trying to get a picture of what you are expecting out of that license condition.

MR. LEHMAN: Sure. There's, I mean, there's a lot done in the condition, but it's confirmatory in nature.

So, the expectation, based on the representativeness of the testing, is that it will match the behavior. But this is just to confirm, when they have more data from the onsite structures, the behavior is the same and that the correlation is matching with what's happening at Seabrook.

So, the expectation is that it will, but this is corroboration with onsite --

MR. SCHULTZ: Okay. Is the condition -- all I see in the condition is a statement that this is going to be done.

But is there enough documentation about the expectation so that six years from now, the NRC and NextEra can determine what needs to be done? They may not be the same people as are here in this room today.

MR. LEHMAN: Yes, that's a great point. And the -- you're right, the license condition is fairly high level and just says, this will be done.

But it has reference to documents that they've submitted on the docket that were reviewed, which had very specific explanations of how it will be done. So --

MR. SCHULTZ: Okay.

MR. LEHMAN: -- yes, that detail is there.

MEMBER BALLINGER: And it's my understanding that there's AMPs that are in place for this, that are independent of any of this, that will ensure that they'll -- if they adhere to the AMPs, they'll keep track of it.

MR. LEHMAN: Yes. Angie will talk about the management programs a little bit later. But, I mean, this program is in place now and it will go into license renewal as the Aging Management Program and we'll be tracking all of this stuff.

This was just to capture that confirmation piece, to make sure that the behavior aspect is the same from the test program to Seabrook. But, yes --

CHAIRMAN SKILLMAN: That was --

MR. LEHMAN: -- the AMPs are in place as well.

CHAIRMAN SKILLMAN: That was the concluding slide from the last presentation. So, I feel comfortable that --

MR. SCHULTZ: Thank you.

CHAIRMAN SKILLMAN: -- the actions going forward are clearly codified for whatever that next generation may be, that will have the accountability to execute this.

MR. SCHULTZ: Sounds good, thank you.

MS. BUFORD: And I was just going to add that the expectation from carrying out the license condition is that the NRC, in its continued oversight of Seabrook, if the results are different than expected, then there would be -- we would expect NRC engagement and Regional oversight activities, how they saw fit, to address a deviation from what they thought to that corroboration piece. So, that's where we would address it.

MR. LEHMAN: All right, if we can go to the next slide, that talks about the license condition as well, too.

So, the NRC staff is requiring a license condition to confirm that future expansion behavior of ASR-affected Seabrook structures aligns with the large-scale testing program specimens.

The first portion of the license condition requires an assessment of overall Seabrook expansion behavior, to ensure that it is similar to the behavior seen during the testing program, while the second portion of the license condition requires the use of potential future Seabrook expansion data to confirm that the modulus expansion correlation can accurately predict expansion. Next slide, please, George.

In addition to the NRR staff review, the Division of Engineering and the NRC Office of Nuclear Regulatory Research provided an independent peer review of the test program development and conclusions and the results of their independent review supported the conclusions reached by the NRR reviewers.

So, staff conclusion on the review of the LSTP. Based on its review of the testing program and the representativeness of the program, the staff finds that it is reasonable to apply the results of the testing program to Seabrook structures and to use the original design equations, as long as Seabrook expansion behavior remains similar to the specimens and expansion remains below the tested limits.

Unless there is further questions, I'll now turn the presentation back to Nik to discuss the Regional oversight of the large-scale testing program.

MR. FLOYD: Thanks, Bryce. The NRC completed a total of six weeks of inspection at the Ferguson Structural Engineering Laboratory at the

University of Texas. This also included one week of a joint inspection audit with the licensing reviewers.

As Bryce stated before, the testing was initiated to help resolve the open operability determinations related to ASR at Seabrook.

As part of the CAL inspections, that's confirmatory action letter inspections, in 2012 and 2013, the NRC verified that the overall testing program approach was sufficient developed and described to support an understanding of the testing plans and objectives.

Our inspections and observations of the testing program allowed for insights into the Seabrook Structures Monitoring Program, the operability determinations, and enhancements to existing Aging Management Programs.

The inspectors communicated these results during periodic Seabrook ASR Issue Technical Team meetings and it was this feedback from the inspectors to Headquarters staff, that assisted in their technical review efforts. Next slide, please.

One of the significant observations identified during the testing program, and also seen during our inspections, was the extent of through-wall expansion examples versus the in-plane expansion.

As a result, NextEra updated its testing program to evaluate the best instrument for measuring through-wall expansion, as you heard earlier.

The inspectors discussed this testing plan and reviewed the results of the instrument selection study with NextEra staff to verify the reliability of the instrument.

NextEra then enhanced their Structures Monitoring Program to include monitoring of through-wall expansion.

The inspectors observed the installation of the instruments in the Seabrook walls and during ongoing periodic onsite inspections, we reviewed this inspection data, we also looked for trends and we verified the expansion is within the bounds of the testing program. Next slide.

Overall, the inspectors observed proper procedural adherence, good test coordination, and proper communications and safety practices exhibited by the testing staff, the supervisory personnel, and the quality assurance overseers.

The inspectors verified proper testing preparations and quality control oversight during each visit to the Structural Lab. And this was really to ensure that such testing met appropriate quality assurance standards.

I will now turn the presentation back to Bryce to discuss the staff's review of the proposed Methodology Document.

MR. LEHMAN: All right, thanks, Nik. I'm going to discuss the methodology now. A lot of the details on methodology, obviously, have already been covered, so I'm going to try to focus on the staff's review and the associated findings. Next slide. Go back just one.

Just a high level of what was in there, as discussed previously, they submitted an LAR to account for the ASR. And the license amendment request proposed a unique three-stage analysis methodology to address the ASR load and associated building deformations.

The proposed methodology includes five supplements to the Seabrook design code of record and a detailed description of how to implement the methodology is captured in the Methodology Document.

Which I think gets to some of the stuff we were just discussing, the detail of how to do it as they move forward.

MEMBER MARCH-LEUBA: Sorry to ask, procedurally, is this an attachment to the LAR? This

Methodology Document?

I'm thinking, are you issuing and SER to approve it? Or are you, by approving the LAR, you are implicitly improving the methodology? How are we handling the approval?

MR. LEHMAN: Well, it was submitted as support of the LAR and it's referenced in, and we'll get to it a little bit later, but it's referenced in the updated FSAR, with the revision number on there.

MEMBER MARCH-LEUBA: Well, if you guys are happy, I'm happy. It's not an issue.

MR. LEHMAN: Okay. So, the staff review of the methodology was supported by Brookhaven National Laboratory and included two site audits to review the implementation of the methodology, as well as multiple rounds of request for additional information.

The review of the methodology focused on the five areas shown on the slide, and I'll discuss each of these in turn. All right. Next slide, please.

The first step in the evaluation methodology is determining the ASR load. Depending on the stage of the analysis, the ASR load is either estimated using concrete strain based on in-plane expansion or a finite element model is developed for the structure.

In situ loads are applied to the model and the ASR loads and concrete backfill loads due to ASR are adjusted until the model deformations match those measured in the field.

The staff reviewed the process for developing the ASR load and finds it reasonable. The Methodology Document clearly defines how the ASR load and concrete backfill load can be adjusted within the model and provides guidance on how it is determined that the model aligns with the field measurements.

In addition, the staff audited multiple calculations in each analysis stage and verified that the licensee was estimating the load consistently and in accordance with the guidance in the Methodology Document.

MEMBER KIRCHNER: Let me ask here, did you ask the applicant team about qualification of the finite element code for this application?

Did you look at that at all in -- I know it's a widely available code, but for this application, did you look at how they actually modeled the structures, the aggregate and the reinforcement, et cetera, in the concrete, in the finite element code in their methodology?

MR. LEHMAN: Yes, we did look at that.

George, can you expand on that at all?

MR. THOMAS: Yes. During the audit, the staff did look at sample calculations to verify implementation of the methodology, including the application of the computer code.

MEMBER KIRCHNER: Well, I don't doubt that the applicant knows how to use a finite element code, my question is perhaps a little more nuanced.

Is the actual modeling of the structure and the impact of ASR within the finite element code? I mean, is the nodalization sufficient to capture that?

I'm not -- I don't find application of a code like that to a large structure showing reasonable agreement as a means for qualifying the code for the task at hand.

Usually you would take elements of the large-scale test program, where they actually bent -- they put loads on beams and check and make sure that the finite element code could reproduce the results of those test. Was anything like that done or checked?

MR. THOMAS: The way the load was applied was the in-plane strain was applied as a thermal strain within the ANSYS computer model.

MEMBER KIRCHNER: Well, it seems to me it's a rather straightforward application of the -- it's

ANSYS, isn't it? -- of the code here to model some of the tests that were conducted in Texas to just make sure that the code can reproduce the measured deformation and stresses that they saw on the test, with these large elements. It's good benchmark material.

I'm hearing that wasn't done, is what I'm -- I would think someone in Research would suggest that.

We typically do that with other codes, when we apply them to systems analysis, do separate effects tests, at least, to make sure that we understand how nodalization and correlation assumptions impact the results.

MR. THOMAS: Yes. Let --

MEMBER KIRCHNER: I guess that's not a question now, it's a comment.

MR. THOMAS: Yes. Well, the way the code was used here was in a simple linear elastic analysis, which is a standard analysis. They didn't go further into the nonlinear aspects.

MEMBER KIRCHNER: I didn't ask whether you went beyond cracking, but up until that threshold, it would be a useful way to benchmark the application of the code to these structures.

MR. LEHMAN: Yes, I think we have a member from Research who --

MR. PIRES: Yes, good afternoon. My name is Jose Pires, I'm from the Office of Research. My understanding is that these analyses are not limit state analyses.

These are linear analyses, design-basis calculations. So, this code has been qualified for this purpose. It is used frequently to analyze reinforced concrete structures for design calculations.

The tests, the testing program went way past the design limits. They are ultimate capacity tests to see if the stress equations in the ACI are applicable. So, they went way past the regime in which the code was used for. The code --

MEMBER KIRCHNER: I understand that.

MR. PIRES: -- the calculations of the code didn't go to that level of deformation and response, are way below that. So, that's -- and the code has been qualified for that purpose, because it's used extensively for design analysis for applications.

MEMBER KIRCHNER: I understand all that. What I'm asking you is, you're studying the effect of ASR on the performance of these structures.

And it would seem to me, are you saying

that there was no -- I'm interested in how you put in the material properties to the code and how you nodalized that model to take into account the variation in ASR, because you had samples of various levels of ASR degradation.

MEMBER BALLINGER: In particular, the modulus? That's really what would be affected.

MR. PIRES: Right.

MEMBER RICCARDELLA: Well, I mean, there were some modeling assumptions that were made. You used shell elements for the shell, you used membrane elements for the rebar.

These are modeling assumptions that could have been -- that could be tested in the -- against, say, one of the beam test programs, to show that you're calculating the proper stresses in the rebar, up to cracking, or things of that sort. I think that's what Walt is getting to.

DR. BAYRAK: Certainly, this is -- once again, this is Ozzie Bayrak. Such validations are always useful, but just to go back to the point that the analyses conducted are linear elastic, using ANSYS.

And if you recall one of the slides I showed, on our rebar anchorage test programs, where we're looking into actually a family of curves, we looked into the first part, control specimen versus ASR-affected, where the stiffness does not change appreciably.

So, that is the range in which you would be doing this validation. And ANSYS, I've used it a number of times, not in the recent past, but in terms of analyzing a typical reinforced concrete beam behavior, it does that just fine.

I would be surprised if such an analysis showed that, particularly within that range, the behavior cannot be captured.

Now, later on in the game, when you have flexural cracking, yielding, and so on and so forth, such nonlinear actions, can you pick that up with ANSYS? My answer to that would be, I have no idea. But for the linear elastic portion, I'm fairly confident.

MEMBER KIRCHNER: Okay.

DR. BAYRAK: I think that's --

MEMBER KIRCHNER: All right, thank you.

DR. BAYRAK: -- what you were trying to indicate.

MR. PIRES: The intent of the testing program, the methodology and so forth, was that you could do that. That you could map the problem into the design analysis situation. So, that was the purpose.

CHAIRMAN SKILLMAN: Let's keep on going.

MR. LEHMAN: All right. I think we're on the next slide, George. And that's all, so I think we understood the comment. Are there any other questions on that? All right, moving on.

MEMBER RICCARDELLA: Did the staff do any independent calculations?

MR. LEHMAN: No, we did not. But I think we understood the comment and we'll look at it more.

The next topic is the development of ASR load factors. So, next slide, please. There, perfect.

To incorporate the ASR load into the existing load combinations, it was necessary to develop load factors for the ASR load. The factors for ASR were developed based on the reliability index approach used to develop probabilistic-based load factors in ACI 318 and ASE 7.

The staff finds this approach reasonable, because it follows the same method used in industry consensus standards and the developed factors maintain the original reliability of the design-basis load combination.

The resulting ASR load factors will be

incorporated into the updated Final Safety Analysis Report. Next slide, please.

The original license amendment request included multiple analysis methods that appeared to be departures from the codes of record. In response to staff requests for additional information and discussions during site audits, NextEra identified five supplements to the existing codes of record.

Supplement 1 was identified as the incorporation of ASR loads into the existing FSAR design-basis load combinations. The staff finds this supplement acceptable, because it officially incorporates ASR loads into the design basis.

Supplement 2 was identified as the use of the original design code equations to determine the strength of ASR-affected concrete sections. As discussed previously, the staff finds this supplement acceptable, based on the results of the large-scale testing program. Next slide, please.

Supplement 3 was identified as using the procedures defined in ACI 318-83, Section 11.7, to calculate shear friction capacity for members subjected to net compression.

The staff finds this supplement acceptable, because the guidance is identical to

Section 11.7 of ACI 349-97, which is endorsed by the staff in Reg Guide 1.142. Next slide, please.

The staff reviewed Supplements 4and 5 together, because both supplements relate to crack section properties. Supplement 4 deals with flexural crack section properties, while Supplement 5 addresses axial and shear stiffness of structural components.

The staff noted that the approach was reasonable for normal concrete, but did not appear to account for the test results, which indicated a relative increase in stiffness with ASR due to the ASR pre-stressing effect.

The staff discussed this issue with NextEra during an audit and issued an RAI. In response to the RAI, NextEra revised the referenced equations and the guidance in the Methodology Document to account for the observed increases in stiffness.

The Methodology Document clarifies the tensile and shear crack initiations are based on net concrete strength after the ASR pre-stressing effects are overcome.

The staff finds this approach acceptable, because it is consistent with industry standards for developing crack section properties and the revised guidance in the Methodology Document ensures the ASR pre-stressing effects are taken into account in the analysis.

The next main topic of review is the threshold factor and threshold limits. These are structure-specific outputs of the methodology that quantify the remaining margin in each structure.

The staff finds the use of the threshold factors and threshold limits acceptable, because the calculations used to develop the values follow the design code of record with acceptable supplements as just discussed.

The threshold factor allows for future ASR expansion and quantifies the remaining margin in each structure.

If an acceptable factor cannot be developed or if a threshold limit is reached, a more detailed analysis stage may be entered or a structural modification may be developed to reestablish the margin. Next slide, please.

The last major topic reviewed by the staff as part of the methodology relates to reinforcement stresses and strains.

The Seabrook design code of record requires that stress and strains in structures remain within elastic limits under normal operation or service load conditions.

However, unlike other service loads, ASR expansion is a self-straining load whose progression has a potential for straining reinforcement beyond yield under service conditions.

To address this, NextEra identified additional actions that will be taken if the in-plane ASR strain exceeds two millimeters per meter over a large region, which is the approximate level at which rebar could yield, based on minimum specified yield strength.

If this limit is exceeded, the Methodology Document recommends further evaluation of the area, which could result in a retrofit or repair to mitigate possible reinforcement yield or slippage, or could result in further analysis to qualify the structure.

MEMBER MARCH-LEUBA: I know it's late, but remind me again -- maybe I should ask the boss. On the CRs, we put limitations and conditions.

On LAR approvals, we don't add limitations, right? So, we either approve what the licensee proposes as these limits or we reject it, is that the case?

MR. DONOGHUE: In this case, we're approving with license conditions. So, they have to satisfy those license conditions as part of their license now.

MEMBER MARCH-LEUBA: So, we can add --

MR. DONOGHUE: Once it's approved.

MEMBER MARCH-LEUBA: -- a license condition on the LAR? You can add a condition to the LAR?

MR. DONOGHUE: Yes. Now --

MEMBER MARCH-LEUBA: Okay.

MR. DONOGHUE: -- there's some particulars about that and we had to work with the licensee to make sure that it's something that's confirmatory.

It's not going to be new analyses or information that are given to us to review, it's something that can be confirmed by inspection, basically.

MEMBER MARCH-LEUBA: So, there is a process to get that? I was thinking --

MR. DONOGHUE: Yes.

MEMBER MARCH-LEUBA: -- because we run into that problem with the design certifications.

MR. DONOGHUE: Right. So, this gets --

MEMBER MARCH-LEUBA: And I'm --

MR. DONOGHUE: I'm sorry. This gets back to an earlier question about, if it's not spelled out in the condition, where is it?

And that's where we're depending on their aging programs and the documentation they have to follow and our oversight, I think Angie mentioned this, our oversight is going to confirm that they live up to their programs. And we do this in all areas throughout the plant, besides just monitoring ASR.

MEMBER MARCH-LEUBA: In opening my mouth, I think I answered my question myself --

MR. DONOGHUE: Okay.

MEMBER MARCH-LEUBA: -- you need an SER if you're modifying Tech Specs.

MR. DONOGHUE: Right.

MEMBER MARCH-LEUBA: But because this doesn't modify Tech Specs, what they have done is a regulatory commitment.

MR. DONOGHUE: Well, no, it's a license condition and they are modifying their license, because now, this program is going to be part of their -- it's going to be put in their UFSAR. And they --

MEMBER MARCH-LEUBA: And there is --

MR. DONOGHUE: -- we needed that -- so, the reason these are coupled to the license renewal is they needed to get this into their current licensing basis to get the license renewal submitted.

MEMBER MARCH-LEUBA: And there is no doubt in my mind that they will follow the proper methodology.

MR. OESTERLE: Yes, so, just let me add something. The -- earlier in the discussion today -- oh, sorry, Eric Oesterle, DMLR.

Earlier in the discussion today, there was mention that the staff had a difference of opinion with NextEra in that, because this was a new method of evaluation, it needed to be incorporated into the UFSAR and the process to do that is via a license amendment.

So, if you look at the criteria in 50.59, there's a question in there about a new method of evaluation. And so, that tripped a criteria, which requires a license amendment to include it in the FSAR.

MR. LEHMAN: But just to clarify, this limit is not part of the license condition. This is not captured in the license condition, this is captured clearly in the Methodology Document, which is referenced in their FSAR update. So, we would still have oversight of it, but it's not part of the license condition.

So, the staff finds this approach acceptable, because a reasonable limit for in-plane ASR strain has been identified and if the limit is exceeded, further evaluation will be performed, including the evaluation of potential rebar slip or yield under service conditions. Next slide, please.

This is sort of the overall summary. The staff reviewed the methodology and based on its review, the staff finds that NextEra's evaluation method is a reasonable approach for analyzing structures with ASR, because the approach is consistent with Seabrook's code of record design philosophy.

NextEra provided acceptable justification for the continued applicability of the code, along with the five proposed supplements to the code.

NextEra's approach for estimating the load due to ASR is reasonable and based on field data, and the load is incorporated into the existing load combinations with reasonable load factors.

The methodology quantifies the future ASR expansion that can be accommodated by a structure and identifies quantitative acceptance criteria for threshold parameters for each structure.

Additionally, limits are in place to ensure structures are evaluated for potential rebar yield under service loads and monitoring programs are in place to ensure ASR expansion remains within the identified test program limits and structure-specific threshold limits.

Angie will discuss the monitoring programs in more detail in the upcoming slides.

Finally, confirmatory actions in the license condition provide assurance that the large-scale testing program results will continue to be applicable to Seabrook structures. Next slide, please.

The staff also finds that NextEra's evaluation methodology is adequately captured in the Methodology Document and the proposed UFSAR update.

The staff audited multiple calculations in each analysis stage and determined the Methodology Document is robust and detailed enough to be repeatable for any structure or analysis stage.

The Methodology Document will provide appropriate monitoring parameters and associated acceptance criteria for each analyzed structure.

The UFSAR update captures the five code supplements and references the Methodology Document. The UFSAR also includes the ASR load and the updated load combinations and identifies the expansion limits.

Based on its review, the staff finds that the proposed methodology is adequately described in the proposed UFSAR update and provides reasonable assurance that ASR-affected structures will continue to meet the design codes as supplemented.

That concludes my presentation on the

evaluation methodology and I will turn the presentation over to Angie to discuss ASR monitoring and plant-specific AMPs.

MS. BUFORD: Okay. Thanks, Bryce. So, the applicant has proposed and is implementing monitoring programs that rely on the robust methodology that the licensee is crediting in their license amendment request and their plan is to monitor ASR-related behaviors under two plant-specific programs.

The staff reviewed the programs against the plant-specific review guidelines, per the ten-element review process outlined in the Standard Review Plan for License Renewal.

We thought that appropriate, considering that the programs that are being implemented today are the programs that are planned for the period of extended operation.

This next slide has been covered, it's just a high level overview of the ASR monitoring plan. So, for time, we'll just move to the next slide.

MEMBER KIRCHNER: Sorry to slow you down.

MS. BUFORD: Sure, no problem.

MEMBER KIRCHNER: I have a question about methodology for the building deformation. Is there any plan to estimate gross movement of individual buildings because of pressure from the backfill expansion and what's the consequence of that?

Is there any limits to -- hypothetically, just say there's a gap there for seismic purposes and it's closing because of expansion and pressure. Is there any program in place that defines an acceptable methodology for estimating that and predicting it going forward?

Or is it going to be a reactive monitor what the gap is and, at some point, if it closes and creates a seismic or other induced load, then you mitigate that or calculate your way out of it or whatever?

I mean, is that the response to this issue of building deformation that's because the structures float and are being pushed, if you will, and stressed by the backfill expanding?

MS. BUFORD: Yes. So, our review process for their -- the licensee actually has a specific program called the Building Deformation Monitoring Program that --

MEMBER KIRCHNER: Right, I saw that coming up.

MS. BUFORD: Yes, so that is coming --

MEMBER KIRCHNER: Right.

MS. BUFORD: -- up, but that's what you're referring to. And so, what that program does is that it looks at all of the different -- for each structure, it looks at the different parameters that are unique to that structure that are related to both ASR and any movement, large cracks, and any ASR-related or building deformation aging effects.

And our guidance says that, when we review this, we need to see that indications are both trended and also there's a forward look in the review to say that the licensee needs to show that, based on prior trending, that they will not reach their threshold limits for any of the monitored parameters before the next inspection time.

And we've heard today that there's actually, even though it's not part of the guidance for license renewal, NextEra actually has a limit that's what they were calling their administrative limit, that's actually even before they would get -- so, that's actually the limit they use, which has a conservatism even built into that.

That's actually what they're trending to, so the program trends up to the next inspection, based on previous movement. And like we said, it's slow and they have years' worth of data that they can use to trend.

And every structure is different, so there is essentially a Building Deformation Monitoring Program for every structure. Does that --

MEMBER KIRCHNER: Okay.

MS. BUFORD: -- answer your question?

MEMBER KIRCHNER: Kind of, sort of, yes.

MR. LEHMAN: I can expand on that.

MEMBER KIRCHNER: It's a little different, I guess, this problem or issue or -- than the actual reinforced concrete structures, which they bounded with their large-scale test program.

And now, you're working within a defined envelope or limits to make sure you don't exceed what was tested.

I don't expect a test program for bulk deformation or large-scale movement of buildings, but I was just curious how you project out through the life of the license and the renewal application.

MS. BUFORD: So, the test program is not -- it was not directly related to the --

MEMBER KIRCHNER: No, I --

MS. BUFORD: -- building deformation, but --

MEMBER KIRCHNER: -- admit that, that's

quite different.

MS. BUFORD: So, actually, the inputs from the test program specific to the actual ASR expansion, that's the ASR monitoring program, which it's actually the other program.

MEMBER KIRCHNER: Okay.

MS. BUFORD: So, the ASR monitoring program is specifically looking at the in-plane cracking and the through-wall cracking and directly comparing to those testing limits.

MEMBER KIRCHNER: I understand that completely.

MS. BUFORD: The Building Deformation Monitoring Program takes -- weaves conclusions from the testing program into the calculation that governs the extent of aging effects for the -- so, it basically wove into the calculation.

And it's not -- the testing program isn't being in any way tied directly --

MEMBER KIRCHNER: No, I understood all that. No, I'm -- I guess, indirectly, what I'm asking is, is there an effort underway to estimate what bulk deformation would occur through the license renewal application time period?

MS. BUFORD: So, no. Our process for the

-- in our programmatic review, we look to understand that there are mechanisms in place to -- and I think that Michael Collins alluded to this previously in the presentation, where we're not looking for them to estimate out the, either the expansion or the bulk deformation through any time period except to the next inspection. And that the monitoring criteria will identify deficiencies prior to that.

But there's no -- it's our understand and it's acceptable to the staff that there is not a projection out to any extended time period, because --

MEMBER KIRCHNER: To the 26-year or whatever --

MS. BUFORD: -- it's a condition monitoring program.

MEMBER KIRCHNER: -- the time frame is.

MS. BUFORD: Yes. So, if at any point --

MEMBER KIRCHNER: So, it's a more reactive, monitor and react approach, rather than to bound the problem, like you did with the large-scale test program?

MS. BUFORD: We'd call it more condition monitoring, because --

MEMBER KIRCHNER: Okay.

MS. BUFORD: -- you're monitoring

conditions up to a point at which you need to go into your Corrective Action Program and look into operability of structures. And that's based on the work that was done.

But the -- programmatically, the NRC looks to make sure that the programs can effectively identify any of the aging effects associated with the structure prior to the next scheduled inspection.

MEMBER KIRCHNER: Well, typically, when we have an issue surface like this, I would hope that Research would be involved and they would be thinking through, okay, what's the implication of this?

I'll bring up some analogies, I guess, at some risk, like reactor vessel degradation, because of neutron irradiation.

What you do is estimate out to the lifetime of the reactor vessel what the fluence is and what the effect is on the structural capacity of the reactor vessel.

Here, it's a little bit different, because we're talking about bulk movement, but I would think that one would want to take a stab at estimating how these islands are floating and being moved, to see whether or not you would then, in the lifetime of the plant, have a condition occur where you have, let me say, building to building contact that's unacceptable because of the loads it would induce, et cetera.

So, I'm just curious if any work is underway to look at that aspect of the problem, or are you just going to monitor --

MS. BUFORD: So, we don't have --

MEMBER KIRCHNER: -- and react?

MS. BUFORD: -- any work underway to do that, and that's -- there is a specific reason for that, because those types of analyses are, under the regulations, are time-limited aging analyses.

And those are the analyses that look out to the end of life of the plant and either bound the behavior or propose Aging Management activities.

One of the criteria for a time-limited aging analysis that looks out to the end of plant life is that there is an analysis that's already in the licensing basis that's associated with time, where it was assumed that there would be a 40-year license and then, licensees, applicants, have to revisit that 40-year analysis out to the extended period.

In this case, there's not a licensing basis calculation associated with --

MEMBER KIRCHNER: I understand, because --

MS. BUFORD: -- the life of the plant --

MEMBER KIRCHNER: -- you discovered this in 2014.

MS. BUFORD: Well, right. But in terms of our -- it's acceptable and adequate for this to be a condition monitoring program, so long as aging effects can be identified --

MEMBER KIRCHNER: Okay, fair enough.

MS. BUFORD: -- prior to the next inspection.

MEMBER KIRCHNER: That's fair enough. Thank you.

MR. COLLINS: So, the issue of the backfill concrete, those loads are being applied by SG&H, as far as in their buildings analysis.

And we have our threshold limits and those threshold limits drive the inspection criteria, whether it be a seismic gap, whether it be a distances between fire gaps. So, we're not expecting a massive blowout of a wall, so we are --

MEMBER KIRCHNER: No, I wasn't --

MR. COLLINS: No, and I --

MEMBER KIRCHNER: -- suggesting that.

MR. COLLINS: -- know you weren't. But I think we got a little dysfunction there with regards to the backfill concrete. That is being monitored, that input of that backfill concrete is being input into our analysis of --

MEMBER KIRCHNER: Okay, fair enough.

MR. COLLINS: -- the structures.

MEMBER RICCARDELLA: Could I just make sure my understanding is correct? You've done the structural models of each of the structures, certainly the ones that fall into the Stage Three.

And my understanding is that the Building Deformation Monitoring Program is just there to confirm the predictions of those structural models. So, that it has been modeled, by including the factor, I forget, the threshold factor in there, that does take it to the end of life.

If you go in there and measure something that says, well, I'm right up to the threshold, to that threshold factor, you basically have to take an action.

MR. COLLINS: That's correct.

MEMBER RICCARDELLA: Right?

MR. COLLINS: Yes. And I'm Michael Collins, Director of Engineering, Seabrook Station.

MEMBER RICCARDELLA: Yes. I mean, that might not be so true for the ones that are maybe a Stage One or a Stage Two, but certainly for anything that was Stage Three, you've got a finite element model predicting deformations and your monitoring program, as I understand it, is just to confirm those measurements, right?

MR. COLLINS: That's well said.

MEMBER RICCARDELLA: Okay, thank you.

MR. LEHMAN: And also, for all of the stages, that limit is a limit they have to take action at. But at a Stage One, it might just be, go to a Stage Two, or go to a Stage Three. At a Stage Three, it's a little bit more and the action might be a mod at that point.

MEMBER RICCARDELLA: Understood.

MR. THOMAS: This is George Thomas. Just to add to that, even if it's a Stage One analysis, if the field observations indicate that the seismic gap is an important parameter, that would be identified as the threshold parameter and monitored. So, it's all field data driven.

CHAIRMAN SKILLMAN: Let's proceed, please.

MS. BUFORD: Okay. So, we were going to move to the next slide. We were trying to skip that slide and so, we are going to still. So, I'm going to go back, I know we talked a little bit about the building deformation monitoring, but that's coming in a couple slides.

The ASR monitoring program, the staff reviewed the ASR monitoring program using the ten-element review guidance that I mentioned in the Standard Review Plan for License Renewal.

And we noted that visual inspections are performed. And for any concrete onsite, that's a five-year basis. That's the baseline. And the frequency for the baseline inspections is adequate -- and actually, I won't call them baseline, but I'll call them routine structures monitoring inspections.

That frequency is adequate because, firstly, NextEra has already performed a comprehensive baseline inspection on all concrete at Seabrook. Any area with visual indications of ASR were noted in that baseline inspection. The five-year inspection is for concrete where ASR has not been previously identified.

The staff agrees that five years is sufficient to be able to both detect initial signs of ASR, since ASR is a slow progressive phenomenon, and has confidence that it would be unlikely for that area to progress from having no signs of ASR to having ASR damage that could challenge the intended function.

The inspection frequencies for all locations that have any indication of ASR are 30 months and move to six months, according to ASR severity.

The program uses combined cracking index, which you've heard extensively today, to measure in-plane cracking for areas whose CCI measures less than one millimeter per meter.

The staff agrees that CCI is a valid method of measuring ASR micro-cracking, because it was -- well, one, it is the standard for -- it's noted in the Federal Highway Administration literature. And also, just because it was found by the large-scale testing program to correlate well to concrete strain.

And also, the one millimeter per meter threshold for more frequent inspections is very conservative, because it represents a low level of strain.

For these low ASR severity levels, the 30-month frequency associated is conservative based on the slow rate of ASR progression.

This has also been validated with data from Seabrook structures and the staff has confidence that for a low ASR severity, a 30-month inspection interval will identify degradation and trend to the next inspection prior to a loss of intended function.

Through-wall expansion is measured in any structure whose CCI exceeds one millimeter per meter. As I mentioned, the testing program demonstrated that through-wall expansion exceeded in-plane expansion for structures with more severe ASR degradation.

One millimeter per meter expansion is a low and conservative factor for through-wall extensometer installation.

The through-wall expansions are measured every six months for every location that uses an extensometer and the expansion limits are based on expansion data from the testing program.

Since the large-scale testing specimens exceeded their structural acceptability, staff has confidence that as long as the Seabrook structures remain within the tested limits, they will be able to perform their intended functions. Next slide.

The staff finds that NextEra's ASR monitoring program is acceptable, because the program begins with visual inspections and progresses to expansion monitoring, as necessary, for increased levels of ASR degradation.

The inspection frequencies are conservative and are aligned with guidance in ACI 349.3R.

The starting point of the five-year frequency aligns with the GALL report recommendations for inspection of concrete in an aggressive environment, which Seabrook concrete is considered to be, since they are susceptible to ASR.

The staff has also performed numerous inspections under the reactor oversight process that look at the expansion and deformation behavior and these inspections have concluded that ASR progress has been very slow.

In addition, the ASR monitoring program compares total volumetric expansion against reasonable limits from the testing program and license conditions are in place to assess continued assurance that the testing program is valid and representative of Seabrook.

In addition, as reflected in the operating experience program element of the program, the program will monitor and evaluate future industry and plant-specific operating experience and the program will be modified if necessary.

Any questions on the ASR AMP? Okay. Next slide.

So, the other program to manage ASR is the Building Deformation Monitoring AMP. For this AMP, structures with indications of ASR micro-cracking and any other manifestations of ASR are analyzed using the proposed methodology that was discussed earlier.

For each structure, analysis defined structure-specific parameters to monitor and has acceptance criteria that is based on an evaluation that's unique to that structure.

The program identifies and monitors parameters generated from the Methodology Document and those parameters are quantitative when feasible.

Also, the licensee has established a unique program for each structure that references threshold factors that must be met and trended to the next inspection.

For each structure, the inspection interval is either three years, 18 months, or six months, based on the stage of analysis, essentially considering the level of conservatism in the calculation or the potential for building deformations to become more severe.

The staff believes these frequencies to be adequate in its audit and review of a sample of each stage of analysis and notes that for areas with higher potential to reach the threshold, i.e., the Stage Three analyses, a six-month frequency is very conservative considering the ASR progression is very slow.

The staff concludes that the implementation of the Building Deformation Monitoring

Program ensures structures continue to meet the code of record, with supplements, if measurements remain below the acceptance criteria. Next slide, please.

The staff finds the proposed Building Deformation Monitoring AMP acceptable, because the program identifies appropriate monitoring parameters and acceptance criteria based on the Methodology Document, which the staff has found technically adequate.

The Methodology Document has identified the method for monitoring each possible parameter.

The staff also finds that the program uses conservative inspection intervals, which are frequent enough to ensure significant changes in deformation are identified and remediation can take place prior to a loss of intended function.

The monitoring is based on more and more stringent frequencies based on ASR degradation and the staff has confidence, because we noted from trended data that ASR has progressed slowly.

In addition, the inspection frequencies associated with this aging mechanism are closely tied with ACI 349.3R guidance for sites that have operating experience with respect to significant degradation mechanisms.

Also, the staff noted that the program includes structural, electrical, and mechanical components in the plant that may be impacted by structural deformations.

These components will also be monitored for continued deformation effects and we verified implementation in the licensee's database during our onsite inspection.

Finally, the Building Deformation Monitoring AMP will monitor and evaluate future industry and plant-specific operating experience and modify the program as necessary.

If there are no questions, I will turn the presentation back to Nik so he can discuss the follow-up license renewal inspection at Seabrook for ASR.

MR. FLOYD: Thank you, Angie. Next slide, please. George, next slide. Oh, thank you.

The NRC conducted a second license renewal inspection at Seabrook to determine whether actions taken by NextEra since the previous license renewal inspection conducted in 2011 was adequate to manage aging in concrete structures due to the effects of ASR.

The inspection was focused solely on ASR, because the 2011 inspection reviewed the other Aging Management Programs.

The timing of this inspection was prompted by NextEra's completion of the large-scale testing program, NextEra's submittal of the license amendment request, updates to the Aging Management Programs for the license renewal application, and the NRC completion of staff licensing audits.

The inspection involved one Regional Inspector, who was myself, and one Headquarters Inspector, who was Angie, with expertise in both materials and civil engineering.

The team was onsite the week of April 30, 2018 and the inspection report was issued August 10, 2018. Next slide, please.

The team reviewed the Aging Management Programs associated with ASR. These were the Structures Monitoring Program, ASR, Building Deformation, and ASME Section 11, Subsection IWL, for containment concrete inspections.

The team performed detailed walkdowns on a sample of three structures affected by ASR and verified that the structural deficiencies were being identified, evaluated, and corrected by the applicant. The team did not identify any new deficiencies that were not previously documented.

The team also performed an in-depth review of the Structures Monitoring Program database. This database captures the results of NextEra's monitoring of structures per the Maintenance Rule and also includes the monitoring results from the ASR monitoring and the Building Deformation Monitoring Programs. Next slide.

NRC Regional Management provided oversight during this inspection. In the photo, you can see the team on the left and the right, provided their observations and assessments on the Structures Monitoring Program during a walkdown in the Fuel Storage Building.

The binder, which you can see in the photo, contained a list of NextEra's documented structural deficiencies, which the inspectors used during their walkdowns to independently verify that all deficiencies were being appropriately identified. Next slide, please.

From the walkdown and review of the Structures Monitoring Program database, the team determined that NextEra was implementing the established monitoring programs and was appropriately identifying and correcting issues.

The team noted that all in-scope buildings were being monitored in the Structures Monitoring Program for ASR.

As part of the new Aging Management Programs, we reviewed ASR-specific monitoring parameters.

Those would include combined crack indexing grids, pin-to-pin expansions, extensometers, as well as building deformation monitoring parameters, which would include seismic gap and specified cracking.

We determined that these parameters were adequately captured in the program and were being monitored at the program-specified frequencies.

NRC inspections of ASR-related issues completed to-date, which would include the semiannual focus inspections, as well as this follow-up license renewal inspection, support the conclusion that there is reasonable assurance that the effects of aging due to ASR in Seabrook structures, systems, and components will be managed through implementation of the programs during the period of extended operation.

Also, just a quick note, review of this database, as well as this inspection, did provide us confidence in NextEra staff's ability to implement the program, given its extensive processes for monitoring.

As far as just, and this is my personal opinion, as far as benchmarking and Structures Monitoring programs go, this really is probably the most comprehensive Structures Monitoring Program that I've observed. So, I'll just offer that observation.

Are there any questions on the scope of the inspection or observations? Thanks very much. I'll turn it back over to Angie.

MS. BUFORD: Home stretch. I'm going to now finish the staff's presentation with our conclusions. Next slide, okay.

The staff found that there are acceptable plant-specific AMPs provided for both ASR monitoring and building deformation.

We found that the existing structures monitoring and ASME Section 11, Subsection IWL AMPs, and structural Aging Management review items have been updated to reflect ASR. And that also includes components that are affected by building deformation.

The license renewal safety evaluation report conclusions rely on the large-scale testing program and the license amendment request safety evaluation findings.

The SER focuses on monitoring parameters, inspection methods and intervals, acceptance criteria, and evaluation of future operating experience.

The staff finds that ASR degradation and related building deformation will be adequately managed so that the intended functions will be maintained through the period of extended operation.

It's been a long six years and the staff can now conclude that, based on our review, the ASR open item from 2012 is closed.

The next slide is just a summary of the regulatory reasonable assurance conclusion.

Number one, the applicant demonstrated that proposed plant-specific Aging Management Programs will adequately manage the effects of aging due to ASR, in accordance with the regulations in 10 CFR 54.29(a).

The license amendment ensures that programs to evaluate and manage ASR will be added to the current licensing basis.

The ongoing Regional oversight and the 71002 inspection concluded, from a Regional perspective, that programs are effectively being implemented today and will continue to be effectively implemented through the PEO.

And the license conditions that are associated with the license amendment request corroborate future expansion behavior, which will ensure continued applicability of the large-scale testing program to Seabrook structures.

With that, I conclude the staff's

presentation and we'd like to welcome your questions.

CHAIRMAN SKILLMAN: Angela, thank you very much. Colleagues, any questions for the NRC staff at this point, please? No questions from my colleagues? Let me just do a headcount.

Vesna, any comments or anything you would like to communicate at this point, please? Go ahead, Vesna.

MEMBER DIMITRIJEVIC: No, I have asked the questions I have been interested in. I think this was a very comprehensive, absolutely wonderful presentation on everybody's contributions.

CHAIRMAN SKILLMAN: Okay. Dr. Corradini?

MEMBER CORRADINI: No, I agree with Vesna, it was quite comprehensive.

CHAIRMAN SKILLMAN: Dr. Rempe?

MEMBER REMPE: No, I don't have any additional comments. I do want to thank the staff and all of the folks associated with the Seabrook LAR who presented, because I do think they gave very good, well thought out presentations to elucidate the issue.

CHAIRMAN SKILLMAN: Dr. Riccardella?

MEMBER RICCARDELLA: I think what I've seen represents a very impressive body of work. I think that the presentations by the licensee and the staff, as well as the documents that we've been provided to review, provide us with adequate information for our deliberations at the main Committee on this topic.

CHAIRMAN SKILLMAN: Thank you. Dr. Kirchner?

MEMBER KIRCHNER: Just to thank the applicant and the staff, as Pete said, quite thorough and comprehensive.

I will reiterate my suggestion from the closed session that as much of the material that we saw today, which I found pretty thorough and complete, that could be made available to the general public, I just would encourage that.

CHAIRMAN SKILLMAN: Okay.

MEMBER KIRCHNER: I'm referring to materials that were marked proprietary.

CHAIRMAN SKILLMAN: Thank you, Walt. Dr. March-Leuba?

MEMBER MARCH-LEUBA: Yes, I have a number of comments. First, I'd like to say that, the staff had done a heck of a job. I mean, you really have done a fantastic job. And maybe you don't realize the two things that I think you've done extraordinarily.

Number one, the Region identified a problem that was not textbook. We're used to walking through the plant and going through the procedures and they're supposed to do something in 15 minutes and they did it in 16, aha, we caught you.

You guys had an open mind and were asking, what could possibly go wrong?, and identified something that was not -- that you were not looking for. So, that is difficult to do and I congratulate you for doing it.

On the Headquarters side, you also did something good, because I wasn't there, but I'm pretty sure the licensee, when confronted with the issue, said, no never mind. Buildings move, sidewalks crack, what are you talking about?

And you didn't take no, never mind, for an answer, and pushed it and identified that this has some safety significance and you have taken it to conclusion.

And that is difficult to do also, so congratulations. You all should go talk to your bosses and ask for a raise. Not that it's going to happen, but you've done a great job.

The licensee has also done a fantastic job. I mean, I'm sure that it took a while to get into the mode of actually responding, but when they did, they've done incredible testing and they have a very good program with AMPs and with calculations and I have, not being an expert, I have great confidence that these structures are going to work.

No, I have a lot more. Now, that's the good side.

On the bad side, for the staff, I'm not sure that this is not a generic issue. I'm not sure that all the other 100 plants out there, some of them no have ASR issues.

So, I don't know, let's think about that and see how we can communicate to them that there might be a problem.

MR. DONOGHUE: One of the issues that we have discussed before, related to subsequent license renewal, is concrete degradation. And there's continuing research on that.

And what we've -- the Commission has agreed that plants can provide a plant-specific approach to that, and there's three other issues, to be able to pursue subsequent license renewal.

So, there is generic work underway that the industry's pursuing, because they would -- it would be easier to have a generic solution to that. So, I'll just leave you with that.

So, there are other plants, as you well

know, there's other applications, they have to address concrete and other issues on a plant-specific basis to obtain a subsequent license renewal approval.

MEMBER MARCH-LEUBA: Okay. I'm glad to hear that, because this morning, the answer I understood was, nobody else has a problem. That's what I understood when I raised the issue at 8:35 this morning. And obviously, that's not the case, so I'm glad to hear that.

Final item, I'm sorry, it's not that late, we have an hour ahead of schedule. I understand we are going to have a full Committee meeting on the license renewal and are we going to recommend that? I do recommend that we have it.

CHAIRMAN SKILLMAN: Well, let's take it one step at a time. We are having a license renewal meeting for the Seabrook Station on November 15.

This meeting was specifically crafted to address alkali-silica reaction, recognizing that there are one, two, or three AMPs in the license renewal application that address this topic.

So, the intention for this meeting was to get the ASR issue resolved for the Committee, prior to our getting to November 15.

We're going to meet on November 15, we

already have the safety evaluation, I've been reassured that we now have the final signed documents. That is our review target for November 15.

And presuming that we clear November 15 without issues, we go to the December full Committee meeting with the intention of writing a letter.

MEMBER MARCH-LEUBA: Here is my question, are we writing one letter or two?

CHAIRMAN SKILLMAN: We're going to discuss that among ourselves or at P&P on Friday morning.

MEMBER MARCH-LEUBA: Okay. And with that, I yield the remainder of my time.

(Laughter.)

CHAIRMAN SKILLMAN: Dr. March-Leuba, thank you. Dr. Ballinger, sir?

MEMBER BALLINGER: I guess I'd like to sort of echo what other people have said. I might add that both the GALL-SLR and the Expanded Materials Degradation Assessment, EMDA, documents, also all require now that ASR and everything be explicitly identified --

CHAIRMAN SKILLMAN: Addressed.

MEMBER BALLINGER: -- so, I don't think we're going to have that issue any more. And lastly, I still feel comfortable going to the Airfield Café near Seabrook.

(Laughter.)

CHAIRMAN SKILLMAN: Thank you, Dr. Ballinger. The distinguished Charlie Brown, Charlie?

MEMBER BROWN: I only had one observation, probably being the least concrete familiar person on the Committee.

I appreciated the NextEra and consultants presenting of the data in what I would call English and not burying it in very obscure jargonese, because I actually understood what you were talking about as you went through the analysis and stuff.

CHAIRMAN SKILLMAN: Minimum acronyms.

MEMBER BROWN: They did a good job and so did the staff, in terms of their follow-up on the stuff, so I thought it was a good presentation for, and it was clean for somebody who not necessarily an expert in that field. So, I appreciated that and I had no other comments other than that.

CHAIRMAN SKILLMAN: Thank you, Charlie. Dr. Bley, by chance are you still with us, please? Dennis, are you there, please? Let's proceed. We have our consultant, Dr. Schultz. Steve?

MR. SCHULTZ: Thank you. My objectives for the meeting were all met in the presentations today.

The summaries that were presented were excellent and they were extremely helpful in clarifying a number of issues, demonstrated comprehensive details, demonstrating the approach developed for investigation, testing, analysis, and monitoring programs.

And the discussion really imparted that the important features of the overall programs have matured to implementation. And I was pleased that that message was delivered today.

I was also pleased that NextEra clearly is integrating the program into the site organization at Seabrook. It's clear that the Station owns the program and the ongoing resolution and monitoring for the entire facility is in place and it's moving forward in implementation.

I agree with the comment regarding the site documentation on monitoring. It was a detailed slide that was presented to us and we didn't go through it in detail, but it clearly demonstrates that the monitoring program is very well developed at Seabrook.

And the documentation that is being provided for the program is going to be very valuable moving forward, to allow the program to be successful, because it's a very complex set of programs that come together for this.

I also would like to really congratulate the staff, as noted by Jose, for their involvement in the inspection and oversight, for several years, through here. Both the oversight and the documentation related to it, in the inspection reports, and then, carrying on into the safety evaluation.

It's very clear the level of detail and the work that's gone into this review by the staff and it shows in the detailed documentation that's been developed for addressing this issue and going into the license renewal safety evaluation as well.

I would just be repeating what I said before, but it looks -- the license condition that's been put forward for the longer term evaluation of the testing program versus what is going to be learned from Seabrook in the next five years and then, 15 years, does look fairly complex to me.

And it's going to take a real investment by NextEra to make that happen, I believe. And I'm a little concerned that the experts that have participated in our program today and in the investigations over the last five years may not be available to move forward with that investigation, so I hope they're doing a lot of mentoring for their staff moving forward to make sure that that is covered comprehensively when it comes to pass.

But thank you all for your presentations, I've learned a lot.

CHAIRMAN SKILLMAN: Thank you, Steve. I would like to make several comments before we go to public comment. When we began this meeting, I identified several things that I was very interested in hearing.

The first was to hear the staff and the licensee communicate that they have a clear understanding of the seriousness of the issue at Seabrook Station.

That has been accomplished. I've heard it from the staff, I've heard it from the licensee, and I've heard it through the thoroughness of MPR and SGH.

I communicated that I was looking or listening for clarity regarding the scope of systems, structures, and components affected by ASR. That has been completed. It's clear in my mind that the licensee and the staff understand the scope and understand the importance of the scope.

I communicated that I was looking for clarity regarding the extent of condition. That has been fulfilled.

I communicated that I was listening for a demonstration of the discipline. What I mean by that is that what you do when you put on the seatbelt buckle and get down and get busy and really get to the bottom of the issue, the technical drive and the discipline to understand the as-found state and the progression of the phenomenon. And it's clear in my mind that that has been fulfilled.

And I was interested in the thoroughness of the licensee's plans, actions, and commitments. To Dr. Schultz's comment, I believe that that which will be codified as a consequence of the license amendment will ensure that this endures for generations to come.

I want to thank the staff, I want to thank MPR, I want to thank SGH for their effort, very comprehensive and very thorough. But I want to say one or two other things.

I want to thank Theron for his effort to put together a conference room that allowed us to do this away from our normal conference space. So, Theron, thank you, sir.

And to Kent, for all of his work to pull this together. Thank you. I wanted to do this before we go to public comment, because I don't know what might be coming.

With that, is there any individual in the room that would care to come to the microphone and make a comment? I invite you to do so and I ask you to speak clearly into the mic, please come.

MR. NORD: Thank you. Wow, good evening. I mean, this has been an amazing --

CHAIRMAN SKILLMAN: Would you please introduce yourself?

MR. NORD: I'm sorry. I will say though, that this has been an amazing thing to sit through. My name is Chris Nord, N-O-R-D. I live in Newbury, Massachusetts.

I have lived within the Emergency Planning Zone for Seabrook for a good part of my adult life and I'm a founding member and board member of the C-10 Research and Education Foundation in Newburyport, Massachusetts.

We have operated the single largest real-time citizens-run radiation monitoring network in the United States for 25 years, under contract with the State of Massachusetts, their Emergency Management Agency, I believe is where we are now.

We also have undertaken to monitor safety at Seabrook, which is what got us involved years ago, through discoveries of our researcher, the presence of alkali-silica reaction at Seabrook, that has led us to three different legal sessions concerning the NRC.

One, a rulemaking petition. One, an emergency enforcement action petition, which happened two years ago. And in 2017, we were granted standing before the Atomic Safety and Licensing Board, for one overarching contention having to do with the license amendment request.

And that contention has to do with the lack of representativeness. We're challenging the representativeness that NextEra claims that it has established for the large-scale testing protocol at Ferguson Labs.

So, my comments are going to be directed toward helping clue you all in, so that you know who we are, of the difficulties that we have with the license amendment request and the order in which all of these issues are coming out in the Nuclear Regulatory Commission through its various agencies.

And I have tried through the day to shorten and shorten how I might get this done, because I know it's very late. So, I'm going to shortcut a lot of things.

We have submitted a document that came into you all, highlighting some of our concerns, which you will receive in writing, or have received digitally already. So, let's see.

So, as I said, we have the overarching contention challenging the representativeness of the Ferguson large-scale testing. Among the -- it's at least seven features of the safety evaluation that I saw, we intend to directly challenge.

They included an inherent bias in the testing methodology, challenging the notion that the Ferguson testing yields improved data on limit states that apply to Seabrook.

Challenging the rationale offered in answer to RAI-T2, for the representativeness of accelerated ASR. Challenging the sufficiency of an independent internal peer review as a peer review in the conventional sense.

And as an aside, I want to tell you that we at the C-10 Foundation feel a tremendous burden of responsibility right now, because we don't see any opportunity, other than the one that is presented, to this larger process, by our intervention in this process, to actually have a peer review.

This material is not being shown to the wider scientific community to offer a peer review and so, it falls to the expert witnesses that we are able to bring to this, that are going to provide an independent peer review.

Which is quite a burden for an organization whose budget really concerns radiation monitoring. This is a big thing for us to bite off. And I mean, I'm not a scientist and none of us are scientists, we're just doing the best we can with what we've got.

I just wanted to illustrate one of many issues that we have and then, I'm leaving all the others out.

The Section 3.2(a), which we saw in Page 29 of the draft safety evaluation, the rationale expressed there for the use of accelerated ASR in the Ferguson testing does not answer RAI-T2, Request 1, with regard to Seabrook structures.

To claim that the use of fast-acting ASR for research at Oak Ridge and NIST makes its applicability as specifically representative of the 40-year-old concrete supporting structures sitting in the uniquely harsh environment of the New Hampshire Salt Marsh, is not an adequate scientific justification.

It is important to note here that because of the long-term inundation of at least one structure, the famous electrical cable tunnel, as it was called, that was intended to be dry, Seabrook Station has operated outside its design basis for its entire license term.

If it is true that this reactor, being one of the last commercial atomic plants to be licensed, is coincidentally the first U.S. reactor to be found with alkali-silica reaction, perhaps it behooves the Nuclear Regulatory Commission and, by extension, ACRS, with all respect, to look more closely at the Seabrook Reactor itself to discover what has caused this exceptional circumstance and not to be persuaded by the licensee to look away from Seabrook's own data in favor of an unprecedented and remote testing protocol.

Okay. I'm going to mix a couple of metaphors and then, I'm going to finish. What I want all of you in this Committee to understand is that from the point of view of the C-10 Foundation, you all have a freight train in your control that's rolling downhill.

And that freight train is occupying the same track that we are, but we're moving much more slowly. And that's because of the two different tracks that we saw much earlier in the day that has this process going along way before we have an opportunity to litigate our case.

Therefore, I am not in a position to be able to prosecute our case in front of the ACRS today, because we're nine months away from being ready to go to court.

But in the meantime, you all are somehow being called upon by what we believe is a skewed process to consider having some kind of a -- making some kind of an advisory decision on the efficacy of this testing protocol before we ever have a chance to litigate it.

And I mean, I just have to point out that that is not a fair system. That is not a democratic system.

So, the second metaphor, it has to do -- I'm going to give you a really short story. More than 30 years ago, a commercial atomic plant out on the edge of the New Hampshire Salt Marsh was fully completed with billions invested, before its evacuation plans were ever adjudicated.

In fact, a majority of the towns within the Emergency Planning Zone rejected the plans as unfeasible, which we all believe actually they still are, maybe even more so, because there are twice as many people living there.

And FEMA's Region I Chief sided with the towns. What happened? The head of the Federal Emergency Management Agency was replaced, the towns were ignored, and the Atomic Safety and Licensing Board put the plant online.

For those of us working for the safety of Seabrook's neighbors for many decades, it seems that the cart has been put before the horse once again.

The goals of a for-profit industry are sometimes at odds with a fair and democratic process. It is worse than unfortunate that the U.S. Nuclear Regulatory Commission personnel concerned with Seabrook's future are being pushed to consider a license extension completely out of sequence with C-10's capability to give voice to crucial issues that bear directly on the plant's qualification to continue operating.

There are nine instances where the NRC staff finds reasonable assurance that the design parameters, including building deformation compression flexure strains on reinforcement in the external seismic strain will be met.

The phrase reasonable assurance is a subjective one. Would not beyond a reasonable doubt be a higher standard?

The goal of the NRC is to protect citizens from exposure to some of the most toxic substances on Earth, which is something that those of us that live within the ingestion pathway for Seabrook, and many of us live much closer, really take seriously. Therefore, the most stringent standard should be required.

Factoring in ASR as a design-basis load would bring Seabrook closer to design-basis limits, which would then become a causal factor in structural failure brought about by internal and/or external strain from beyond-design-basis events, accident, attack, natural disaster.

While 40 years ago, it might have seem implausible and unnecessary to worry over such events, we now know such worries are not unfounded, while the consequences of such an event occurring in one's own community are truly unfathomable.

C-10 urges the Advisory Committee on Reactor Safeguards, and by extension, the NRC, not to allow the erosion of margins of safety built into Seabrook's supporting walls by design and not to allow the erosion of trust of residents of our EPZ.

We ask the federal regulators charged with protecting us to hold NextEra to a higher standard.

Lastly, we ask for assurance that the planned public hearing on LAR 1603 be allowed to proceed before any decision is made on Seabrook's request for a 20-year extension for the plant's operating license. Thank you.

CHAIRMAN SKILLMAN: Thank you for coming to the microphone. Welcome to you and we respect your participation here. Thank you.

MR. NORD: If you really do, give us a chance.

CHAIRMAN SKILLMAN: Is there anyone else in the room that would care to come to the microphone? If so, would you please come and introduce yourself?

Hearing none, on the phone line, is there any individual out there? If so, would you simply say hello?

MR. WALDEN: Hello, this is Scott Walden.

CHAIRMAN SKILLMAN: Good afternoon, sir. Now, to Scott and to anyone else, would anyone wish to make a comment, please? If so, announce who you are and then, please make your comment.

MR. WALDEN: Okay. This is Scott Walden. I'd like to make a comment. I'm from Southern Nuclear and I am the Chairman of the NEI License Renewal Civil Structural Working Group.

And I just wanted to say that, as an industry, we are well aware of the alkali-silica reaction and what has occurred and going on with Seabrook.

And it's a common topic that we have at our meetings, to discuss ASR, how we're going to address it in the future, and looking at how we want to look at things that are, what I would say, are leading indicators, has been discussed with closing up gaps and things like that.

So, we're, as a group, we're well involved and working with EPRI. As a matter of fact, we're looking at submitting at all of our structural monitoring procedures to EPRI and next year, EPRI will be putting out a report with that information, looking at how we can develop commonality within the utility group.

CHAIRMAN SKILLMAN: Thank you for your comment, sir. Is there anybody else out there that would wish to make a comment? If so, would you please introduce yourself and make your comment?

MR. OSSING: Hello, my name is Mike Ossing, from Marlborough, Massachusetts. Just a couple of quick comments.

I would like to commend the NRC staff on the thoroughness of their review. I thought it was detailed and it took eight years to go through it and that's right on point.

Reminded that ASR is a reaction and it does take a while. I think the key to the whole process is a robust monitoring plan, which I believe NextEra has in place.

And I appreciate the thoughtful deliberation by the ACRS Subcommittee. Thank you.

CHAIRMAN SKILLMAN: Thank you, sir. Is there anybody else out there that would like to make a comment? If so, please identify yourself and please make your comment. Hearing none, Theron, please close the phone line.

Colleagues, one last chance for comment. I want to go around one last time. Vesna, any comment?

MEMBER DIMITRIJEVIC: No.

CHAIRMAN SKILLMAN: None? Mike, you good?

MEMBER CORRADINI: Yes.

CHAIRMAN SKILLMAN: Joy, good?

MEMBER REMPE: No more comments, thank you.

CHAIRMAN SKILLMAN: Pete, good?

MEMBER RICCARDELLA: I'm good.

CHAIRMAN SKILLMAN: Walt, good?

MEMBER KIRCHNER: No thank you.

CHAIRMAN SKILLMAN: Jose, good?

MEMBER MARCH-LEUBA: No.

CHAIRMAN SKILLMAN: Dr. Ballinger?

MEMBER BALLINGER: No.

CHAIRMAN SKILLMAN: Honorable Charlie Brown?

MEMBER BROWN: I'm good.

CHAIRMAN SKILLMAN: Dr. Schultz?

MR. SCHULTZ: No additional comments, thank you.

CHAIRMAN SKILLMAN: Ladies and gentlemen, thank you very much, we are adjourned.

(Whereupon, the above-entitled matter went off the record at 6:24 p.m.)

Evaluation and Management of Alkali Silica Reaction (ASR) at Seabrook Station

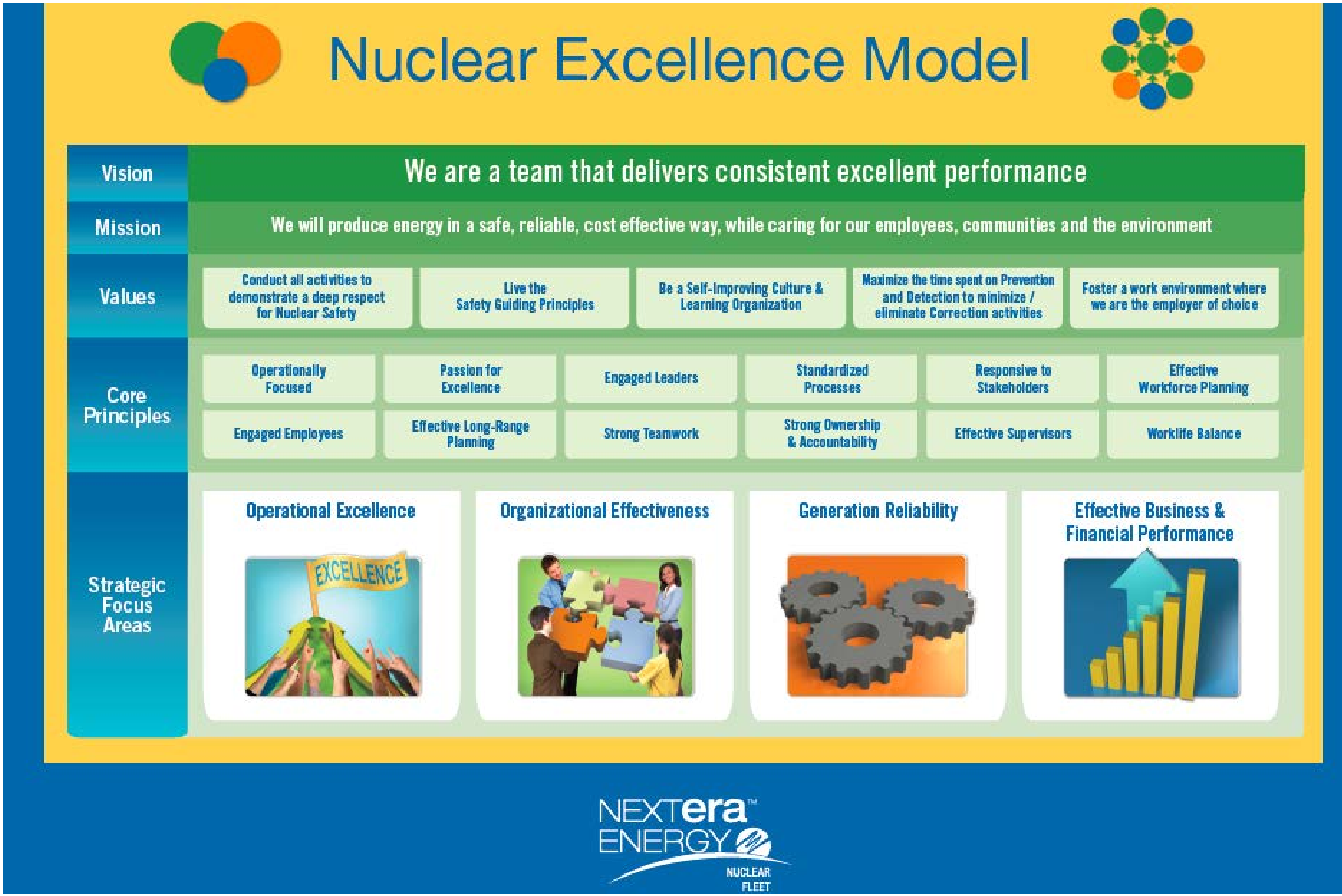
Introduction and Background

October 31, 2018

Speakers:

Kenneth Browne,	NEE Seabrook Licensing Manager
Michael Collins,	NEE Seabrook Director of Engineering
Edward Carley,	NEE Seabrook Engineering Supervisor

The foundation for everything we do are the Values and Core Principles of our Nuclear Excellence Model



Key Personnel in Attendance: NextEra Energy Seabrook

NextEra Energy:

- Eric McCartney, Regional Vice President
- Larry Nicholson, Director of Fleet Licensing
- Michael Collins, Director of Engineering
- Kenneth Browne, Licensing Manager
- Jaclyn Hulbert, Engineer – Structures Monitoring Program
- Edward Carley, Engineering Supervisor
- David Robinson, Chemistry Manager

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Key Personnel in Attendance: MPR Associates, Inc. (MPR)

Personnel in Attendance:

- John Simons
- Amanda Card
- Christopher Bagley

Key Efforts:

- Extent of Condition
- Interim Structural Assessment
- Large-Scale Testing Regarding Capacity
- Monitoring and Assessment of Expansion Behavior
- Aging Management

Key Personnel in Attendance: Simpson Gumpertz & Heger Inc. (SGH)

Personnel in Attendance:

- Dr. Said Bolourchi
- Glenn Bell
- Matthew Sherman (PE)
- Michael Mudlock (PE)
- Liying Jiang
- Dr. Andrew Sarawit

Key Efforts:

- Concrete Technology
- Concrete testing & Petrography
- Inspections/Monitoring
- Methodology for Evaluating ASR-affected Structures
- ASR Load Factors
- Structural Evaluation
- Structural retrofit support
- Aging Management

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Technical Consultants in Attendance

Dr. Oguzhan Bayrak (PhD, PE, F ACI)

- The University of Texas at Austin
- Ferguson Structural Engineering Laboratory (FSEL)

Dr. Bruce Ellingwood (PhD, PE, NAE, F SEI, Dist M ASCE)

- Colorado State University

Brian Brown (PE)

- NEE Seabrook, Retired Structural Engineering Supervisor

Robert Schofield

- ENERCON

SEABROOK BACKGROUND

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Seabrook Background

- **Seabrook Station is a single unit Westinghouse 4-loop pressurized water reactor with a General Electric turbine generator**
- **Located in the town of Seabrook, New Hampshire**
  - Two miles west of the Atlantic Ocean
  - Approximately two miles north of the Massachusetts state line
  - Approximately 15 miles south of the Maine state line
- **Reactor housed in a steel lined reinforced concrete containment structure which is enclosed by a reinforced concrete containment enclosure structure**
- **3648 MWt Thermal Power; ~ 1,250 net megawatts electric**
- **Atlantic Ocean is the ultimate heat sink**
  - A Seismic Category I mechanical draft cooling tower provides additional safe shutdown capability.

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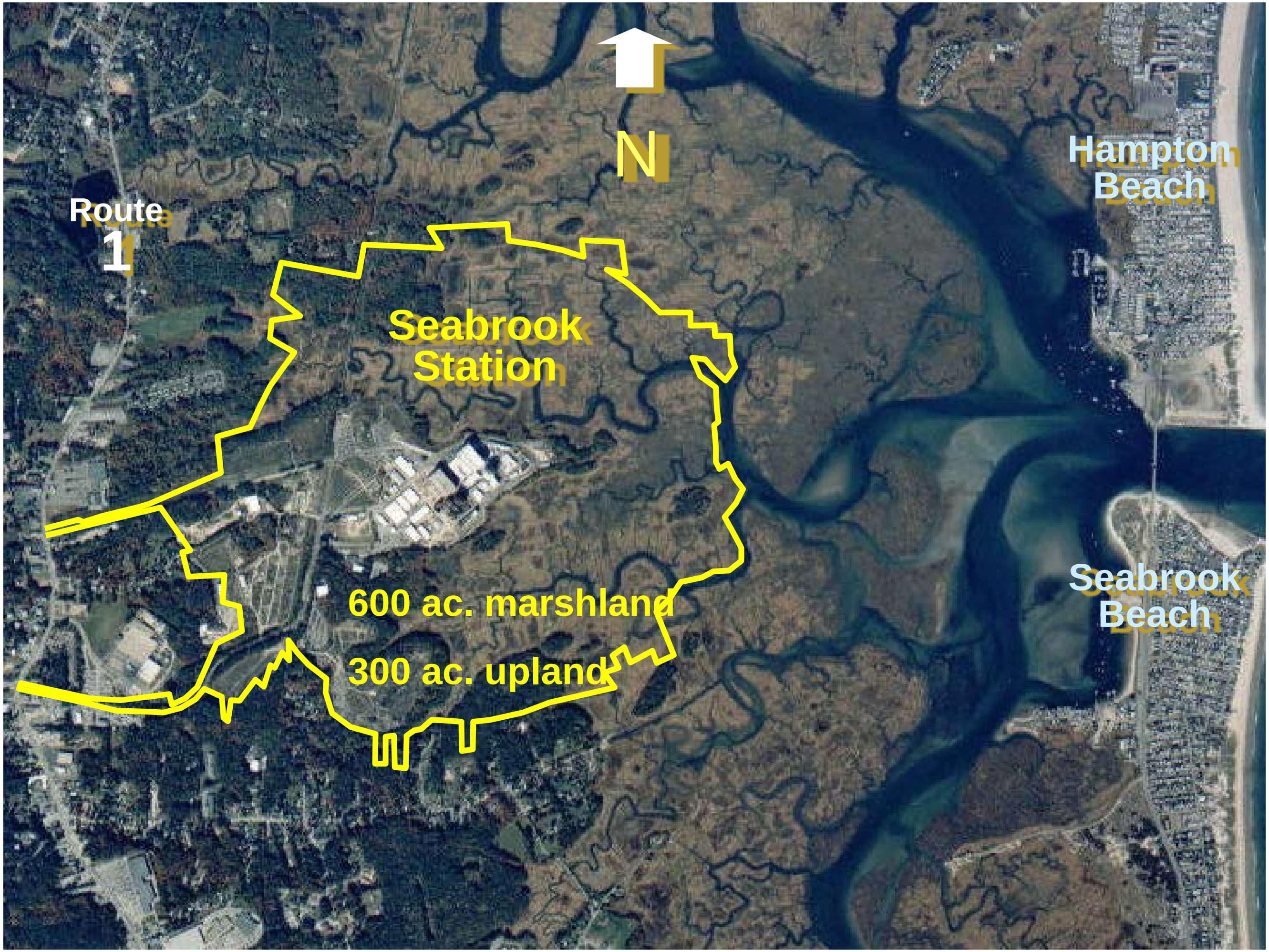
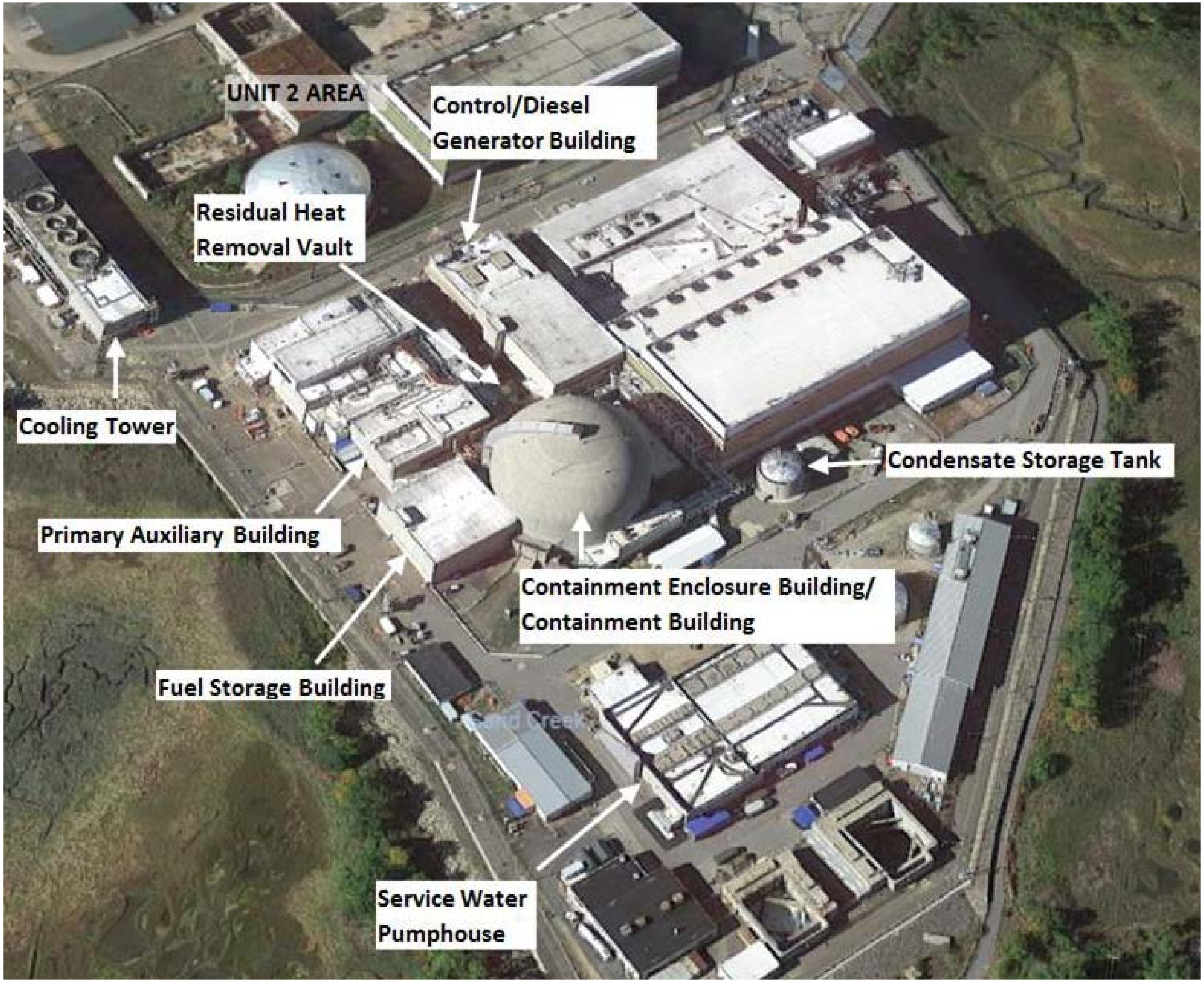
Seabrook Background: Plant Footprint



Seabrook Background: Plant Layout



Seabrook Background: Licensing Timeline

Construction Permit (CPPR-135)	July 1976
Zero Power Operating License (NPF-56)	October 1986
Low Power Operating License (NPF-67)	May 1989
Full Power Operating License (NPF-86)	March 15, 1990
Commercial Operation	August 1990
Operating License Transfer to FPL Energy (NextEra)	November 2002
Stretch Power Uprate (3587 MW)	February 2005
Zero Power Recapture (3.4 years)	December 2005
Measurement Uncertainty Uprate (3648MW)	May 2006
LR Application Submitted	May 25, 2010
Operating License Expires	March 15, 2030

Status of ASR Effort at Seabrook Station

Completed a comprehensive effort to:

- Conduct large-scale testing to understand the structural implications
- Develop methodology for evaluation of ASR-affected structures
- Evaluate Seismic Category I structures
- Develop monitoring strategies for ASR-affected concrete and associated SSCs

Demonstrated compliance

- Seismic Category 1 structures comply with proposed licensing basis in LAR
  - Modifications to several structures are underway

Actively tracking developments in ASR research

NextEra Energy Seabrook has implemented an effective program for evaluating and managing the impacts of ASR on affected concrete structures and associated SSCs

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Purpose of Presentation

Describe the comprehensive approach for addressing ASR at Seabrook Station

Provide an overview of the technical basis for the ASR management approach

- Large-Scale Testing
- Methodology for evaluating ASR-affected structures

Summarize implementation of the Structures Monitoring Program for aging management of ASR-affected structures

Presentation Outline

ASR Background

Approach for Addressing ASR

Technical Basis for ASR Management Approach

- Large-Scale Test Programs
- Structural Evaluation Methodology for ASR-Affected Structures

Implementation of ASR Management Approach

- Structures Monitoring Program
- Status of Relevant Licensing Actions
  - License Amendment Request (LAR)
  - License Renewal Application (LRA)

Conclusions and Closing

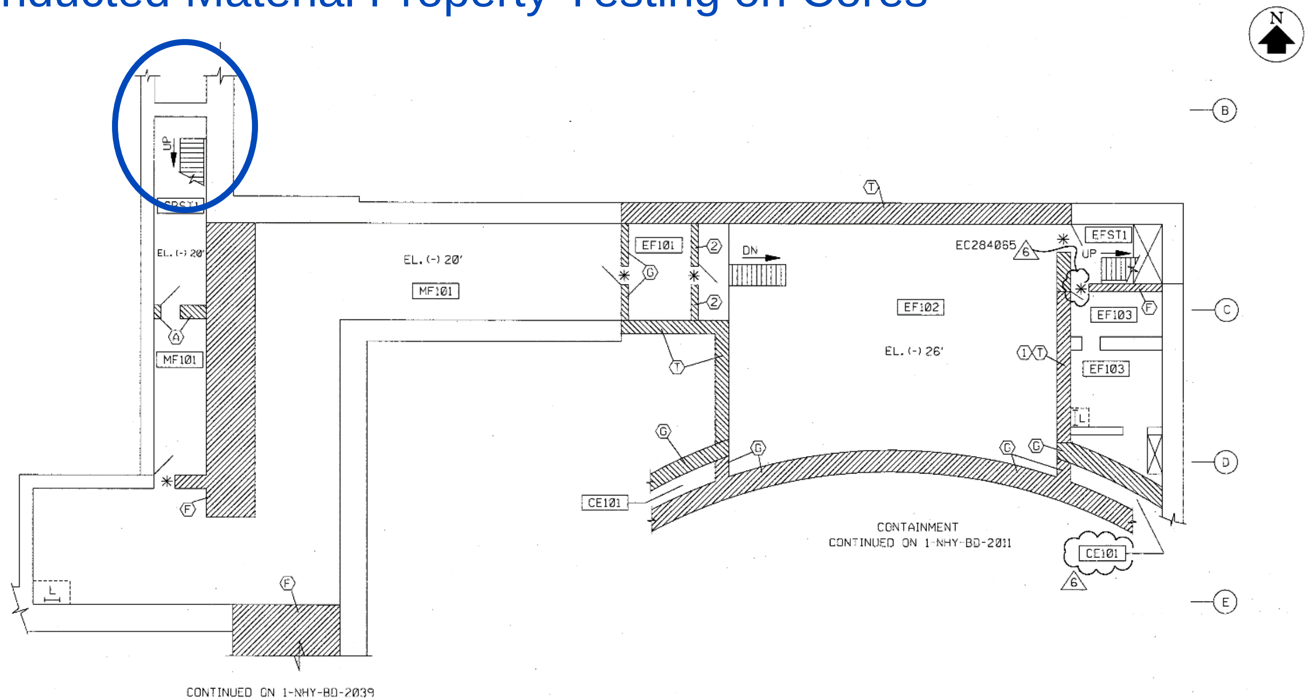
BACKGROUND OF ASR AT SEABROOK STATION

SEABROOK

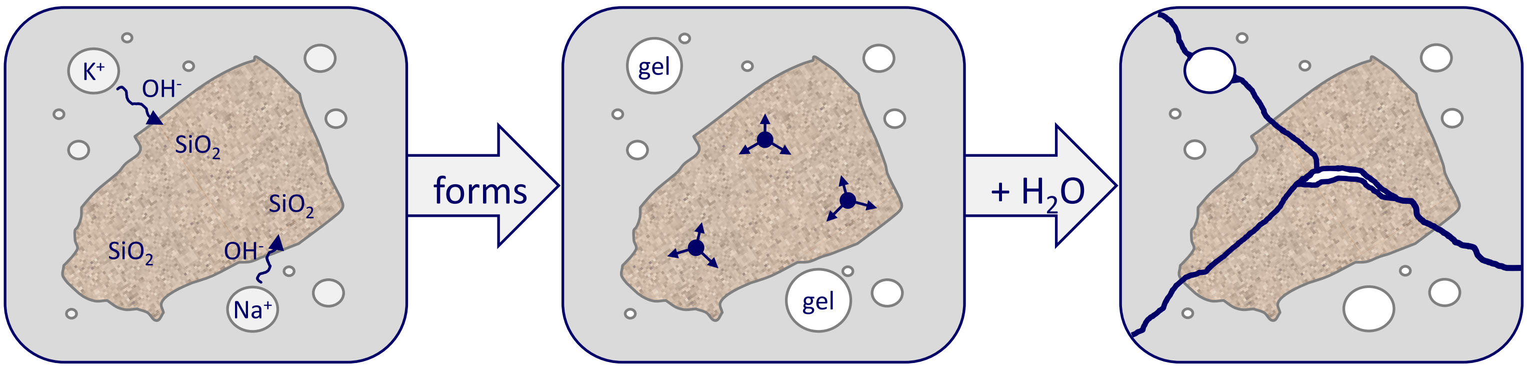
ASR Background: Discovery at Seabrook Station

Initial Diagnosis

- Identified Pattern Cracking in the B Electrical Tunnel
- Performed Petrography on Cores (Confirmed ASR)
- Conducted Material Property Testing on Cores



ASR Background: Alkali-Silica Reaction (ASR)



alkali cement + reactive aggregate

expansive gel

cracking of the aggregate and paste

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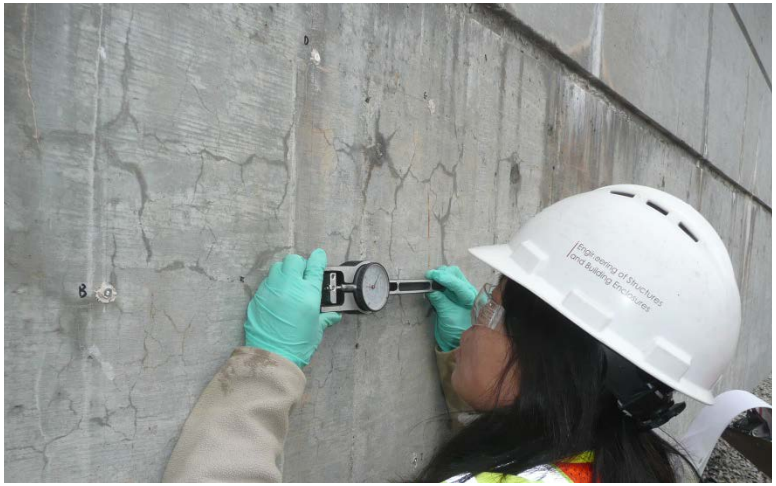
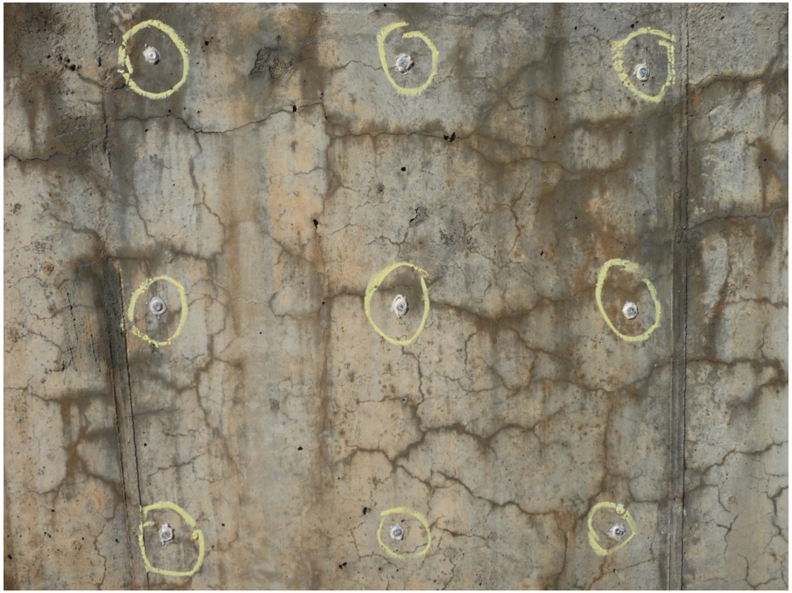
ASR in Country’s Infrastructure





Photos courtesy of SGH

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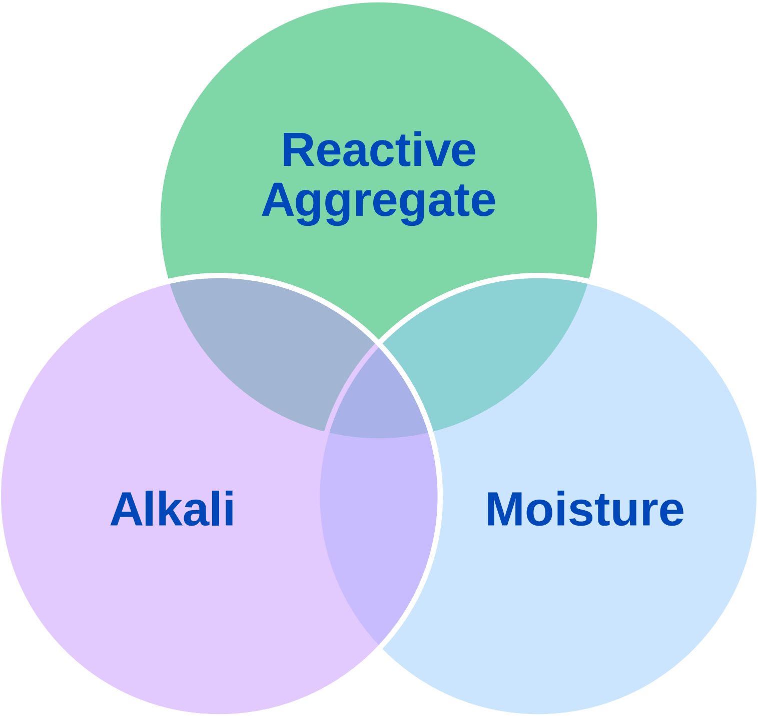
ASR Background: Causes of ASR

- **Preventive measures taken during plant construction to prevent the development of ASR**
  - Aggregate reactivity testing
  - Low alkali cement
- **Current state of knowledge**
  - Aggregate reactivity testing
    - ASTM test methods used during plant construction not reliable for slow reacting aggregates
  - Limiting alkali content of cement
    - Not sufficient by itself to prevent ASR

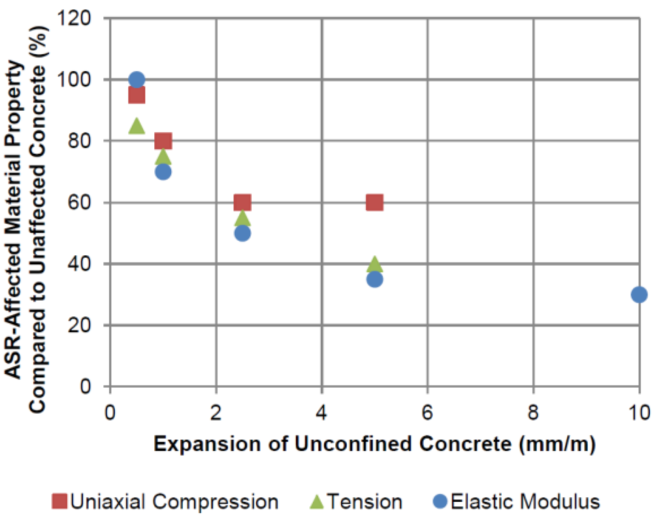


ASR Background: Visual Indications of ASR

ASR Background: Implications of ASR

Reduction in material properties and their effect on structural capacity

- Compressive strength
- Tensile strength
- Modulus of elasticity



Effect of ASR expansion on structural demands

- Structural deformation

Potential impact to plant systems and components

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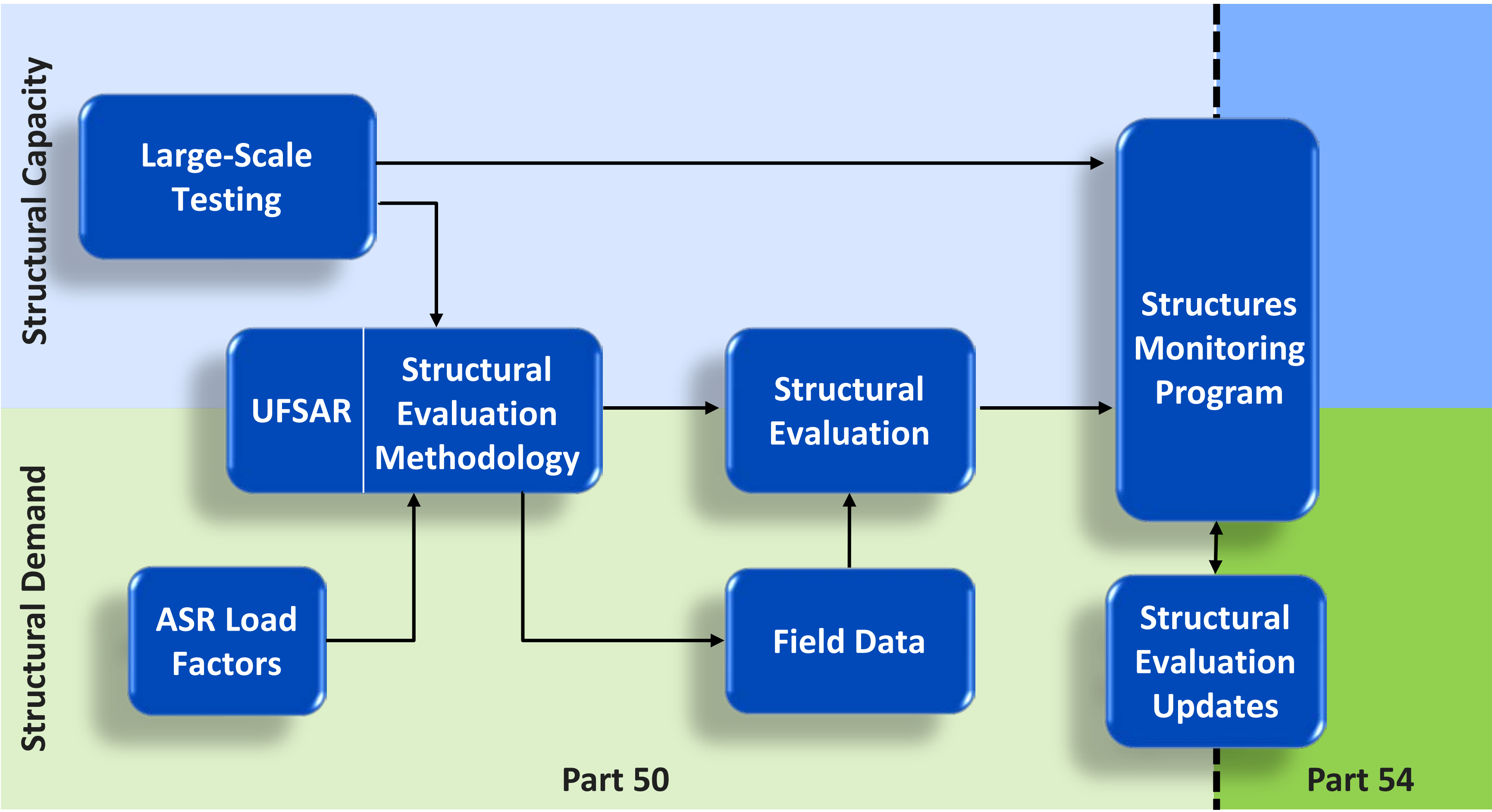
Approach for Addressing ASR at Seabrook Station



Conclusions

Large-Scale Test Programs

- No adverse impact of ASR on structural capacity within test limits
- Limits have been established for monitoring of plant structures

Evaluation Methodology

- Defined process that considers the impact of ASR on both structural capacity and structural demands

Structural Evaluations

- Demonstrate Seismic Category I structures comply with licensing basis

Structures Monitoring

- Comprehensive program addresses ASR expansion, building deformation and impact on systems/components

NextEra Energy Seabrook has implemented an effective program for evaluating and managing the impacts of ASR on affected concrete structures and associated SSCs

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Evaluation and Management of Alkali Silica Reaction (ASR) at Seabrook Station

Methodology for Structural Demand Evaluation of ASR-Affected Structures

October 31, 2018

Speakers:
Simpson Gumpertz & Heger Inc. (SGH)
- Dr. Said Bolourchi,
- Glenn Bell,
- Matthew Sherman

Supporting Personnel:
- Dr. Bruce Ellingwood

Structural Evaluation Methodology

- **Define a consistent and repeatable analysis and evaluation methodology for all Seismic Category I structures**
- **Apply the methodology to evaluate structures to show:**

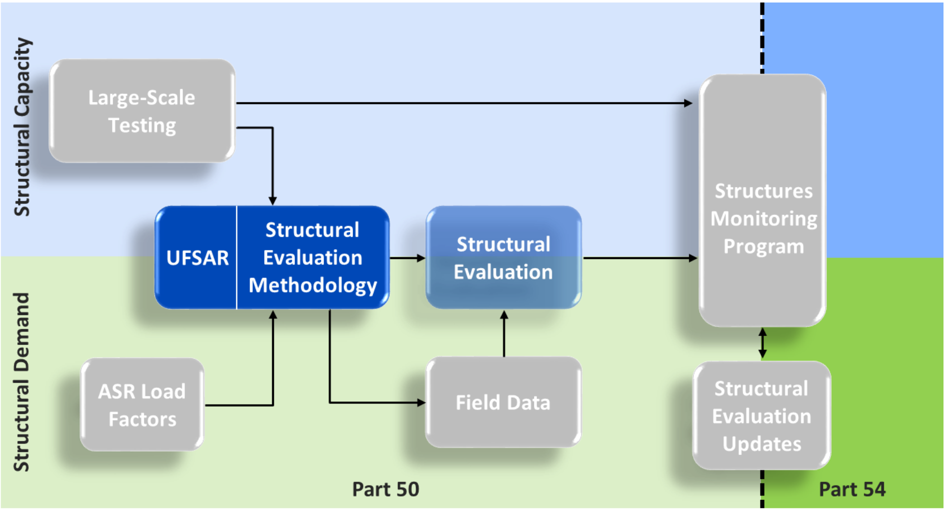
Structural Capacity

- No impact on Code capacity
- Change in stiffness relates to the prestressing effect

≥

Structural Demand

- Include ASR loads in UFSAR load combinations
- Field data for ASR status
- Modeling to account for ASR-induced prestressing



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Why does ASR Change the Demand?

- **If concrete is unrestrained, ASR causes expansion in the concrete, but no forces develop in the structure.**
- **If concrete is restrained, forces develop in the structure.**
- **This restraint can come from:**
  - Reinforcement
  - Other segments of the same structure
  - Adjacent structures
  - Surrounding bedrock
- **These forces must be considered, as they were not part of the original design basis defined in the UFSAR.**

ASR-affected structures must be evaluated

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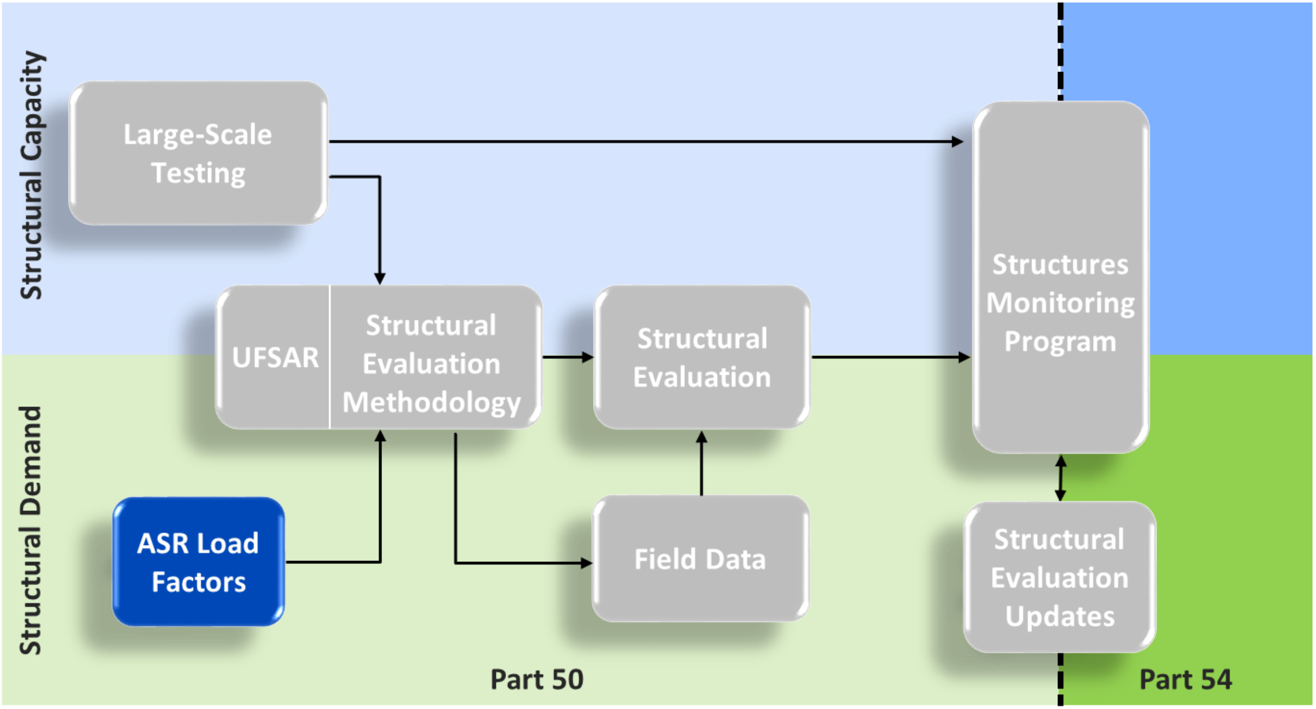
Structural Evaluation Methodology for ASR-Affected Structures Presentation Outline

- **Evaluation of all Seismic Category I structures at Seabrook is based on UFSAR and defined in the Methodology Document**
- **Structural Evaluation Methodology:**
  - ASR Loading and Load Factors
  - Methodology Document
- **Methodology Document provides details for collecting field data and evaluating all Seismic Category I structures at Seabrook Station**

ASR Load Factors

Supplement the original design load effects with ASR loads, while maintaining the level of structural performance implicit in the original design criteria and codes

- Determine the appropriate ASR load factors to supplement ASME Section III 1975 and ACI 318-71 load combinations

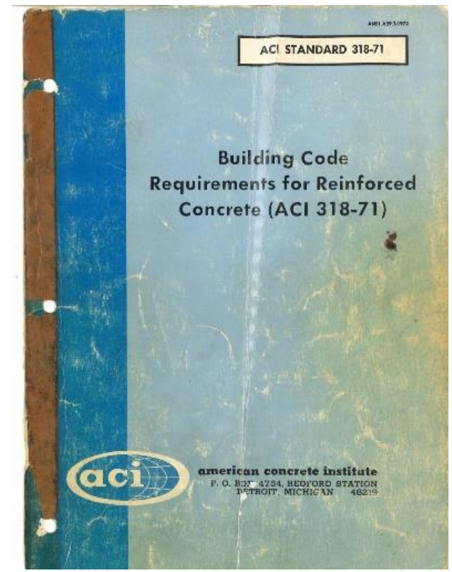


Load Factor Principles

Containment Building
ASME Section III 1975

Allowable Stress Design
Primary objective: Limit stresses in concrete and steel reinforcement.

All Category I Structures other than Containment Building
ACI 318-71



Strength Design
Primary objective: Assure adequate strength.

CONTAINMENT BUILDING ASME SECTION III 1975

Containment Building

ASME Section III 1975

- Service Load Conditions: Construction and normal plant operation conditions that act frequently. Concrete stresses well below compressive strength, steel stresses well below yield.

- Factored Load Conditions: Severe and extreme environmental and abnormal conditions that act infrequently. Permitted stresses higher than for Service Load Conditions but generally below concrete compression and steel yield strengths.

Containment Building

$$Capacity \geq Load\ Effects$$

$$F_a \geq \sum \boldsymbol{\alpha}_i S_i$$

S_i = Load Effects (Dead, Live, Earthquake, ASR, etc.)

$\boldsymbol{\alpha_i}$= Load Factors associated with each Load Effect

F_a = allowable stress = kF_{cr}

F_{cr} = *critical stress*

k = stress partial factor of safety

- Loads are deterministic: established by positing various scenarios.

- Most load factors = 1.0. Some 1.25 to 1.5 for severe environmental or abnormal condition load combinations.

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Containment Building

Develop ASR loads that have a very small likelihood of exceedance and use an ASR load factor of 1.0

- Consistent with the deterministic philosophy used in the development of ASME Table CC-3230-1

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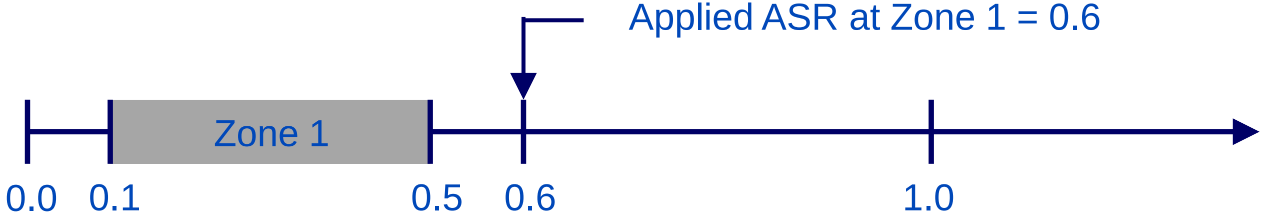
Containment Building

Zone 1	Zone 2	Zone 3	Zone 4
	No ASR in Zone 2	No ASR in Zone 3	No ASR in Zone 4
0.1 ≤ CI < 0.5 mm/m	0.5 ≤ CI < 1.0 mm/m	1.0 ≤ CI < 2.0 mm/m	CI ≥ 2.0 mm/m



Methodology

- Map the Containment Building into the four zones of ASR severity (Containment Building has only Zone 1 ASR)
- Apply to the entirety of each zone an ASR strain corresponding to the upper limit of CI in that zone and increase it by 25%
- Apply to this conservative ASR loading a load factor of 1.0

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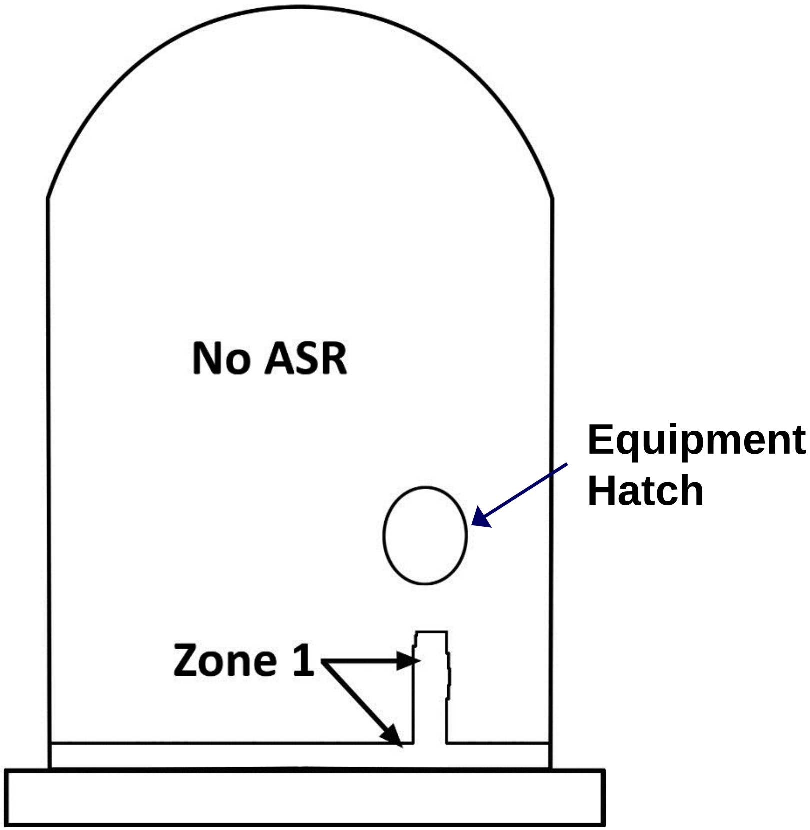
Containment Building

Schematic Illustration



Why this Approach is Conservative

- The highest level of strain in each zone is applied to the entire zone
- An additional 25% margin is added to that highest level of strain
- The Large Scale Testing Program demonstrated that, on average, CI measurements conservatively predict ASR strain
- The literature shows that ASR strains measured at the concrete surface over predict strains at reinforcement depth

For each load combination, a conservative value of ASR strain is applied for each ASR zone in combination with a load factor of 1.0.

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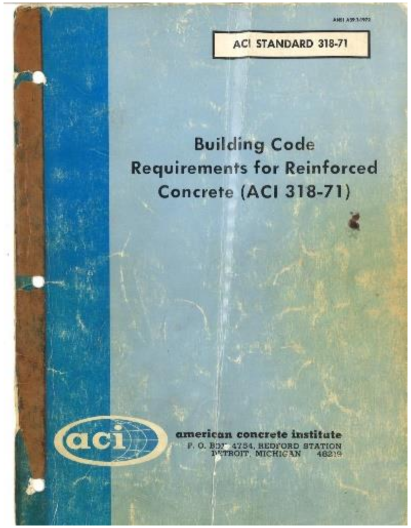
SEISMIC CATEGORY I STRUCTURES OTHER THAN CONTAINMENT BUILDING ACI 318-71

Category I Structures Other Than Containment Building

ACI 318-71



- Strength is checked via code equations that assess a reinforced concrete member's maximum achievable strength.
- Supplementary "serviceability" checks made under less extreme loading conditions.

Category I Structures Other Than Containment Building

$$Capacity \geq Load\ Effects$$

$$\phi R \geq \sum \boldsymbol{\alpha}_i S_i$$

S_i = Load Effects (Dead, Live, Earthquake, ASR, etc.)

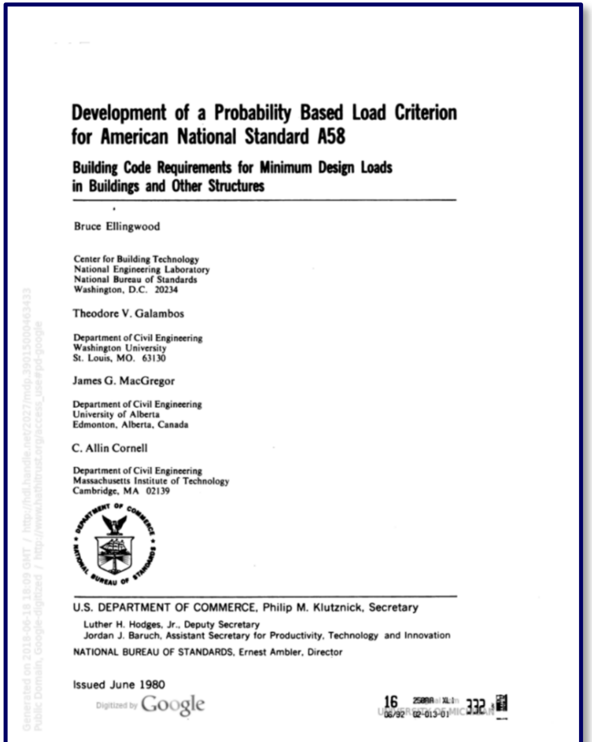
$\boldsymbol{\alpha_i}$= Load Factors associated with each Load Effect

R = nominal "strength" capacity

ϕ = strength reduction factor

Load factors for strength checks generally between 1.4 and 1.7, but in load combinations involving wind, seismic, and accident conditions they may be lower.

Load Factors of ACI 318-71



Development of a Probability Based Load Criterion for American National Standard A58

Building Code Requirements for Minimum Design Loads in Buildings and Other Structures

Bruce Ellingwood

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National Bureau of Standards
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NATIONAL BUREAU OF STANDARDS, Ernest Ambler, Director

Issued June 1980

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"The NBS Report"

- **Ellingwood et al. established the inherent reliability of ACI 318-71 for use in probability-based design**
- **Adopt the same probabilistic approach to establish ASR load factors for use with ACI 318-71**
- **Average reliability indices (β) found in NBS study are used as basis for calculation of ASR load factors:**
  - For gravity load combinations: 3.0
  - Load combinations with wind: 2.5
  - For load combinations including the Operating Basis Earthquake: 1.75

Approach for Application of ACI 318-71 to Category I Structures Other than the Containment Building

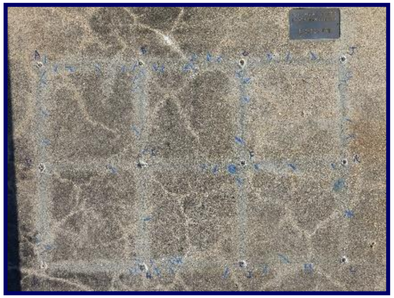
Zone 1

CI < 0.5 mm/m

Zone 2

0.5 ≤ CI < 1.0 mm/m

Zone 3



1.0 ≤ CI < 2.0 mm/m

Zone 4

CI ≥ 2.0 mm/m

- **For each zone determine ASR strains from CI statistics gathered over those zones in the entire plant**
- **Map the four ASR severity zones onto each structure**
- **Apply an ASR strain corresponding to the <u>mean value of CI</u> measured in each zone**
- **Apply a probabilistically determined load factor as described in the following slides**

Calculation of ASR Load Factors

Input Variable	How Addressed
Target reliability, β	Based on NBS Report for each load combination as previously described
Probability distribution of structural resistance	Based on NBS Report
Probability distribution of non-ASR load effects	Based on NBS Report
Probability distribution of ASR load effects	From statistics of CI measurements taken at the plant
Ratio of ASR load effects to total load effects, K_{asr}	Representative values calculated for each ASR zone

Calculation that finds the ASR load factor that results in the target reliability for each type of load combination

ASR Load Factors for Use with ACI 318-71

Load Combination	ASR Load Factor	
	Zone 1	Zones 2-4
Static	2.00	1.60
Wind	1.70	1.36
OBE	1.30	1.04

Notes:

- Per ACI 318-71, for load combinations involving differential settlement, creep, shrinkage, or temperature change, load factors may be reduced by 25% but may not be less than 1.0.
- For “unusual” load combinations involving SSE and tornado, ASR load factor is 1.0.

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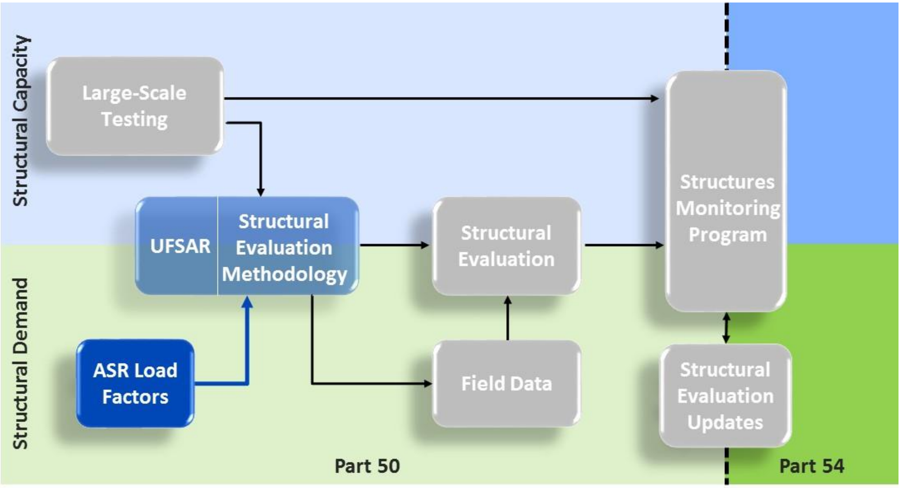
Key Conclusions Regarding ASR Load Factors

ASR load factors were developed to:

- Be added to UFSAR design load combinations
- Be consistent with the underlying philosophy of the original design criteria and codes



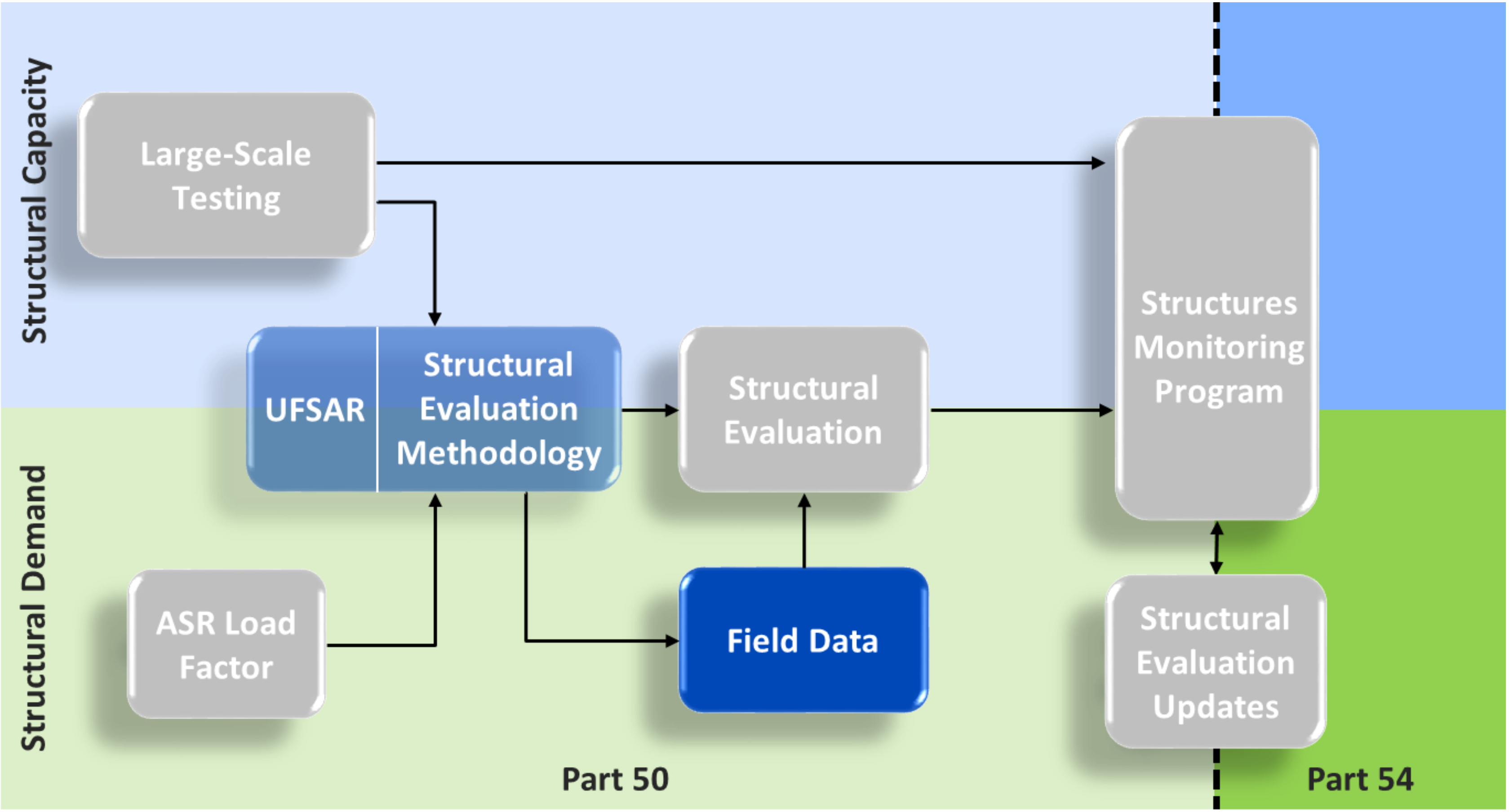
ASR load factors maintain the level of reliability and margin of safety inherent in the codes of record.

Independent Review by Dr. Bruce Ellingwood

- For the **Containment Building** the methods employed for revising the load combinations to account for the structural actions due to ASR are entirely consistent with the deterministic approach to safety assurance historically taken in developing the ASME Code.

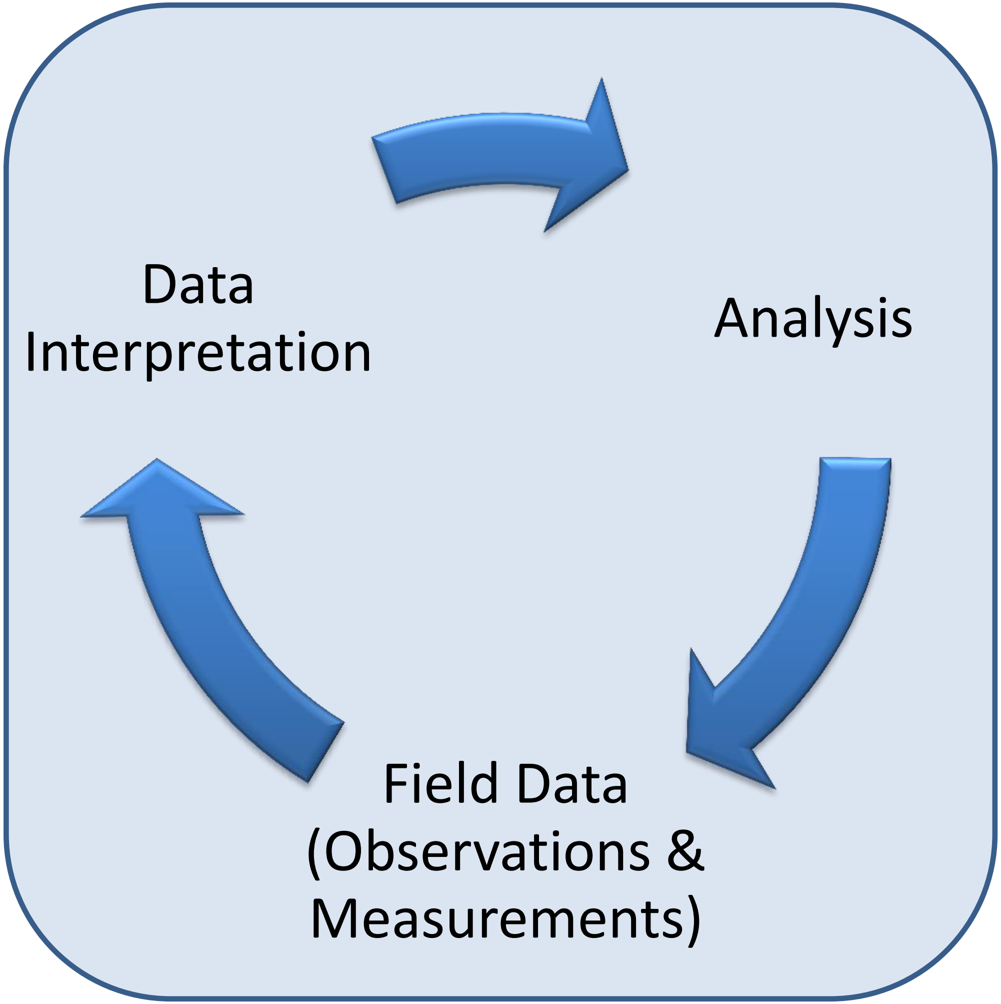
- For those **Category I structures other than the Containment Building**, the proposed modifications to the original design load combinations to account for the structural actions due to ASR will maintain the target reliability indices provided by the load combinations of ACI 318-71.
  - This conclusion is based, in part, on independent calculation checks of reliability indices.

Field Data



Structural Capacity
Structural Demand
Large-Scale Testing
UFSAR
Structural Evaluation Methodology
Structural Evaluation
Structures Monitoring Program
ASR Load Factor
Field Data
Structural Evaluation Updates
Part 50
Part 54

Use of Field Data



Field Data Overview

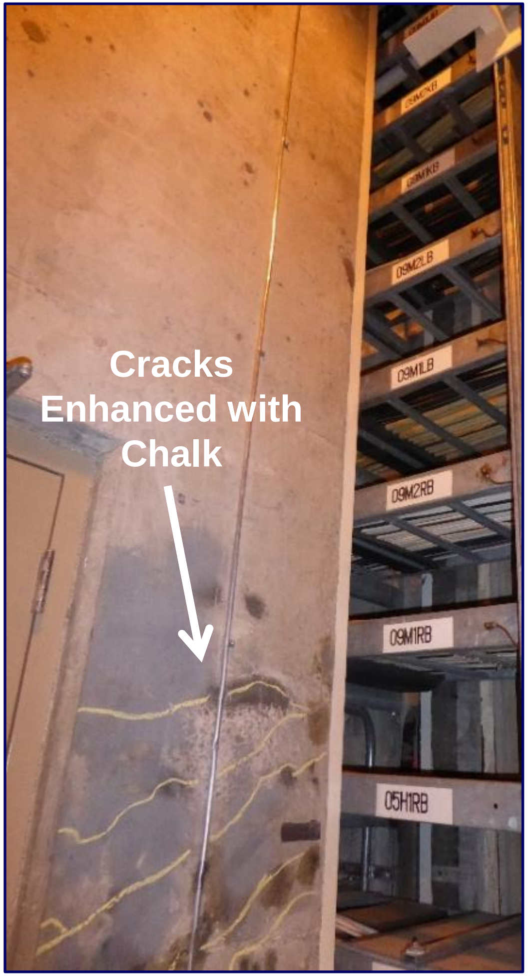
Observations: Non-quantifiable information and guidance

Measurements: Quantifiable information and data used directly in analysis

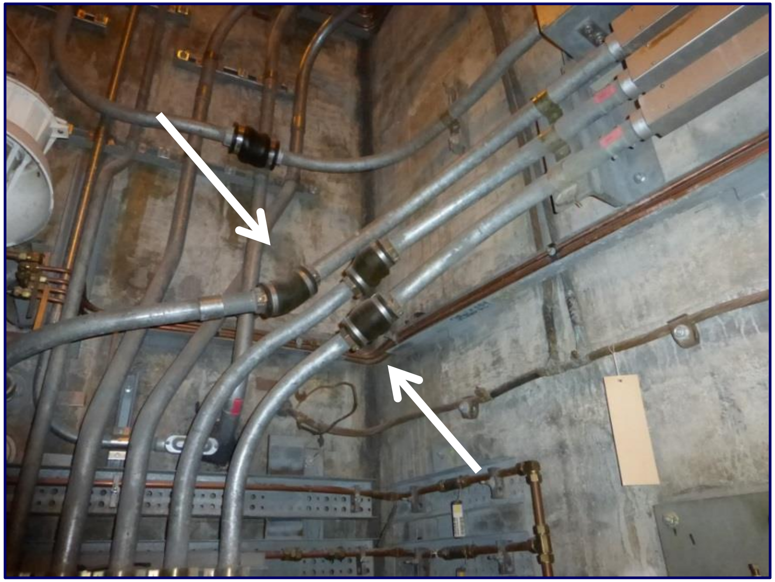
Specialty Testing: Supporting or interpretive information and data

OBSERVATIONS

Field Data – Observations: Visual, Sounding



Field Data – Observations:
Crack Patterns and Relative Movement



Movement of Flex Joint/Connector

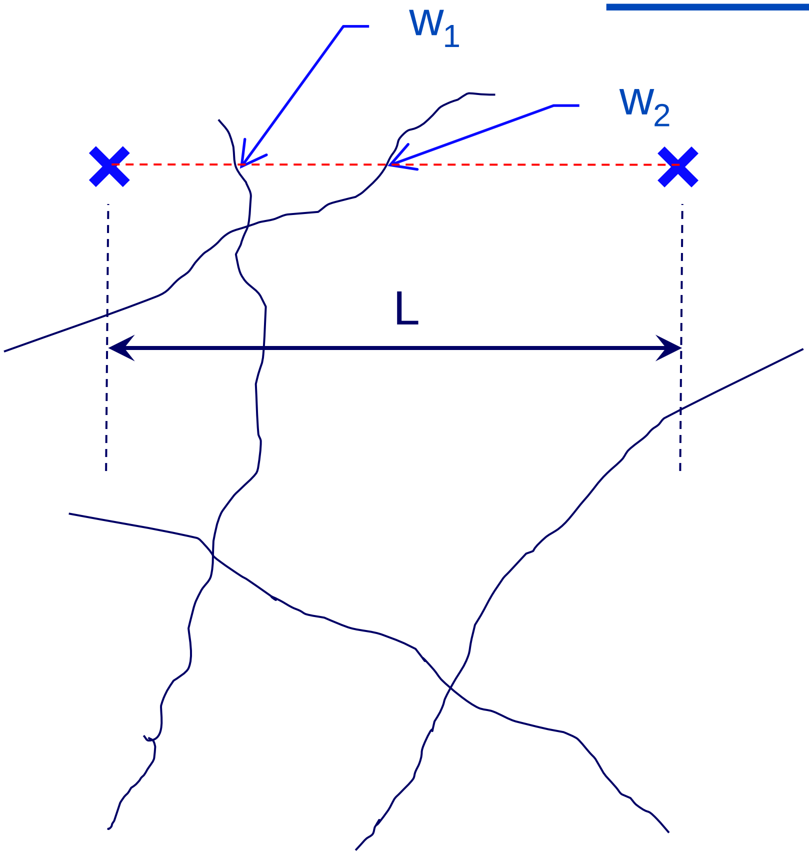
EXPANSION MEASUREMENTS

Field Data – Expansion Measurements: Cracking Index

Cracking Index (CI) and Combined Cracking Index (CCI)

- **Optical measurement**
- **Provides indication of ASR expansion-to-date**

Field Data – Expansion Measurements: Cracking Index

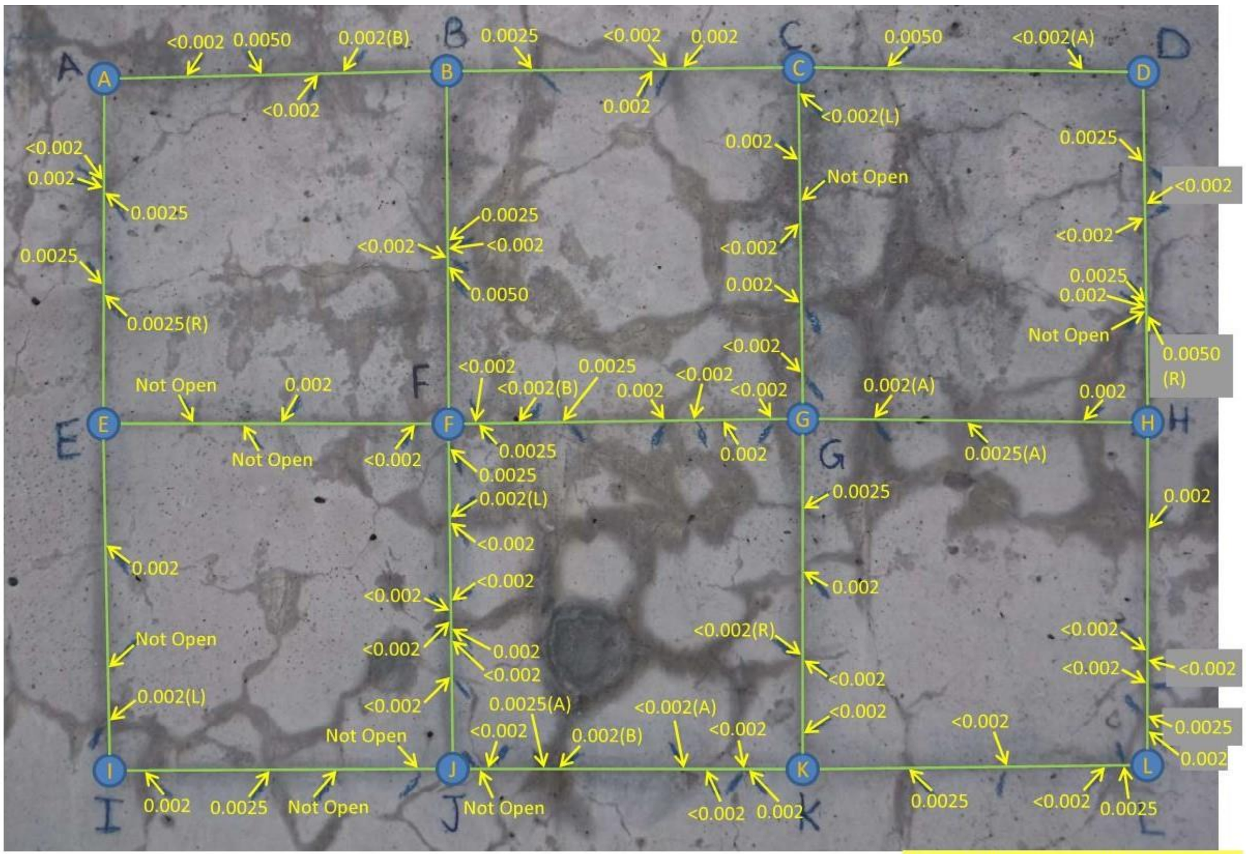


- Lay out measurement line
- Measure crack widths where they cross the line
- Add together measured widths
- Divide by total length

$$\boxed{= \frac{w_1 + w_2}{L}}$$

Field Data – Expansion Measurements: Cracking Index example

Area with suspect ASR cracking



Note 1: All measurements are in inches.

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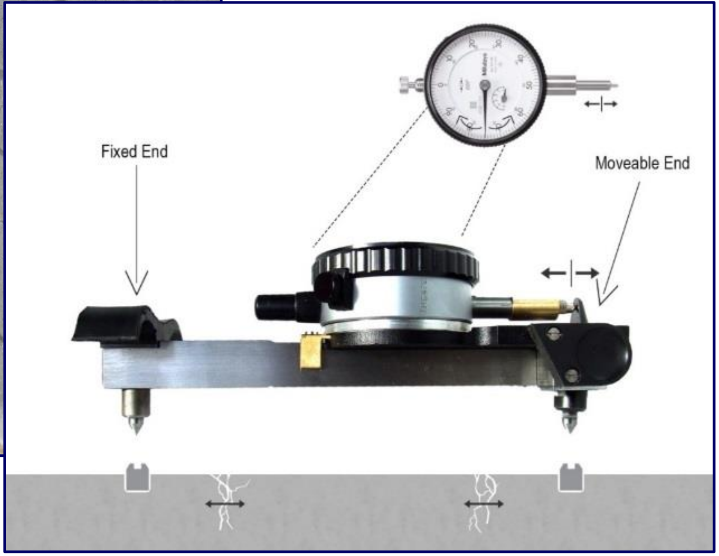
Field Data – Expansion Measurements: In-Plane Expansion

In-plane "pin-to-pin" expansion

- Higher-precision mechanical measurement
- Used in monitoring program for measuring ongoing changes



Field Data – Expansion Measurements: Through-Thickness Expansion

- Used in monitoring program for confirmation that the structure and associated analyses remain within the bounds of the FSEL testing.

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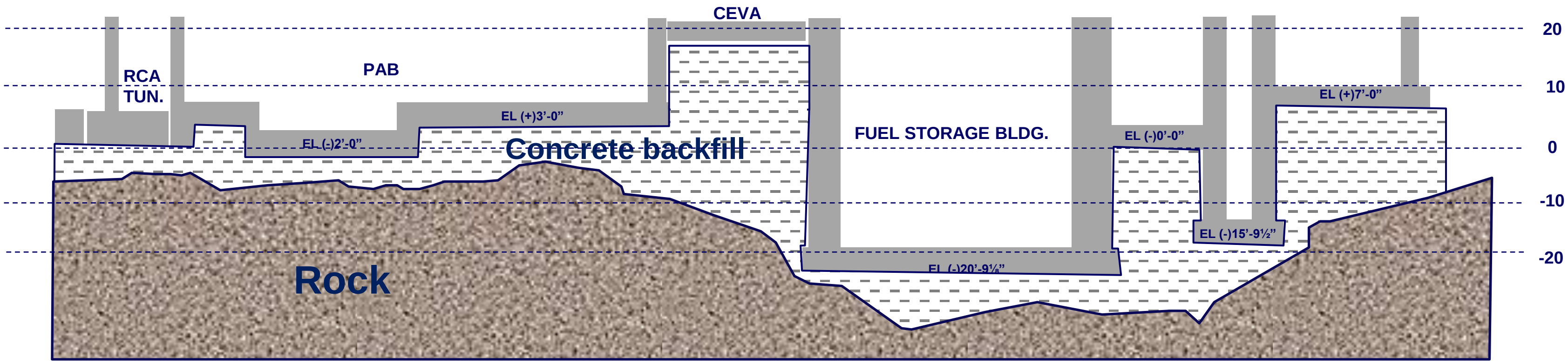
DEFORMATION MEASUREMENTS

Concrete Backfill



Section Cut View

- The station was built into the excavated bedrock.
- Construction used concrete as backfill between the final structure and the excavation face.
- Backfill concrete is of the same type and composition as the structural concrete.

Field Data – Deformation Measurements

- **Plumbness measurements – Wall structure**

- **Levelness measurements – Slab structure**

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Field Data – Deformation Measurements (cont'd)

- Seal/gap width measurements
- Annulus width measurements

SPECIALTY TESTING

Field Data – Specialty Testing: Petrography

- **To investigate if in-plane expansion is caused by mechanisms other than internal ASR expansion**

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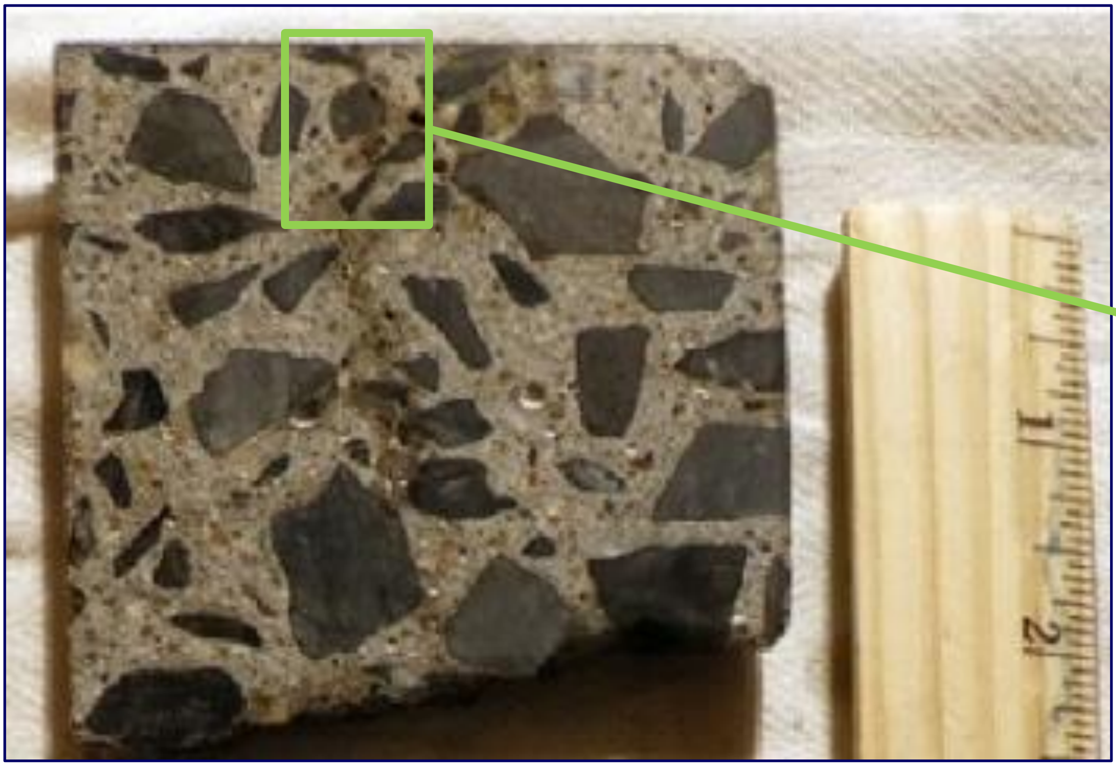
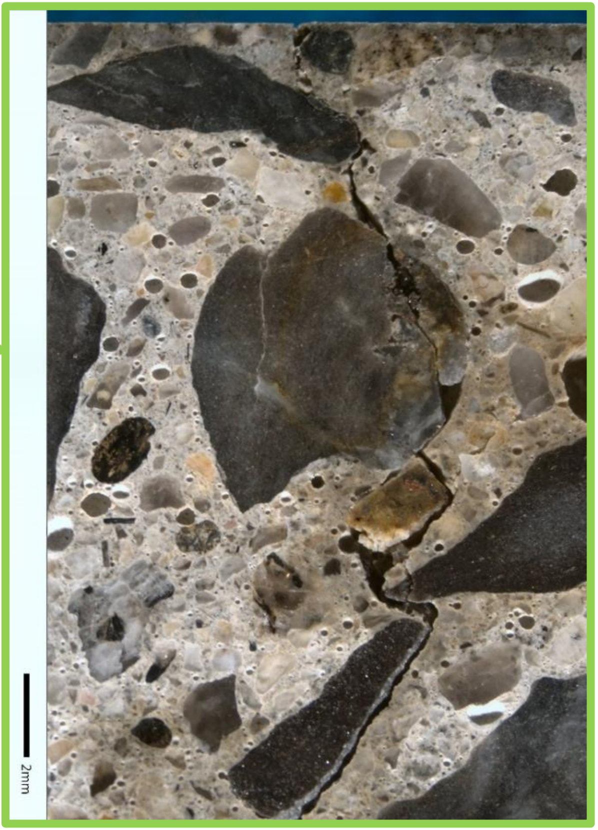
Field Data – Specialty Testing: Petrography

- **Petrography to determine expansion mechanisms**

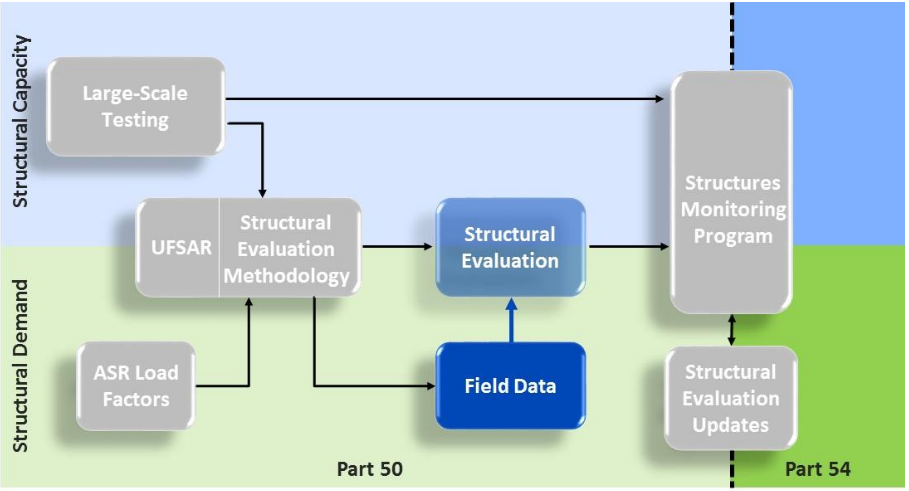




Key Conclusions Regarding Field Data

Field Data provide:

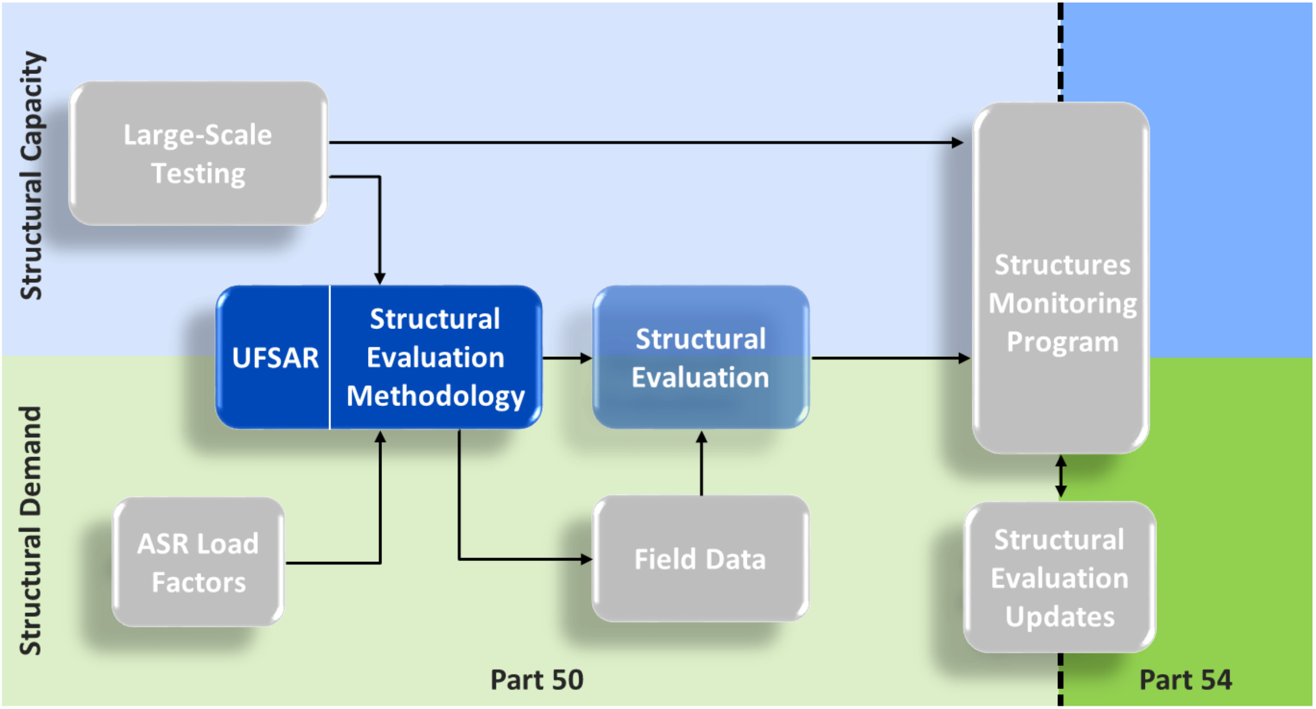
- Input data, feedback, and correlation to support modeling
- Reference values for future monitoring in Structural Monitoring Program



Field data support evaluation and future monitoring.

Structural Evaluation Methodology

- Define a consistent and repeatable analysis and evaluation methodology for all Seismic Category I structures
- Establish threshold limits for potential future ASR expansion



ASR Structural Evaluation Process

UFSAR
(As Amended by the License Amendment Request)

- Load combinations and load factors
- Material properties
- Graded analysis approach
- Codes supplements

Methodology Document

Analysis Approach

- Repeatable analyses process
- Graded approach field data

Threshold Limits

- Design margin for future ASR expansion

Structural Evaluation

- Structural Capacity ≥ Structural Demands

Structures Monitoring Program

- Parameters monitored and frequency
- Trending
- Action if approaching threshold limits

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Threshold Definition

- **The threshold limit, $(k_{th}S_a)$, is additional margin to accommodate demands associated with future ASR growth.**

$$\underbrace{\phi R}_{\text{Capacity}} \geq \underbrace{\sum \alpha_i S_i}_{\text{Sum of factored design-basis loads}} + \underbrace{\alpha_a (k_{th} S_a)}_{\text{Factored ASR load}}$$

Where:

R = Nominal strength

ϕ = Capacity reduction factor

S_i = Original design load (Dead, Live, Earthquake, etc.)

S_a = ASR Load

α_i = Load Factors associated with each of original design load

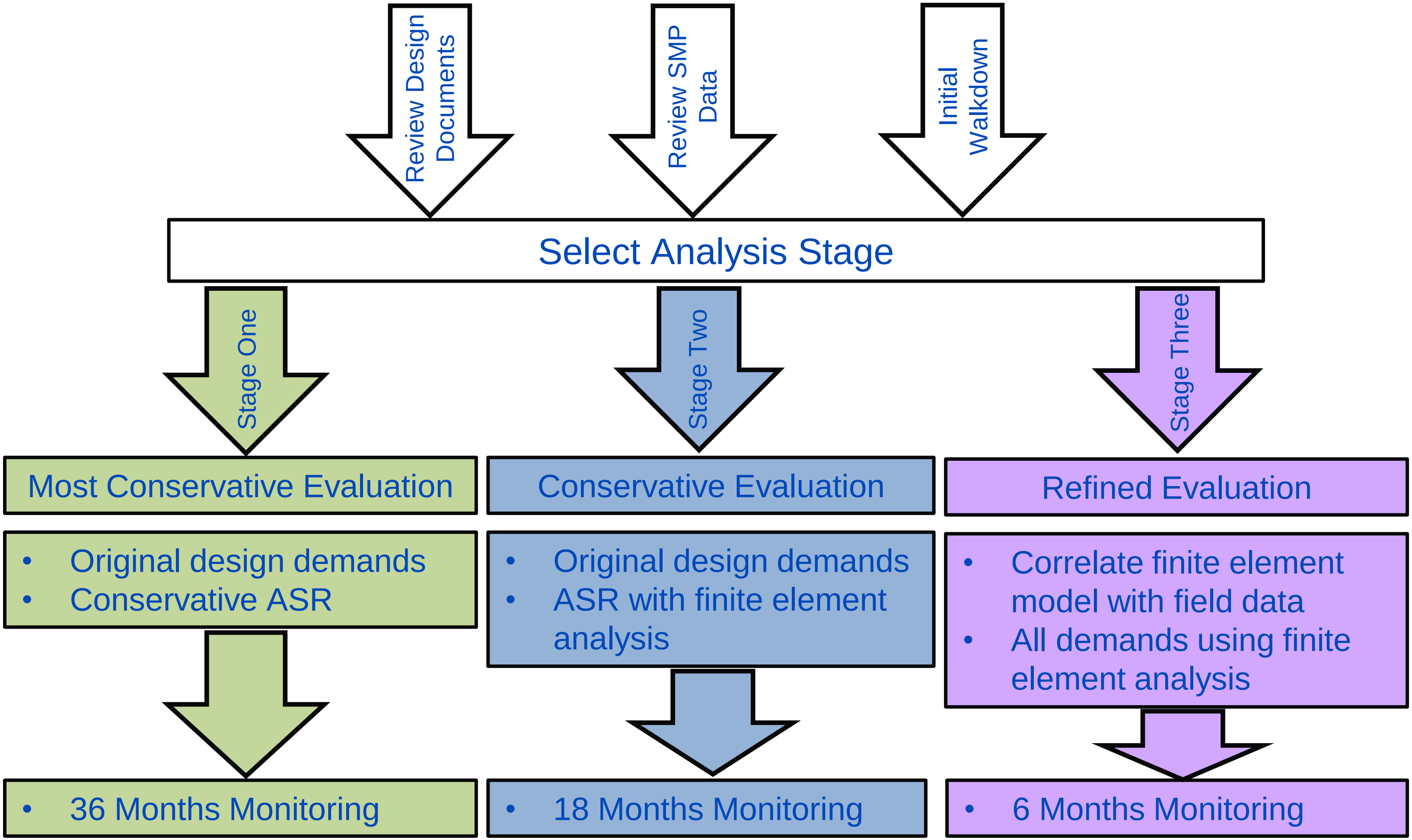
α_a = Load Factor associated with ASR load

$\boldsymbol{k_{th}}$ = Threshold Factor

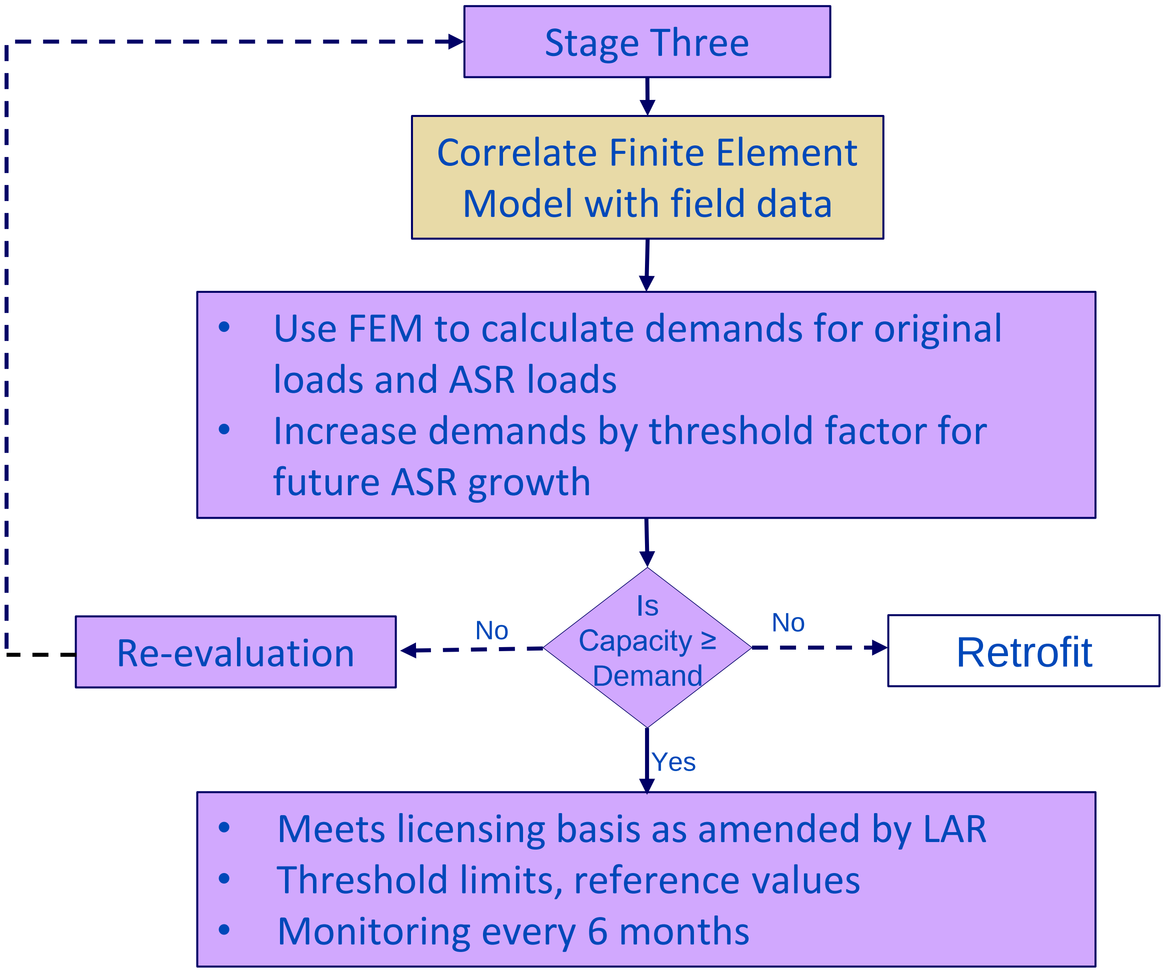
Field Data

- **Walkdown observations**
- **Graded approach for field data collection**
- **Typical Field Data include**
  - In-plane strain: CI, CCI, and Pin-to-pin
  - Changes in seismic isolation gaps
  - Structural deformation
  - Structural distress
  - Crack width
- **Adjusted in-plain strain for**:
  - Cracks not indicative of ASR which could be due to: pressurization, temperature, differential ASR between regions, structural deformation, other design loads.
  - Petrography confirmation

Graded Analysis Approach

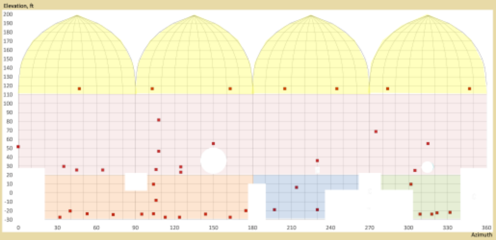


Stage Three Analysis



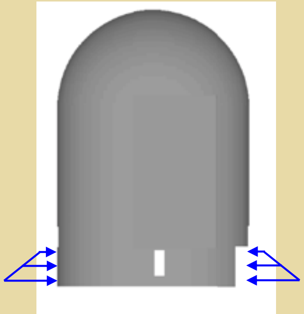
Correlating Analysis Model to Field Observation
Containment Enclosure Building

Analysis Input:



ASR CI Measurements, CEB

+



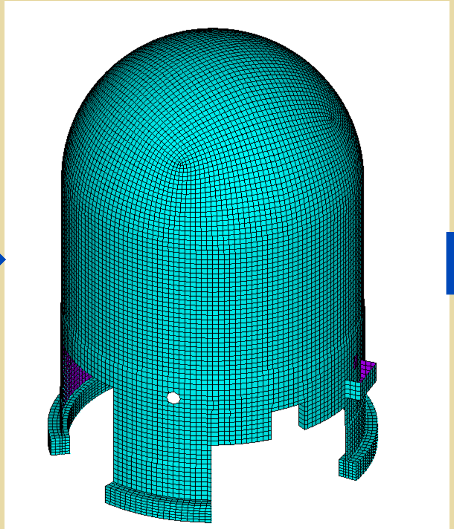
Concrete backfill pressure due to ASR expansion

+

Other sustained loads

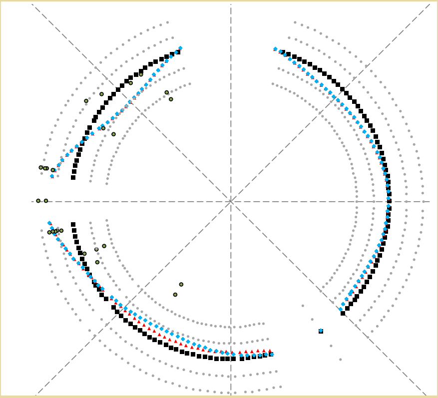
Analysis Method:

- Finite Element Analysis

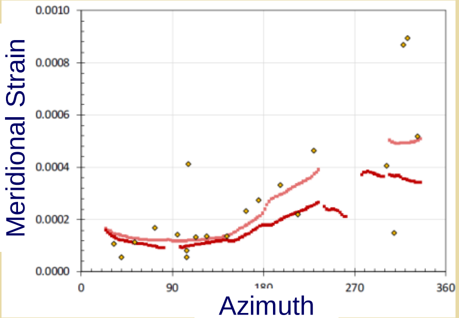


Analysis Output:

- Correlate to field data



Compare deformation



Compare strain

Key Attributes of Modeling

- **General purpose finite element analysis software ANSYS is used for modeling structures.**
- **Internal ASR effects on reinforced concrete structures are simulated:**
  - Prestressing effects are captured by applying CI measured strain to concrete portion of reinforced concrete elements.
- **Concrete backfill expansions are captured by vertical and lateral pressures applied to structure.**
- **Effects of structural cracking are captured by reducing member section properties.**

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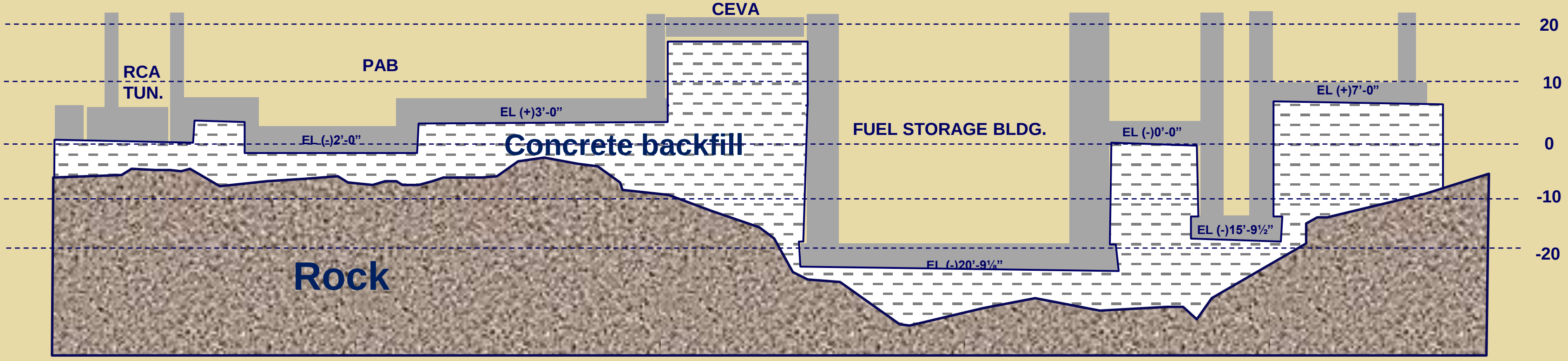
Concrete Backfill Simulation

The impacts of ASR expansion of concrete backfill are back-calculated by correlating structural responses to field data.

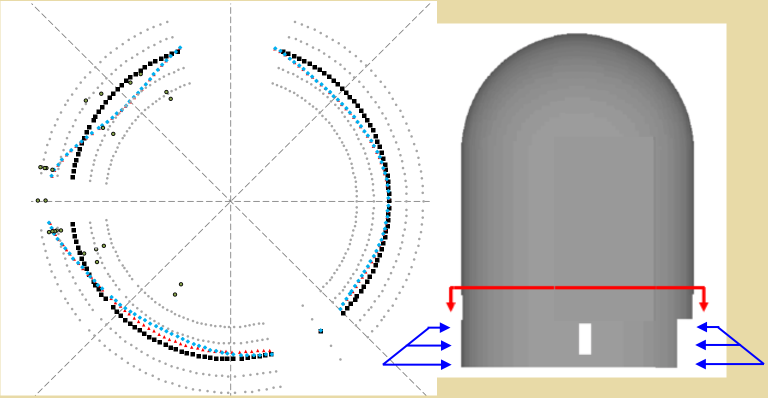
- **Direct concrete backfill testing and strain measurements are not feasible because of inaccessibility.**



Section Cut View

Concrete Backfill Lateral Pressure

- Set lateral pressure equal to overburden pressure
- Reduce lateral pressure to simulate overall deformations



- Reduce lateral pressure to simulate flexural crack initiation when structural cracks are not observed

LAR Code Supplements

- **Acceptance criteria remain as original Code of Record (ASME Section III 1975; ACI 318-71) as supplemented by the LAR**

Supplements	Supplemented Document
1 – Add the ASR load and load factors to UFSAR load combinations	UFSAR & ACI 318-71 ASME Section III 1975
2 – Code-defined strengths not impacted for members affected by ASR expansion	ACI 318-71 ASME Section III 1975
3 – Analyze shear-friction capacity per ACI 318-83, Section 11.7	ACI 318-71
4 – Reduce section property to 50% of gross section property to account for flexural cracking	ACI 318-71
5 – Reduce axial and shear stiffness to account for cracking	ACI 318-71

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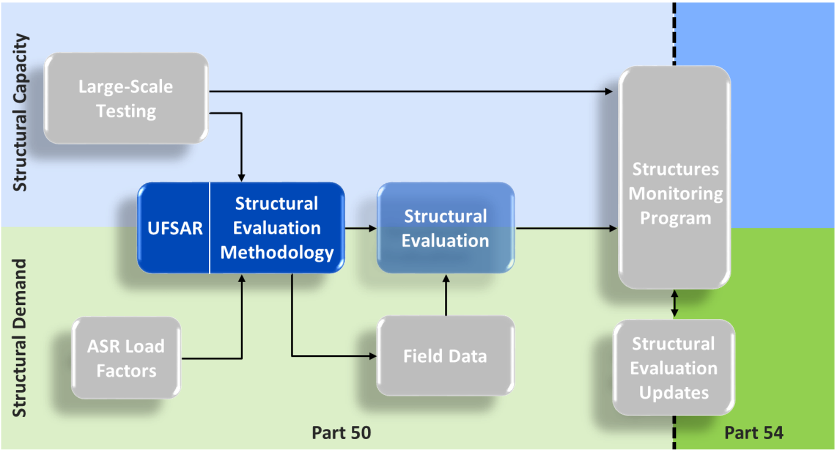
Threshold Parameters

- **Structure specific threshold parameters are selected for structural monitoring program**
- **Selected threshold parameters can be quantitative and qualitative parameters**
- **Structure specific threshold parameters are a subset of parameters defined in Methodology Document including:**
  - In-plane expansion
  - Through-thickness expansion
  - Seismic joint width
  - Structural deformation
  - Crack lengths and widths

Key Conclusions of Structural Evaluation Methodology

Structural Evaluation Methodology provides:

- ASR load factors that maintain the level of reliability inherent in the codes of record
- Repeatable graded approach for analysis and evaluation process
- Threshold factor, parameters, and monitoring frequency



Repeatable analysis and evaluation process applicable for all Seismic Category I structures at Seabrook

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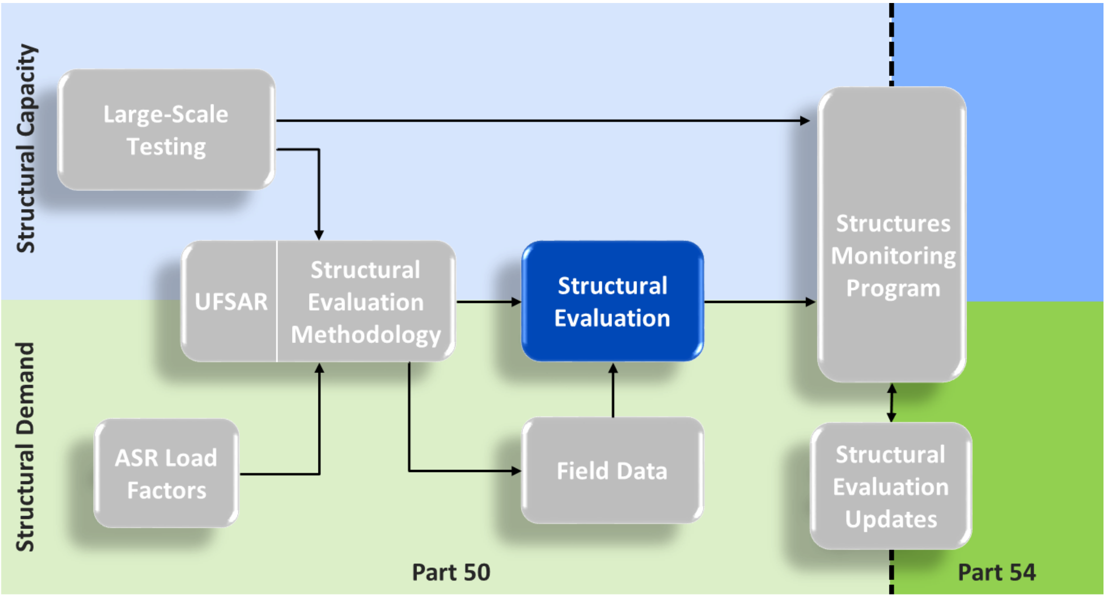
Structural Evaluation

- Evaluate each structure using the Structural Evaluation Methodology
- Establish ASR threshold limits, parameters, baseline values, and frequency of monitoring for each structure

Structural Capacity ≥ Structural Demand



Evaluations of Seismic Category I Structures

- **All Seismic Category I structures are evaluated:**
  - Confirm structure meets Code of record.
  - Determine Threshold Factor for each structure, which is the margin available to accommodate future ASR expansion.
  - Define parameters, reference values, and limits to be monitored, and monitoring frequency.
  - Identify structural areas that may require enhanced monitoring or retrofits.
- **Evaluation status:**

Status of Evaluation Packages	Number of Evaluation Packages	Analysis Stage			Threshold Factor
		One	Two	Three	
Completed	19	7	6	6	1.2 – 3.7
In progress	8	1	4	3	TBD

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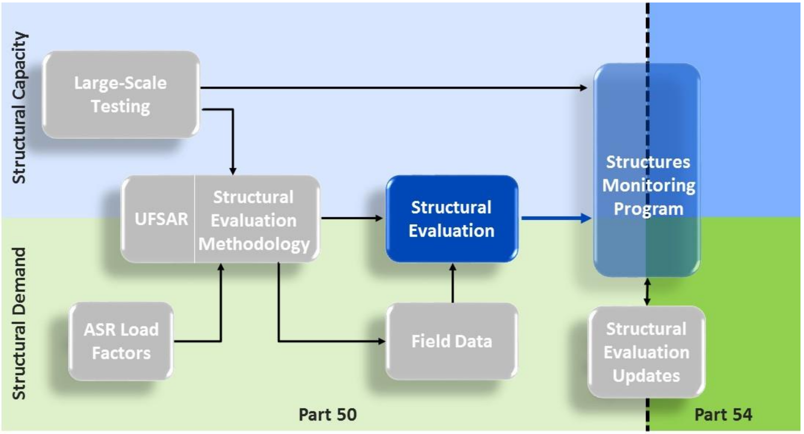
Key Conclusions of Structural Evaluation

Seismic Category I structures are evaluated to meet acceptance requirements of UFSAR and the Structural Evaluation Methodology

- **Provided ASR threshold factor, parameters, reference values, and monitoring frequency.**
- **Defined action required for structural members.**



Seabrook Seismic Category I Structures are evaluated to meet the UFSAR and Structural Evaluation Methodology requirements.

Evaluation and Management of Alkali Silica Reaction (ASR) at Seabrook Station

Implementation of ASR Management Approach at Seabrook Station

October 31, 2018

Speakers:

Jaclyn Hulbert, NEE Seabrook Engineer – Structures Monitoring Program
Edward Carley, NEE Seabrook Engineering Supervisor
Michael Collins, NEE Seabrook Director of Engineering
Kenneth Browne, NEE Seabrook Licensing Manager

Current Status at Seabrook Station
Presentation Outline

Structures Monitoring Program

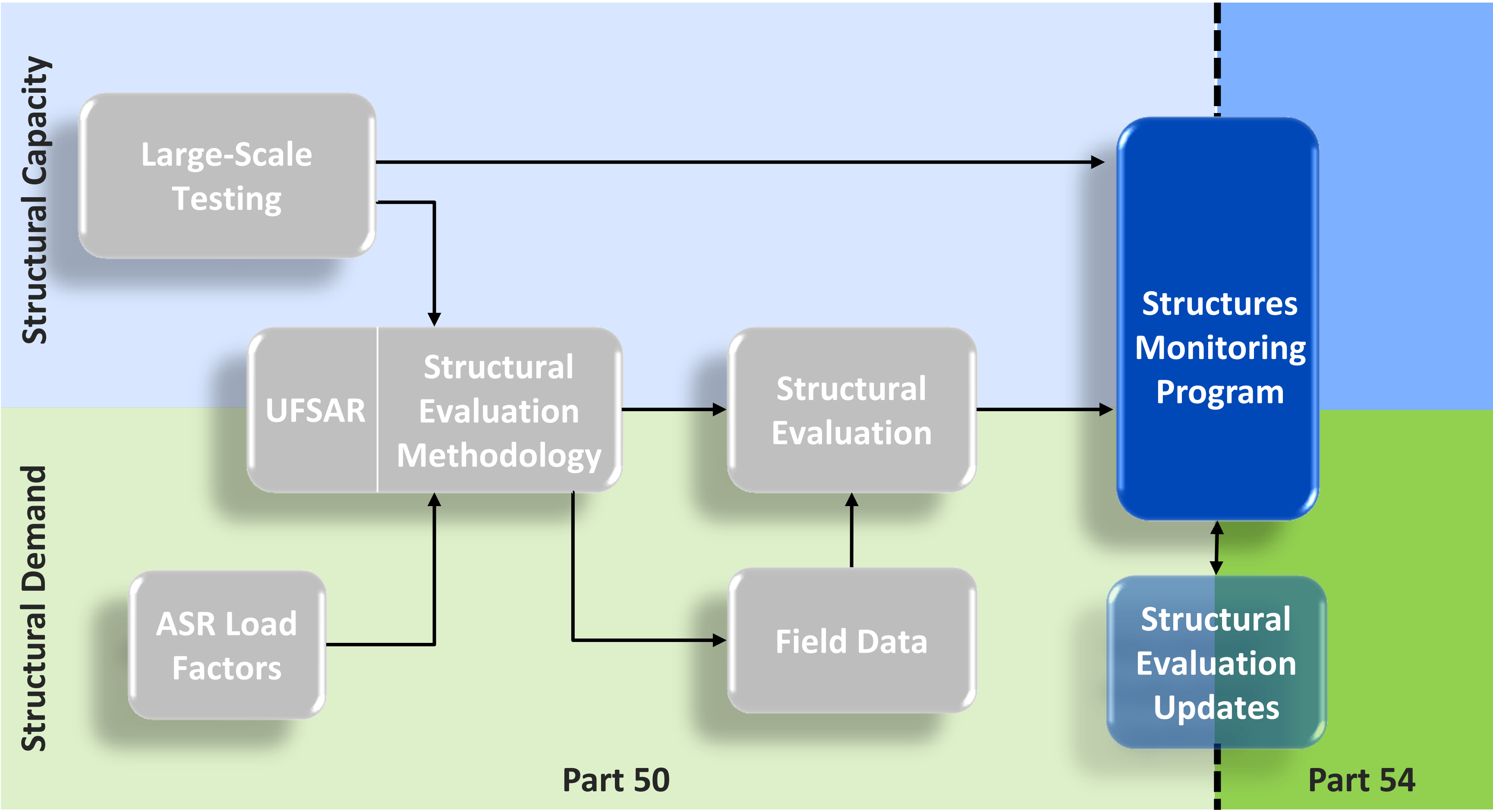
- **Monitoring Efforts**
  - Monitoring Parameters and Acceptance Criteria
  - Monitoring Locations
- **ASR Progression and Expansion at Seabrook Station**
  - Current Level of ASR Progression

Status of Relevant Licensing Actions

- **License Amendment Request (LAR)**
- **License Renewal Application (LRA)**

STRUCTURES MONITORING PROGRAM

Structures Monitoring Program



Structures Monitoring Program Overview

- **Comprehensive Structures Monitoring Program that incorporates identification, evaluation, and monitoring of ASR-affected structures and associated SSCs**
  - "Structures Monitoring" Maintenance Rule 10CFR50.65
  - ASR Monitoring
  - Building Deformation Monitoring
  - Equipment Impacted by Structural Deformation Monitoring

- **Training program to increase awareness of ASR expansion and ASR-induced building deformation at Seabrook Station**
  - Web-based training for all personnel badged at Seabrook
  - Focused training for departments that are inside plant structures on a frequent basis

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SEABROOK STATION

CLOSE APP

STRUCTURES MONITORING PROGRAM DATABASE

Is there a way to open the SMP Program and procedures?

Rev: 5/18/2018

SMP 2.1
Structures Monitoring Walkdowns, Data Collection, and Evaluation

STRUCTURES MONITORING

Structures Monitoring Deficiency Reporting Data

View/Edit Program Records

- Enter SMP Deficiency Initial Discovery
- Enter SMP Deficiency Engineering Evaluation
- Enter SMP Deficiency Follow-Up Inspection

STRUCTURES MONITORING Reports

- SMP/PEG-98 Deficiencies by Bldg and Room
- SMP AR/WR Status
- SMP WR Status Report
- SMP WR Status by Bldg
- SMP WR Status to *.xls
- SMP WR Status by Deficiency (Incl Follow-Ups)
- SMP Deficiency Evals Pending
- Open Un-Entered Data Report

SMP 3.1
ASR Monitoring Walkdowns, Data Collection, and Evaluation

ASR MONITORING

ASR Monitoring Results by Monitoring Location

View/Edit Program Records

- Enter Extensometer Measurements
- Enter Cracking Index Measurements
- Enter Pin-to-Pin Expansion Measurements

ASR MONITORING Reports

- ASR Extensometer Data
- ASR CI Data Entered by FP
- ASR Exp Data Entered by FP

SMP 4.1
Building Deformation Monitoring Walkdowns, Data Collection and Evaluation

BUILDING DEFORMATION

Building Deformation Monitoring Results by Building

View/Edit Program Records

- Enter Seismic Gap / Annulus Width Data
- Enter CCI Data
- Enter Crack Gauge Data
- Enter Invar Wire Data
- Enter RH Probe Data
- Enter FSB Laser Data

BLDG DEF MONITORING Reports

- Crack Gage Data
- Crack Gage Data by Date
- Bldg Def Data Entered by FP
- Bldg Def Data Summary

SMP 5.1
Equipment Impacted by Structural Deformation Monitoring Walkdowns, Data Collection, and Evaluation

EQUIPMENT DEFICIENCIES

Equipment Deficiency Walkdown Findings by Room

View/Edit Program Records

- Enter Baseline/Periodic Walkdown Results
- Enter Follow-Up Item Walkdown Results

EQUIP DEFICIENCIES Reports

- Walkdown Results by Room
- Equip Def AR/WR Status
- W/D WR Status Report
- Conduit Flex Connections
- Conduit FlexAR Status
- SMP Flex Status to *.xls
- Conduit Flex Boot Priorities
- Items Without Element

SMP 6.1
Ground Water Sampling Data Collection and Evaluation

GROUNDWATER MONITORING

Ground Water Monitoring

View/Edit Program Records

- Enter Groundwater Sample Results
- View Site Well Map

GROUNDWATER SAMPLING Reports

Structures Monitoring Program Overview

View All Deficiencies for a Given Building, Room or Program by selecting the appropriate items below

Close

SELECT BUILDING

CWPH	CW Pumphouse
DG	Diesel Generator Bldg
EFW	Emergency Feedwater Pu
EV	CEVA
FPH	Fire Pumphouse
FSB	Fuel Storage Bldg
LOSB	Lube Oil Storage Building
MSFW-E	Main Steam and Feedwat
MSFW-W	Main Steam and Feedwat
PAB	Primary Auxiliary Buildir
RCA	Radiologically Controlle
RHR	RHR, CS, & SI Equipment \
SEPS	Supplemental Emergency
SWG	Non-Essential Switchgeai

SELECT ROOM

(All)	(All Rooms)
RV101	Containment Spray Pump Roc
RV102	Containment Spray Pump Roc
RV103	RHR Pump Room (A)
RV104	RHR Pump Room (B)
RV201	Safety Injection Pump Room (
RV202	Safety Injection Pump Room (
RV301	Containment Spray (A) Hx
RV302	Containment Spray (B) Hx
RV303	RHR (A) Hx
RV304	RHR (B) Hx
RV401	Personnel Walkway To Outsi
RV402	Personnel Walkway Top Of S
RV501	Cable Raceway Area

PROGRAM

- (All/Any)
- SMP
- EQ-DEF
- ASR

DEFICIENCY TYPE

EQ-DEF	Anchor Bolts Bent or Distorted
EQ-DEF	Misaligned Pipes at Wall or Floor Penetrations
EQ-DEF	Other Misc. Affected Items (Corrosion or Water In-Leakage)
SMP	(No SMP Walkdown Deficiencies Noted in this Room)
SMP	(TBD)
SMP	Building Seal - Deterioration of filler material
SMP	Building Seal - Environmental Degradation
SMP	Building Seal - Increased hardness or shrinkage
SMP	Building Seal - Presence of debris in gap
SMP	Building Seal - Separation
SMP	Building Seal - Water Infiltration
EQ-DEF	Building Seals
SMP	Coating and Liner - Delamination
SMP	Coating and Liner - Environmental degradation
SMP	Coating and Liner - Other, not serving intended function

To filter by Deficiency Type, you must select Building and/or Room FIRST and then select Deficiency Type. You can choose multiple types by holding the Ctrl key while selecting

IDENTIFIED DEFICIENCIES - Double Click Item below for form preview

RM	BLDG	ITEM	COMMENT	ID	SOURCE
RV101	RHR, CS, & SI Equipment Vaults	Steel - Corrosion	Wall in good condition, dry, no cracks. I&C supports/instruments on wall in good conditon on S	RV101-D-001	SMP
RV101	RHR, CS, & SI Equipment Vaults	Steel - Corrosion	Wall in good condition, dry, no cracks. I&C supports/instruments on wall in good conditon on S	RV101-D-002	SMP
RV101	RHR, CS, & SI Equipment Vaults	Concrete - Groundwater In-Leakage	Dried calcium deposits from in-leakage of ground water through fine cracks in concrete.	RV101-D-003	SMP
RV101	RHR, CS, & SI Equipment Vaults	Steel - Corrosion	Minor corrosion on platform structural steel.	RV101-D-004	SMP
RV101	RHR, CS, & SI Equipment Vaults	Steel - Corrosion	Cover plates of sump have failed coating and some surface corrosion.	RV101-D-005	SMP
RV101	RHR, CS, & SI Equipment Vaults	Steel - Corrosion	Concrete of floor is sound, minor cracks (<0.04'). Base plates and anchors are sound, minor coi	RV101-D-006	SMP
RV101	RHR, CS, & SI Equipment Vaults	Concrete - Crack	Minor cracking in wall (0.04"). Calcium buildup, moisture resulting in corrosion products on p	RV101-D-007	SMP
RV101	RHR, CS, & SI Equipment Vaults	Concrete - Spalling	West Wall: Image 0038-0047 – Concrete spall adjacent to support with corrosion	RV101-D-008	SMP
RV101	RHR, CS, & SI Equipment Vaults	Concrete ASR - Pattern Cracking	RV101 (-)61':	RV101-D-009	SMP
RV101	RHR, CS, & SI Equipment Vaults	ASR Monitoring Location		RV101-01	ASR
RV102	RHR, CS, & SI Equipment Vaults	Concrete ASR - Pattern Cracking	West Wall	RV102-D-001	SMP
RV102	RHR, CS, & SI Equipment Vaults	Steel - Corrosion	West Wall	RV102-D-002	SMP
RV102	RHR, CS, & SI Equipment Vaults	Concrete - Crack	East Wall (-) 50'	RV102-D-003	SMP
RV102	RHR, CS, & SI Equipment Vaults	ASR Monitoring Location		RV102-01	ASR
RV103	RHR, CS, & SI Equipment Vaults	Concrete - Crack	Minor cracking on walls (<0.04"). Floor has some minor paint flaking. Ceiling is in good conditi	RV103-D-001	SMP
RV103	RHR, CS, & SI Equipment Vaults	Coating and Liner - Peeling	RV103 (-)61':	RV103-D-002	SMP
RV104	RHR, CS, & SI Equipment Vaults	Concrete - Crack	East Wall:	RV104-D-001	SMP
RV104	RHR, CS, & SI Equipment Vaults	Concrete - Groundwater In-Leakage	South Wall:	RV104-D-002	SMP
RV104	RHR, CS, & SI Equipment Vaults	Misaligned Pipes at Wall or Floor Penetrations	Insulation around pipe 1-CBS-1203-5-151-6" is in contact with the eastern edge of the pipe's cei	RV104-01	EQ-DEF
RV104	RHR, CS, & SI Equipment Vaults	Misaligned Pipes at Wall or Floor Penetrations	No apparent change in the noted condition.	RV104-01	EQ-DEF
RV104	RHR, CS, & SI Equipment Vaults	Building Seals	Bisco seal 1-PB—61-RV104-1002 appears slightly "popped out" of its wall penetration in room	RV104-02	EQ-DEF
RV104	RHR, CS, & SI Equipment Vaults	Building Seals	No apparent change in the noted condition.	RV104-02	EQ-DEF
RV201	RHR, CS, & SI Equipment Vaults	Concrete - Crack	Horizontal cracks North wall and South wall, <0.04" in width.	RV201-D-001	SMP
RV201	RHR, CS, & SI Equipment Vaults	Electrical Boxes, Panels, or Fittings	No change in noted condition; continue to monitor under the Equipment Impacted by Structural	RV201-01	EQ-DEF

Monitoring Parameters and Acceptance Criteria for ASR-Affected Concrete and Associated SSCs

Parameter	Acceptance Criteria	Frequency
Expansion • In-Plane • Through-Thickness • Volumetric	Limits from the Large-Scale Testing	Based on the level of in-plane expansion • In-plane: 30, 18, or 6 month basis • Through-thickness and Volumetric: 6 month basis
Structural Deformation • Seismic Gaps • Annulus Width (CEB) • Plumbness • In-Plane Expansion • Observations • Sounding	Thresholds from the Structural Evaluations (Building-Specific)	Based on results from the Structural Evaluation (Building-Specific) • 36, 18, or 6 month basis

SSCs attached to ASR-affected structures are monitored at least every two years to ensure functionality is not lost. Corrective action is taken if an adverse condition is noted.

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Monitoring Locations

CCI/In-Plane Expansion Grids

- Total of 136 locations for ASR in-plane expansion monitoring
- 21 additional grids have been established for deformation monitoring only

Extensometer/Through-Thickness Expansion

- Total of 48 currently installed
- ~ 200 cores taken for material property testing (compressive strength and elastic modulus)
- Expansion to date was determined using the modulus correlation methodology

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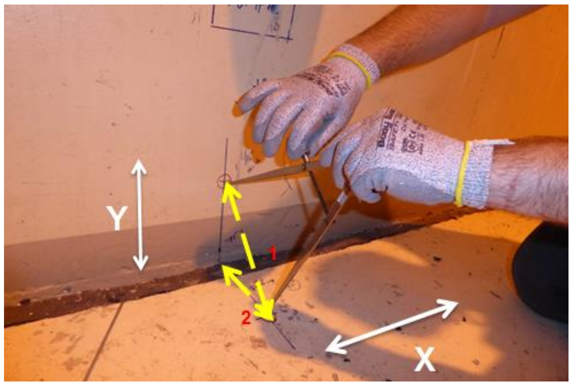
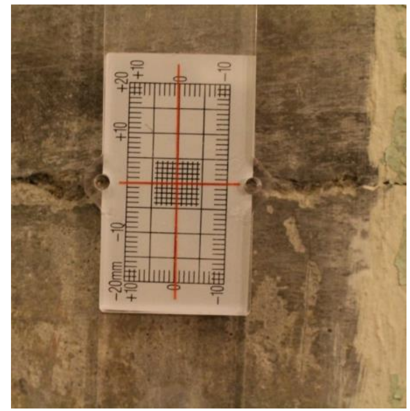
Monitoring Locations (cont'd)

Deformation Monitoring Locations

- 24 structures currently monitored

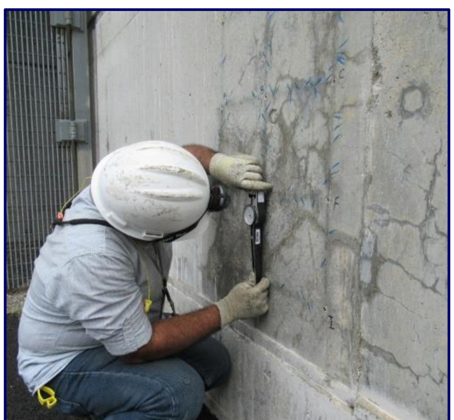
Seismic Gap Measurements (between adjacent structures)





Crack Gauge Measurements

In-plane expansion



Annulus Measurements (between CEB and Containment)

ASR Progression at Seabrook Station

Expansion levels are within Large-Scale Testing limits

Structures within Thresholds from the Structural Evaluations

- Expansion levels
- Deformation

Expansion at Seabrook Station is slow

- Monitoring intervals are sufficient to ensure that limits are not approached prior to the next inspection interval

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STATUS OF RELEVANT LICENSING ACTIONS

License Amendment Request (LAR)

Rationale for LAR

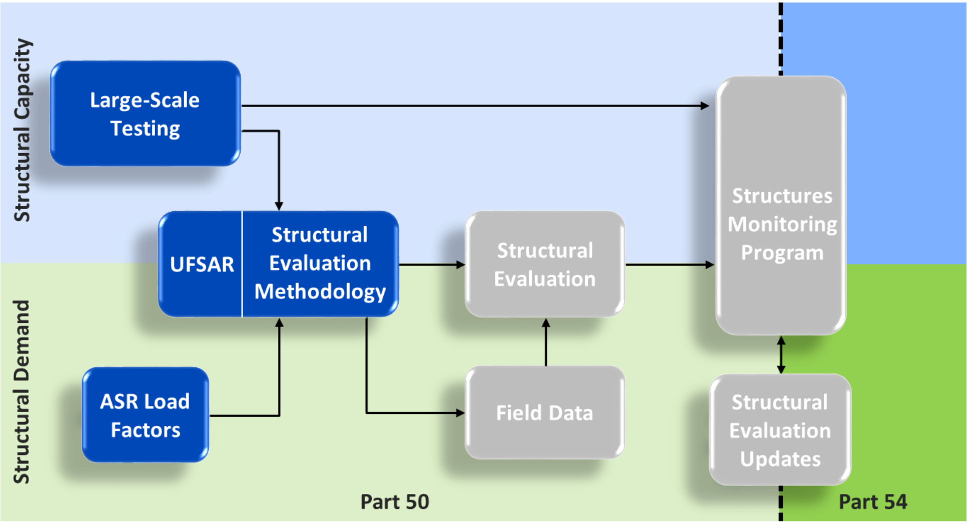
- Original design basis did not include consideration of ASR loads
- No approved guidance on how to address degradation associated with ASR

Function of the LAR

- Incorporates Evaluation Methodology and Large-Scale Test Program results
- Includes provisions for monitoring

Status: Pending

- Submitted in August 2016
- Draft SE in September 2018



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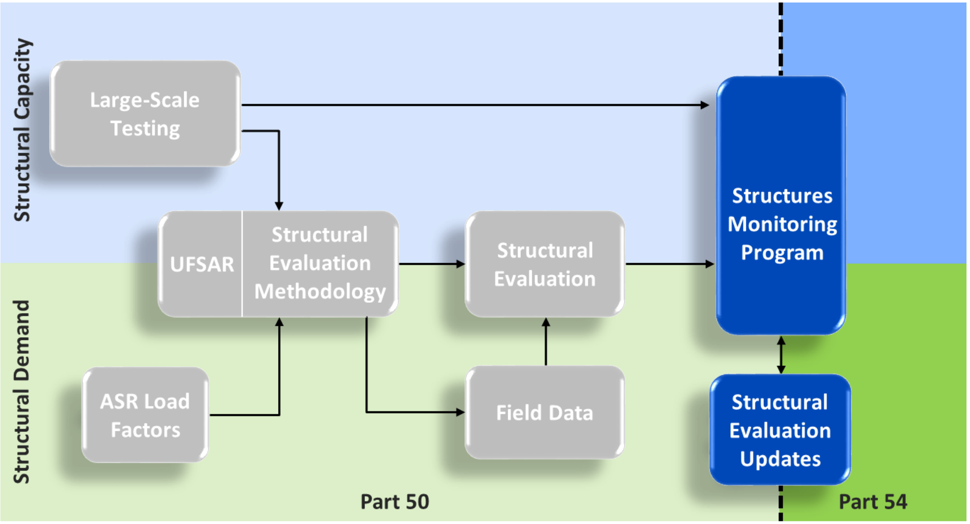
License Renewal Application (LRA)

ASR monitoring and management efforts in the Structures Monitoring Program (SMP) are carried forward in the Aging Management Programs (AMP)

- Structures Monitoring Program
  - ASR AMP
  - Building Deformation AMP (also considers SSC functionality)

Status: Pending

- Subcommittee Meeting
  - November 15, 2018
- Full Committee Meeting
  - December 6, 2018



Open Item – Structures Monitoring Program

OI 3.0.3.2.18-1

- Aging management of concrete structures affected by Alkali-Silica Reaction (ASR).

Resolution

- LRA updated to augment existing Structures Monitoring Program by addition of plant specific Alkali-Silica Reaction (ASR) and Building Deformation (BD) Aging Management Programs.
- Aging management of ASR has been integrated into the Section XI IWL Program.
  - -- Inspection, tracking and evaluation are in accordance with guidance of ACI 349.3R.

NextEra has implemented a program that effectively evaluates and manages the aging effects of ASR on affected concrete structures and associated SSCs

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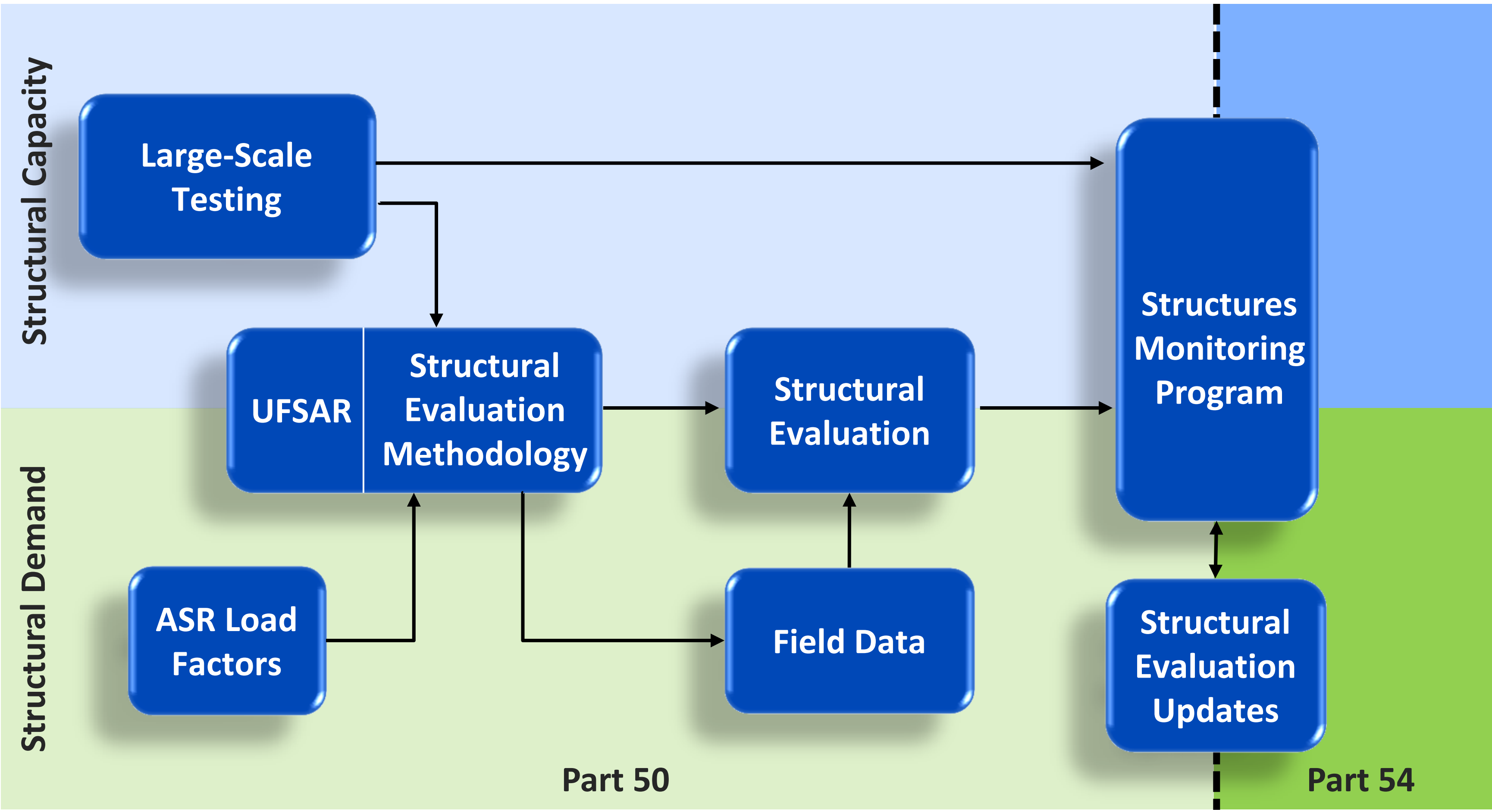
CONCLUSIONS

Approach for Addressing ASR at Seabrook Station



Completed Seismic Category I Structural Evaluations

Evaluation	Stage	Threshold Factor	Action Required
Containment Internal Structures	1	No ASR	
Service Water Access Vault	1	No ASR	
Containment Building (CB)	1	1.8	
Containment Equipment Hatch Missile Shield	1	1.5	
Containment Enclosure Ventilation Area and RCA Tunnel	1	3.0*	Relieve rebar stress on North wall (design is completed)
Safety-related Electrical Manholes (7 units)	1	3.0	
Electrical Cable Tunnel (North)	1	1.3*	Enhanced monitoring and develop retrofit for future bracing the of the walls
Condensate Storage Tank Enclosure	2	1.6	
Pre-Action Valve Building	2	1.3	
Main Steam & Feedwater Pipe Chase -West & Personnel Hatch	2	1.8	
Main Steam & Feedwater Pipe Chase - East & Hydrogen Recombiner Room	2	1.5	
Primary Auxiliary Building	2	1.5*	Reevaluate or retrofit the below grade walls at elev. 7’
Safety-related Electrical Manholes (6 Units)	2	1.5 to 1.7	
Containment Enclosure Building (CEB)	3	1.3	Missile shield CEB to CB Seismic Gap restored
Control Room Makeup Air Intake Structure	3	1.4	
Residual Heat Removal (RHR) Equipment Vault	3	1.2	
Fuel Storage Building	3	1.2	
Mechanical Penetration	3	1.5*	Retrofit north and south walls between elevs. -26’ to +1’
Service Water and Circulating Water Pumphouse	3	1.4	

* After proposed/completed action

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Conclusions

NextEra completed a comprehensive effort to:

- Conduct large-scale testing to understand the structural implications ASR
- Develop methodology for evaluation of ASR-affected structures
- Evaluate ASR-affected structures
- Develop monitoring strategies for ASR-affected concrete and associated SSCs

Structural Evaluations Demonstrate Seismic Category 1 structures comply with licensing basis

NextEra has implemented a program that effectively evaluates and manages the impacts of ASR on affected concrete structures and associated SSCs