Official Transcript of Proceedings ACRST-3253

NUCLEAR REGULATORY COMMISSION

ORIGINAL

Title: Advisory Committee on Reactor Safeguards 506th Meeting

PROCESS USING ADAMS
TEMPLATE: ACRS/ACNW-005

Docket Number: (not applicable)

Location: Rockville, Maryland

Date: Wednesay, October 1, 2003

Work Order No.: NRC-1102

Pages 1-280

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NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS) 506th MEETING

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WEDNESDAY, OCTOBER 1, 2003

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ROCKVILLE, MARYLAND

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The Advisory Committee met at 8:30 a.m. at the Nuclear Regulatory Commission, Two White Flint North, Room T2B3, 11545 Rockville Pike, Dr. Mario V. Bonaca, Chairman, presiding.

COMMITTEE MEMBERS:

MARIO V. BONACA Chairman

GRAHAM B. WALLIS Vice Chairman

GEORGE E. APOSTOLAKIS Member

THOMAS S. KRESS Member

GRAHAM M. LEITCH Member

DANA A. POWERS Member

VICTOR H. RANSOM Member

STEPHEN L. ROSEN Member

WILLIAM J. SHACK Member

JOHN D. SIEBER Member

ACRS STAFF PRESENT:

JOHN T. LARKINS Director

SHER BAHADUR Associate Director

SAM DURAISWAMY Technical Assistant

ALSO PRESENT:

WILLIAM BURTON, NRR

JOE COLACCINO, NRR

DAN FREDERICK, Conax

SUDESH GAMBHIR, OPPD

MIKE MAYFIELD, RES

JOE MUSCARA, NRR

SELIM SANCAKTAR, Westinghouse

JAMES SCOBEL, Westinghouse

JENNIFER L. UHLE, NRR

BERNIE VAN SANT, OPPD

RON VIJUK, Westinghouse

I-N-D-E-X

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

(10:17 a.m.)

CHAIRMAN BONACA: Good morning. The meeting will now come to order. This is the first day of the 506th meeting of the Advisory Committee on Reactor Safeguards.

During today's meeting, the committee will consider the following: Final review of the Fort Calhoun license renewal application; interim review of the AP1000 design; proactive material degradation assessment program; preparation for meeting with the NRC commissioners; and proposed ACRS reports.

A portion of this meeting will be closed to discus the proposed ACRS reports on safeguards and security. This meeting is being conducted in accordance with the provisions of the Federal Advisory Committee Act. Dr. John Larkins is the designated federal official for the initial portion of the meeting.

We have received no written comments or requests for time to make oral statements from members of the public regarding today's sessions. A transcript of portions of the meeting is being kept. It is requested that the speakers use one of the microphones, identify themselves, and speak with sufficient clarity and volume so that they can be readily heard.

Before we get into the agenda, I would like to point your attention to items of interest we have in front of you. There are no speeches in it this time, but there are a number of issues about operating events and NRC information notices.

And in the back, you have also printed out the metrics from the RFP inspection finding summaries. It may be of interest to you.

With that, if there are no further comments from anybody regarding the introduction here, I would like to move to the first item on the agenda.

I am responsible for this item. So this is the final review for the Fort Calhoun license renewal application. And we have in front of us the Fort Calhoun people. So Mr. Gambhir?

MR. GAMBHIR: Thank you very much, Mr. Chairman. And thank you very much for the opportunity to come and speak before this committee about the Fort Calhoun application.

With me today -- let me start out with the introductions -- I have Tom Matthews here, who is the licensing lead for us on this project; and Bernie Van Sant. Bernie has been the project manager on the license renewal project. And Joe Gasper I think you all know. He was the original project manager and has been the program manager for us. Also we have Mike Fallin back there. Mike is with the Constellation Nuclear Services. And they have done an extremely good job for us on putting the application together.

As far as our presentations are concerned, they will be brief. I am aware of the time limits we have here, and I think much of the presentation will be made by the NRC team. I will be very brief and introduce Bernie for his presentation.

Just to start out with the plant operating status, we are in the middle of the refueling outage right now. This was 468-day breaker-to-breaker run for us. Since '97, Fort Calhoun has improved the reliability of the unit significantly. And this is our third breaker-to-breaker run in four cycles.

We are fully aware of the fact that when good things happen to you, you need to start paying attention to little things. As you will see on my next slide, that is precisely what we are doing.

All NRC performance indicators are green. The inspection we had from the NRC in our corrective action program, the problem identification and the resolution program, there were no green or higher findings. In general, the program is well-run.

We were recognized for industrial operating excellence by INPO earlier this year. So overall Fort Calhoun performance has been pretty good.

I mentioned earlier that the performance improvement program started back in '97. We have a vision of keeping the nuclear option alive to 2033 and beyond. And with that, what it means is even though Fort Calhoun is a small unit and also is fully one-third of the power we produce at OPPD, but it's an important mix. And that's the biggest value that we have for Fort Calhoun station.

We introduced what we call a six factors formula. You call it a CHOICE. And we have been emphasizing the critical self-assessments and the broad and lasting corrective actions, human performance, making the operations event-free, and focusing on the high visibility issues and also being a cost-effective producer and then ensuring excellence in material condition. Let me speak to that.

I talked about the reliability of the unit. Our board of directors has recently authorized several upgrades for Fort Calhoun station. We have a contract that is signed by MHI for the replacement of the steam generators, reactor vessel head. And since we will have to make a hole in the containment to do those things, we also have approval to go ahead and take out the pressurizer. So we will be the first one to replace the pressurizer. We do have a contract with MHI.

Those are just three examples that I decided for you of several projects that we have. We are in the process of buying a new simulator from CAE.

So the board has shown confidence. We are making investments in there. And there are a lot of other improvements that we will be making in the unit.

VICE CHAIRMAN WALLIS: What's the time scale? Are you going to do all of these changes for this --

MR. GAMBHIR: The steam generators, the reactor vessel head, and the pressurizer will go in 2006 outage. We will be also replacing the condenser in 2005 outage. So there is a lot of things that we're doing to improve the reliability of the unit.

MEMBER LEITCH: Sudesh, I noticed at the beginning of the current outage, there was a fuel assembly that was dropped. I was wondering if that was an equipment problem or a human performance problem and just what your reaction is to that situation.

MR. GAMBHIR: Yes. We have completed preliminary root cause analysis on that. The root cause that we have identified was a human performance issue.

Now, there are some other contributing problems. None of those are material condition issues. But there were some others, you know, for example, not using effectively operating experience.

Previously we had handled a few ourselves. For the last three outages -- this will be the third -- we have brought in a vendor to handle the fuel during the outage. And I would say it's a human performance, but this is a human performance issue that could have been prevented.

Those are the things that we will be working on now, the long-term corrective action.

MEMBER LEITCH: Now, the fuel handling has to be done with an individual with an SRO at your facility. Now, that's not the vendor. In other words, you have an SRO responsible for the fuel handling as well?

MR. GAMBHIR: It's the supervision. There has to be supervision. Actually, engaging the bundle can be done by the contractor.

MEMBER LEITCH: But the supervision?

MR. GAMBHIR: Yes, we have the supervision. There are a lot of contributing causes there that we are still working on, but it was a human performance issue.

MEMBER LEITCH: Okay. Thank you.

MR. GAMBHIR: Joe, do you want to add anything to that?

DR. GASPER: No. I think you covered everything.

MR. GAMBHIR: Okay. If there are no other questions, then I will turn it over to Bernie. Bernie is going to go for the implementation. Are you okay here, Bernie?

MR. VAN SANT: As Sudesh said, I want to cover two topics. One is to go over some of the inspections that we have been doing on two of our RCS components. And then I also want to talk about license renewal implementation.

Two components that I will be going over are the CEDM drive mechanisms and the reactor vessel head. I will give you a little background. In the early '90s, Fort Calhoun had a leak in our upper CEDM housing. Shortly after that, Palisades, who has a similar design, CEDM housing, and dry mechanism started having leaks in their drives.

As a result of that, OPPD committed to developing a CEDM material reliability plant. That plant consists of going in on an outage basis and doing inspections on the welds, on the CEDM upper housing, and on the CEDM seal housings for all the drive packages, taking those, a group, at a time, every outage until we get a good identification of what the cause of the cracking is, mechanisms, and how to implement a program to ensure that we don't have any in the future.

We have committed that whatever comes out of this plan, which would be mutually agreeable between NRC and OPPD, that we have committed to carry that program into the period of extended operation as one of the commitments we made for license renewal.

I will get into the inspection results in 2002. We inspected the seal housings for the control and the dry mechanisms using eddy current testing methodology.

We tested eight seal housings and found no indication in any of the eight seal housings. We then attempted to use a robotic UT measurement machine on the upper housing welds. We did this because of the high-dose area involved in examining the housings.

Unfortunately, this was somewhat of a

prototype machine and didn't perform like we had anticipated. So we ended up having to go back in and manually do UT on some of these welds. As a result, we only had two welds that we ended up achieving a UT reading on. Both of those were acceptable.

This outage we're going back in with a new style of UT machine we hope to have a much better success rate on. We have completed the --

MEMBER SHACK: Excuse me. What are you inspecting with the eddy current system?

MR. VAN SANT: The seal housing on the dry package. The way our seal housings are set up may be a little different than what you are used to. We have an upper housing, which is essentially a ten-foot tube that goes from the reactor vessel nozzle up to the control element dry package and in the control element dry packages where the seal housing is.

So the upper housing has three welds on there that are susceptible to cracking that we are inspecting. And then inside the control element dry package, there's a seal housing that we inspected that a current --

MEMBER SIEBER: And the entire tube is a pressure boundary?

MR. VAN SANT: Yes.

MEMBER SHACK: And this is all 347?

MR. VAN SANT: The control element upper housing is a 316, I believe. And the dry package, I think that is a 347, but I can't say for sure.

As I said, we just now have started this week attempting the robotic inspection of the UT on the upper housing welds. So I don't have any results to report on it as of yet, but that should be done by the end of this week.

The reactor vessel head, we did a bear head inspection in 2002, again with the robotic visual inspection. I did not identify any buildup of boric acid or any leakage around any of the nozzles.

We repeated that again this outage, the same results, haven't seen any buildup of boric acid. We have compared the digital pictures from 2002 with the pictures we take in this outage, in 2003, and there's little, if any, change in the condition of the head. It's clean, in good shape. So we're very happy with that.

MEMBER LEITCH: Bernie, are you able to fully comply with the NRC order in your 2003 inspection?

MR. VAN SANT: Currently, we are at just under 12 EFPY. So the bear-head and visual inspection both comply with the current order. We will have to do a volumetric in '05.

MEMBER LEITCH: In '05, yes.

MR. VAN SANT: We are replacing the head in '06. And based on the results of the inspections and the planned replacement in '06. We are considering going in for an exemption on the volumetric on '05, but we are planning to do that.

MEMBER LEITCH: Okay. Thank you.

VICE CHAIRMAN WALLIS: While we're on the RCS, I noticed you have a crack in your pressurizer lower shell instrumentation nozzle.

MR. VAN SANT: Yes.

VICE CHAIRMAN WALLIS: And I was rather surprised to see this is going to be managed entirely by calculating things. I would think that you would want to inspect as well.

MR. VAN SANT: The nozzle will be evaluated for TLAA. We have imposed a fix on that nozzle. And the TLAAs address the --

VICE CHAIRMAN WALLIS: This is calculations, isn't it?

MR. VAN SANT: Yes. But we are replacing it in '06.

VICE CHAIRMAN WALLIS: Yes.

MR. VAN SANT: This nozzle as part of the pressurizer will be --

VICE CHAIRMAN WALLIS: You are relying entirely on the theoretical work to ensure that it is okay?

MR. VAN SANT: We won't be relying on the theoretical work for the new license at all because it is going to be replaced in '06.

VICE CHAIRMAN WALLIS: Between now and '06, it's there.

MR. VAN SANT: Right.

DR. GASPER: Between now and '06, the pressure boundary weld was moved to the external side of the pressurizer.

VICE CHAIRMAN WALLIS: So you have another pressure boundary.

DR. GASPER: And that, then, was incorporated into the ISI program as required by the code.

VICE CHAIRMAN WALLIS: Right. So it really doesn't need much management because you've got a new pressure boundary?

MR. VAN SANT: Right.

DR. GASPER: That is correct.

VICE CHAIRMAN WALLIS: Thank you.

MEMBER SIEBER: Does the code allow a repair like that?

DR. GASPER: Yes. We either have or will be submitting to the NRC. The code also requires a submittal to the NRC. And I do not know the exact status, whether that's --

MEMBER SIEBER: You're probably relying on a code case, right?

DR. GASPER: Yes. I don't remember --

MEMBER SIEBER: Because a code itself, that's not adequate repair.

DR. GASPER: Yes. I don't remember the exact details.

MEMBER SIEBER: There have been other places that have used a code case.

DR. GASPER: Yes. But a number of CE design plants have implemented this fix.

MEMBER SIEBER: Okay. Thank you.

MR. VAN SANT: The analysis that we were talking about was only for the period of extended operation. We currently have the analysis in place for the weld as it exists now.

MEMBER ROSEN: Have you had a look at the reactor vessel bottom head yet?

MR. VAN SANT: We have no nozzle

penetrations in our bottom head. So the answer is no, we have not looked at that.

MEMBER ROSEN: You have no instrumentation, thimble heads, or --

MR. VAN SANT: No.

DR. GASPER: All our instrumentation is top-mounted. All the NCOR instrumentation comes in through the top of the reactor vessel.

MEMBER ROSEN: So the bottom head is completely smooth? There's no --

DR. GASPER: Yes. There are no penetrations in the bottom head.

MEMBER ROSEN: Okay.

MR. VAN SANT: Continue on? The next topic I wanted to cover was our license renewal implementation. One of the things I wanted to emphasize was that in preparation of the license renewal application, we performed our scoping in accordance with 10 CFR 54.4.

What that means is we looked at all SSCs in our plant. We did not screen any components based on safety classification, went back and looked through the database for all the license renewal components.

There are a significant number of components that are not safety-related. If my memory serves, it was approximately 16 percent of the components that we have in our database are not the safety-related classification, did not have a safety-related classification.

The other bullet that I have here is to identify that we are updating our configuration control procedures for modifications and engineering changes to incorporate the requirements of 10 CFR 54.37.

We will be using the same criteria for evaluating configuration changes that we used in scoping for the license renewal application. If we identify a component that meets the criteria for the scope of license renewal, we will be including aging management programs, applying those programs to those components the same as we did in the license renewal application.

I wanted to talk a little bit about the commitments we have made as part of our license renewal application. We have the commitments listed in the SER as well as in our USAR supplement.

These commitments consist of three different types of commitments. One is for new programs that we have had to develop; program enhancement to existing programs, where we have had to do additional work to satisfy the requirements of the GALL and the NRC; and then, finally, commitments to perform TLAA evaluations for components prior to entering the period of extended operation.

These commitments will be tracked in the Fort Calhoun station regulatory commitment tracking system, the same as we track all of our regulatory commitment items. In that system, we have assigned orders and established commitment dates for those items to ensure that they are completed on time.

Finally, for those programs that we have credited for license renewal, all of those programs have implementing procedures to carry out the requirements of the program. In those implementing procedures, we have annotated either the whole procedure or the steps in the procedures that are required to comply with the needs of the aging management program.

So it's obvious to anyone using the procedure or trying to change the procedure that these steps are commitments to the NRC and need to be treated accordingly.

MEMBER LEITCH: Do you have any idea how many of those programs either are or will be implemented short-term versus waiting until you're 39 and a half, so to speak, before implementing them or --

MR. VAN SANT: We're in the process of implementing the changes now. The goal is within the next few years to have those all implemented. We're not waiting until 2013 in the period of extended operation to get those implemented. We need to get them in process and get them off our books, basically to move on. We don't want to come on 2013 and try and figure out what it is we committed to.

MEMBER LEITCH: Right.

MR. VAN SANT: So we're going forward with those now.

MEMBER LEITCH: Yes. That's good. We're concerned not only about your resources if you wait until the last minute but NRC inspection resources as well. This could be a very high peak load if everybody were to just wait until the last minute. So I'm pleased to hear you're moving towards implementing those programs.

DR. GASPER: As part of the implementation of the new procedures, we will have training for all of the engineers that will be doing configuration changes that could impact the license renewal application commitments.

OPPD also will be training any new engineers that come on board. They have to be qualified to perform certain tasks. Those people that will be qualified to perform configuration change activities will receive training on the procedure, which will include training on the license renewal commitments and the process of scoping and screening for license renewal.

We also will have the plant equipment database updated to reflect those components that are part of the license renewal commitments that were scoped in as part of license renewal. This combined with the procedure annotation to identify those commitments and the training we feel will ensure that we maintain our commitments to the NRC throughout the period of extended operation.

CHAIRMAN BONACA: I have a question.

DR. GASPER: Yes?

CHAIRMAN BONACA: In the late '80s, you did experience movement of the thermal shield, some vibration.

DR. GASPER: Yes.

CHAIRMAN BONACA: And I think in 1992, you replaced 11 pins.

DR. GASPER: That's correct.

CHAIRMAN BONACA: And then the vibrations were reduced essentially to normal. Okay? Now, if I remember, you are proposing to continue to monitor thermal shield vibration to this thermal shield monitoring program.

Now, if I understand, that's essentially inspections but is not -- I guess where I am going is, how do you identify the vibrations? What is a normal level of vibration? What isn't normal? You do not have a loose part monitoring system, right?

DR. GASPER: Right.

CHAIRMAN BONACA: And you are claiming that you don't need to have one to monitor this. So if you could elaborate on that?

DR. GASPER: The monitoring is done using neutron noise analysis. We do neutron noise analysis on start-up from every refueling. And, actually, when we detected the original motion on that thermal shield, it was detected in neutral noise analysis such that we determined that we needed to go in and do visual inspections.

And we're going to be continuing that program because we fully recognize that those pins can certainly relax again. And it was successful previously, but we weren't able to identify that sudden motion was starting and we needed to go in and inspect those pins.

CHAIRMAN BONACA: Okay. I understand how you did that. And that's the basis for saying we don't need a loose part monitoring system?

DR. GASPER: Yes. Basically, our feeling is that if we detected it would be a loose part, it would probably be too late. We would potentially have damage to the shield. So that is why we are using neutron noise.

CHAIRMAN BONACA: The other question I had was regarding CEDM, just a clarification of your presentation. You said you had leakage from the CEDM package. If I understand it, this is the package above, directly over the head.

DR. GASPER: Right.

CHAIRMAN BONACA: Okay. Now, you're replacing the head in 2006, which gives us comfort insofar as leakage from the CEDM there, but the other leakage you are still monitoring through normal means, I guess, right, for the foreseeable future? You're not changing your upper package?

MR. GAMBHIR: We're changing the CEDM housing also.

CHAIRMAN BONACA: You're changing the

upper housing. Okay.

MR. GAMBHIR: The leak we had, it was a spare penetration that we had. And that was out of the housing itself.

DR. GASPER: Yes. That was actually that ten-foot pipe basically. And it was due to stress corrosion cracking due to the fact that those were not vented. So we tracked oxygen in them.

CHAIRMAN BONACA: And you are replacing those?

DR. GASPER: Actually, the ones that are cracked, those have been removed.

MEMBER ROSEN: Going back one slide to your license renewal implementation discussion on slide 10, I think you are appropriately identifying training as important and also that you're going to be implementing some of these requirements beginning soon and not waiting until the end and embedding those requirements in your procedures.

All of those things are good, but what are your thoughts about putting this program under the control of one person who is identifiable as the license renewal guru or do you feel that you don't need such a person in an ongoing manner that just using a broad scope procedural approach would be satisfactory?

MR. VAN SANT: Our belief is that if you haven't properly documented the procedure, that doesn't mean you have a license renewal guru, so to speak, to be able to address it. You should have an adequate procedure guidance that can walk somebody through the evaluation to determine if they have an impact on the commitments or license renewal application.

MEMBER ROSEN: This is different than some other licensees who have appeared before us and been granted license renewal. Some of the licensees have identified site points of contact, for example, on license renewal, someone who is the keeper of the knowledge that was gained during the review and knows where all the pieces of the program are and who can teach new people and examine issues as they come up separate from the procedural network.

That gave me some comfort in that I felt that the program was less than automatic. There was someone who was guiding and able to guide and who had the history and could respond to issues as they came up if they had a tangential or even a direct impact on license renewal activities.

MR. VAN SANT: We have people who will be available to support that, but the recognition was that in going forward, at some point, you are going to lose that historical knowledge, that you need to have that control in procedures such that you are not dependent on people to provide that function.

MEMBER ROSEN: I think that is a little bit of a red herring. I'm not talking about being dependent on people and not having it in the procedures. I'm suggesting that, in addition to having it in the procedures and in addition to the training was some comfort to me to be advised by a licensee or several licensees that they had someone who could be pointed to by management and say, "The license renewal implementation is your bag. You're the guy who has to be thinking about that as part of your job."

MR. GAMBHIR: Let me address that. I think that's a good point. Here are the lessons learned personally for me over the years, that people change, conditions change. So you do need to have a strong documentation background so we can move forward.

One of the things that we did at Fort Calhoun was -- this is back when we did the design basis reconstitution -- we also developed what we call the program basis documents.

We have very detailed program basis documents. They're not part of the license. I mean, they were not done for this. They have been done since many years. And things like steam generators, erosion corrosion programs, the relief valves, the safety valves, I mean, all of these things, you wanted to preserve the knowledge.

Bernie, correct me if I am wrong. We are looking at a program basis document on the license renewal. So we will have a program basis document on the license renewal also because that will be the master document that retains all of the knowledge. It's in there.

And I'm sure there will be a sponsor assigned. Each of the documents has a sponsor assigned. So indirectly I think we will have what you are talking about, and then each of the procedures then implement it.

MEMBER ROSEN: I think that's fine. You have a go-through guide and a program basis document that is really the intent of my comment that I think --

MR. GAMBHIR: We'll have that. And your point is valid. I mean, there are so many things in these that you can't write in every procedure. And then sometimes things do get mixed up. And so we will have.

The program basis documents in general have served us extremely well. We preserve from year to year how many man-hours were used, what did we find. We had a change of system engineers on steam generators and weren't able to just switch over to the next person. So that's the same concept we'll have in the license --

MEMBER ROSEN: It said knowledge management issue.

MR. GAMBHIR: Right.

MEMBER ROSEN: I think what you have described now would go a very long way to giving me the same kind of comfort that, for instance, the site point of contact approach has given me in the past. I thank you.

VICE CHAIRMAN WALLIS: I have a question about FAC, flow-accelerated corrosion or flow-assisted corrosion. You have had thin walls because of corrosion. You actually had one that ruptured.

DR. GASPER: In '97.

VICE CHAIRMAN WALLIS: So as these machines get older, the pipes, walls get thinner, may rupture. That apparently is okay because they're managed by checkworks and all that kind of stuff. And as you monitor these pipes, they're replaced when you have to replace them. And, therefore, they're not an obstacle to renewing the license and that public perception might be that as these things get older and they wear out, then that's a bad thing.

But the fact that you can renew these pipes makes it okay. Is that really sort of putting it in the kind of everyday terms? Is that the way FAC works?

DR. GASPER: Yes. Typically checkworks is used in a predictive method to identify where the maximum wear is occurring. That's confirmed basically with your inspection program. You are then selecting the sites that have the maximum rates and going and inspecting those.

As we get to replacements, typically right now we are trying to the best of our ability to replace with FAC-resistant material in order to cut down the amount of inspections and stuff, we've got to do that. That's an outage expense every year.

So the relative costs of replacing with FAC-resistant material versus continuous inspections leads you towards at least in our case to replace with resistant material.

So that's right now basically our philosophy. We are trying to replace with resistant material where we can.

MR. GAMBHIR: In addition to that, for the condenser that we're putting in, that will have titanium tubes. And that allows us to do better chemistry management also. So we're kind of looking at it from that point of view, too.

MR. VAN SANT: We're also replacing feedwater heaters. As we go in and replace the feedwater heaters, at that time, when we're cutting into the extraction lines, we're looking at what piping we can replace as part of that.

VICE CHAIRMAN WALLIS: Yes. Those extraction lines have historically given you problems.

MR. VAN SANT: Right. That's the danger area.

MEMBER ROSEN: And the material for the construction of the feedwater heaters is?

MR. VAN SANT: It's going to be stainless steel tubing. It's currently stainless steel tubing right now. And we'll replace with stainless steel tubing.

CHAIRMAN BONACA: Would you be doing all

of this work if you were not planning for license renewal?

MR. VAN SANT: No.

MR. GAMBHIR: I think what it is is that part of the justification is that the operation to 2013 becomes uneconomical. We solved it. For example, we are doing condenser inspections. It's going to cost about $7 million just to inspect those.

The condenser has been a source of problem for us in the past. So the economic case that we have put together is that we need these things for going to 2013 even. But it would have not been economical if we were going only to 2013.

So the fact that we can go to 2033 -- this is where I believe strongly that license renewal adds to the safety of the plant because what we are doing is this is going to help improve the reliability of the unit and, in turn, improve the safety of the unit.

MEMBER ROSEN: And not have a long, lingering period where you're managing to get through and then shut down in 2013. Instead of that, taking a proactive approach, improving the material condition of the plant across the board, and planning to go on for a longer period.

MR. GAMBHIR: That is correct.

MEMBER SIEBER: Have you purchased the condenser tubes yet?

MR. VAN SANT: No, not yet. We're going out for bid shortly.

MEMBER SIEBER: I presume that you are aware that the moment of inertia of titanium tubes is different than what you now have and they are prone to vibration. And you may be in a situation where you have to stake the condenser because the tube support plates are too far apart. Just so you are aware of that and spend --

MEMBER ROSEN: I think that is well-known, Jack. I think that places where titanium condensers have been installed to replace, for instance, Admiralty brass, Monell metal have been successful.

MEMBER SIEBER: Some have. Some haven't.

MEMBER ROSEN: My own experience has been that it's very satisfactory.

MR. VAN SANT: We're not just re-tubing. We're replacing the entire module.

MEMBER SIEBER: Oh, really? Okay. So you all have new support plates.

MR. VAN SANT: Right.

MEMBER SIEBER: Okay. That solves that problem.

CHAIRMAN BONACA: Okay. Any other questions?

(No response.)

CHAIRMAN BONACA: If not, then we will hear from the staff. Thank you.

MR. KUO: Thank you, Dr. Bonaca.

My name is P. T. Kuo. I am the Program Director for the License Renewal and Environmental Impacts Program. Butch Burton is going to make the presentation. He's the project manager, as you know.

And, briefly, just a status report that during the top of SER with open items, we had 11 open items. By the time that we finished the subcommittee meeting, we had only one left, which had to deal with the changing of tables by the applicant in the application. And since then, even this issue has been resolved already. Butch is going into the details of that.

And I also want to mention that given Fort Calhoun being the first GALL plant, we have a number of lessons learned. We are trying to incorporate these lessons learned into the future application reviews. Butch is also going to go over some of the lessons we have learned.

So with that and if he is ready, then I

will turn it over to Butch.

MR. BURTON: All right. Thanks, P. T.

MR. KUO: Sure.

MR. BURTON: Can everybody hear me okay? First, one housekeeping item. The slides that I am going to have up here, I had to make some last minute changes to them. The committee members have the correct slides. For some of the folks in the audience, you are going to find very minor differences between the slides I have up here and what you have; again, very, very minor.

Thank you for allowing me another opportunity to talk with you about the staff's review of the Fort Calhoun license renewal application. Let me start with a very brief overview. I know it looks like a lot of slides, but I intend to move through them fairly quickly.

The application was actually submitted by letters dated January 9th and April 5th. And as I go through, I will explain to you a little bit about how and why that happened in two submittals, as opposed to one.

As you know, it's CE PWR located just north of Omaha, Nebraska. Current license expires in August of 2013. They're requesting a 20-year extension of the license. We issued our SER with open items in April. We had our subcommittee in June. And we issued the final SER in September.

We also had a brief session with the full committee -- I believe that was in March -- to try and familiarize you all with the application since it was the first to utilize GALL.

VICE CHAIRMAN WALLIS: This SER, we have had comments on SERs in the past, license renewal. My impression is that it's, for me anyway, much more complete than the earlier ones. It goes over the history and how the RAIs were resolved, there were not inspections, and so on, gives much more explanation as to why you reached the decisions that you did. And I found that very useful.

MR. BURTON: Good, good. I'm glad to hear that. We thought that it was important that we communicate to our stakeholders some of the background of GALL, how it was developed because it was the first one to understand how things were structured and how we performed our review. So we did try to include all of that. I am glad to hear that you found it helpful.

One of the things that I know that you all are always interested in is how this application compared to previous ones. As I mentioned, it's the first application to fully implement the GALL process.

If you remember, St. Lucie applied portions of GALL, but we were the first ones to actually look at an application that instituted the full process.

As a part of that, we had to do some re-engineering of our review process. And I have some lessons learned with that. One of them was that it was the first plant where we actually did a confirmation of their claim of consistency with GALL for the aging management programs. And we actually included that as part of the AMR inspection. Again, there were some lessons learned associated with that that I will talk about.

It was also the first plan to utilize an SER template. What we tried to do was we tried to make the review a little bit more consistent from a stakeholder's point of view to be able to consistently document how we did what we did. And so we actually developed a template. And we have actually used that concept with applications after Fort Calhoun. So those are some of the things that were different from some previous applications.

Okay. I'm actually going to begin at the end. I am going to start with the staff's conclusions. Ten CFR Part 54 lays out what has to be met in order to issue a renewed license. There are basically three requirements that are documented in 54.29.

One is that actions have been identified, have been or will be taken. You have heard this language before. This is basically the reasonable assurance finding associated with the safety review.

The second item is basically that we have to look at the environmental impacts and make sure that there are -- if you have seen the conclusion there, it is very legalistic, but it basically says that environmentally we have not found anything that would prevent them from implementing this license renewal option if they choose to; and then, finally, matters raised under 2.758, which is basically a hearing. And there were no requests for hearings or petitions to intervene. So that last requirement has, in fact, been met.

So these are the conditions. Basically, most of the rest of my presentation is how we came to reach this first finding, this first reasonable assurance finding.

Okay. The first thing that the staff looks at is the methodology. The reasoning behind that is that if the methodology is not sound, you can't trust the results. So the first thing is they have to look at what they're doing and make sure their methodology is sound.

Specifically, we're looking to make sure that the methodology meets the requirements of the rule and that it is consistent with how it is described in the application. So that is what we are looking at.

We supplement the staff review with a methodology audit. That's normal procedure for us. As a result of the review and the audit, we had four requests for additional information having to do with methodology.

I've identified functional realignment. You know that always comes up. And so that's one of the things that we always look at. One of the things that came up, we had a question with regard to functional realignment.

For those who may not be aware of what that means, it's basically when you take the functions of one system and actually functionally, not physically but functionally, associate them with another system. The one that comes up most often has to do with containment isolation. Often you will have systems that they would have no other in-scope function except for containment isolation.

And so what some applicants have done is, rather than bringing that whole system in scope, they will take that particular component that does that in-scope function and actually functionally realign it to a new system that is normally called in this case containment isolation.

But from a methodology point of view, all of that needs to be clearly laid out and described. What we found was that when you looked at some of the documentation, it wasn't real clear how all of that was done.

When we find those kind of apparent discrepancies, what we do during the inspection is we say, "Okay. The paperwork, the description doesn't seem to be in line with what you're claiming. Let's sit down, and you go through with us exactly what you did in order to do this functional realignment."

What we found is that they, in fact, did it correctly. The problem was just in the documentation. In fact, that was one of the RAIs associated with it. And they came back and made a fix that clearly described that methodology.

There were no open items. We had one

confirmatory item, which we resolved, which had to do with the realignment. So from a methodology point of view --

CHAIRMAN BONACA: In the process of scoping and screening, did you identify other items that should be in scope?

MR. BURTON: Yes. In fact, after we looked at the methodology, then we looked at the scoping and screening results. And that's what's going to come up in the next slide.

CHAIRMAN BONACA: Okay. And you'll tell me how many systems and also if these were part of the interim staff guidance?

MR. BURTON: Sure, absolutely.

CHAIRMAN BONACA: I guess where I am going is if we have the application, we see that there is a significant number of components and systems that are included in the scope after the staff reviews and finds that there are discrepancies.

I would expect that once GALL becomes fully institutionalized in the applications and a member of -- I mean, there shouldn't be the need for the staff to come in and identify all of these components. Okay? So how can we say the methodology is adequate if, in fact, it doesn't lead to have two reviewers coming to the same conclusion?

MR. BURTON: Right. And, actually, that is a very good question, and the staff has looked at that. When you find that the results -- if there are a number of things that had not been brought into scope, then you question the methodology, which is basically what you are saying. And, in fact, during the inspections, we did look at that and ask for some explanation. And often what it was is that -- you will see this in some of the RAI responses -- it's not that they missed it.

It's that they looked at it and made a determination for various reasons that the RAIs will talk about the details, why they made a conscious decision not to scope it in. And the staff would have a disagreement. And that is part of what some of the discussions were. And a lot of that is documented in the RAIs and the subsequent SER.

We would have been particularly concerned if it was something where they just completely missed it. And what we found was when we questioned them about that.

For instance, I'll give you a for instance about the scoping: the circ water tunnel. One of the issues that came up when we were doing the review was the circ water tunnel was not initially included in scope. Let me just say that. And so we said, "Well, what if the tunnel failed? Could it not block raw water discharge?" because it all goes through that tunnel.

And our first thought was, "Well, the applicant just missed it."

And, in fact, when we started to talk to them, they said, "No. We did not miss it. We did look at that and consider that, but we found that if the tunnel collapsed, there would still be room for raw water discharge to get through."

So we got into those discussions. And ultimately what they did decide to do was to actually bring the tunnel in scope and actually made it part of the intake structure, which was already in scope.

And then when something comes into scope, we bring all of the associated aging management information with it. But what we found was that when you looked at concrete, steel, whatever the structural components were that were associated with the tunnel, they were already captured in the intake structure.

So when all was said and done, there really was nothing that really changed other than bringing that additional tunnel into scope.

Does that answer your question?

CHAIRMAN BONACA: Yes, it does. I mean, my main concern is to see progressively as we move through these license renewals, that the guidance is clear and that you will come to the same conclusion and there isn't the need for the staff to identify all of these additional components because whenever there is a discrepancy, I'm left to the question, how many things have been missed by both the staff and the licensee?

MR. BURTON: Right. You're absolutely right. Yes, we do expect that that kind of thing will be reduced and eventually go away as we go on, certainly.

So, anyway, in terms of scoping and screening methodology, when all was said and done, we found that the methodology was adequately described after some of the discussions and the commitments to make some modifications to the functional realignment description but other than that, that they were, in fact, meeting the requirements in terms of methodology.

Now, once we went through the methodology, then we looked at the results. Okay? We did a staff review here in headquarters supplemented by a scoping and screening inspection, which, again, is what we normally do. Exactly 69 RAIs came out of the scoping and screening review and inspection.

After going through the responses to the RAIs, we found that there were three that carried over as open items, all of which have been resolved.

And I do want to add that during the subcommittee meeting in June, when we looked at the exact status of all the open and confirmatory items, at that point, everything had already been resolved with one exception, which I will talk about.

So in terms of the specifics of the open items, we had already discussed them at the subcommittee meeting. And they were resolved at that point. Later on, I do have several slides. I won't go into detail, but it gives a list of all of the open and confirmatory items, what the issues were, what the final resolution was.

MEMBER LEITCH: Assume the ISGs were not fully promulgated at this time. Would you think that if he had been, that a number of these RAIs would have been greatly reduced?

MR. BURTON: I don't know about greatly reduced. It certainly would have impacted on the number. There's no question. Because you're right, at the point that we started our review, many of the ISGs had not been issued. In fact, even now, like, for instance, seismic 2/1, that takes us back to Hatch. There's been a long development and issue process with that.

The one thing that I can say, not only with Omaha Public Power but with some of the other applicants, is that it doesn't look like the industry is waiting for the final ISG to be issued. If they can address it in the development of their application, they seem to be trying to do that. If they are too far along in the development of their application or if they application is already in-house, they know that they can expect RAIs. And they're ready for them.

So we find that even when the ISGs are still in development, they look at what the staff's initial position is. And they do try to address it.

So yes, a lot of the scoping and screening review results, we had three open items, one of which was the tunnel that I had just talked about, and no confirmatory items.

Okay. One issue that came up during the subcommittee meeting and has since been mentioned, I understand, at St. Lucie and I know it came up at

Robinson yesterday has to do with the pressurizer spray nozzle. I tried to kind of summarize where we are with that.

The way it started off was the staff identified an issue with the spray nozzle. From our point of view initially, we said, "Well, the spray pattern is really critical. It would seem to us that the spray pattern is critical to meeting the depressurization as far as reaching cold shutdown for Appendix R. And on that basis, it seems to us that the spray head should be in scope."

Applicant came back and said, "No. Actually, the spray pattern is not critical to meeting Appendix R and depressurizing and reaching shutdown."

What they had done was they had done a study and found that the pattern is not so important as the fact that you get the water in the pressurizer. It's not as efficient clearly, but in order to get the thing shut down in, I believe it is, 72 hours, it may not be the most efficient way to do it, but as long as you can get that water in there, you will get there.

So what is in scope, what is in scope, is the pressurizer in the piping that ensures that the water can get in there. The problem is that when we documented this in the SER with open items, it didn't come across that way because in their response, they also talked about alternate ways of reducing pressure.

Our conclusions, the way it sounded, it sounded like the basis for our finding was that they had all of these alternate means of reducing pressure.

I guess it would be similar to everybody says with the spent fuel pool cooling, they always say, "If push comes to shove, we can run a garden hose in there to keep the fuel covered."

That's fine. That's good. That's nice. That's not a basis for reaching any kind of safety finding. And I think our SER sort of read that way. And you guys called us --

VICE CHAIRMAN WALLIS: Your SER is a little confusing because the statement in there is "The pressurizer spray head has no intended function." Well, obviously it has a function or it wouldn't be there.

What you should say is it has no necessary safety function or something.

CHAIRMAN BONACA: Yes, for the license renewal.

VICE CHAIRMAN WALLIS: It obviously has a function.

CHAIRMAN BONACA: Yes, yes.

MR. BURTON: Okay. Yes. I understand where you are going with that, but for license renewal, intended function has a specific function. An intended function is a function that is needed to --

VICE CHAIRMAN WALLIS: It depends on the context, yes.

MR. BURTON: Yes.

VICE CHAIRMAN WALLIS: But this is too sweeping a statement, it seems to me. If someone just reads this, it doesn't make sense and has no intended function. All parts there have some intended function.

MR. BURTON: Okay.

VICE CHAIRMAN WALLIS: But they're not relevant to this particular issue. That's all.

MR. BURTON: Okay. Yes. And these kinds of things may come up again. I guess what I will say is if there is still something in the SER that is still not clear, that certainly may be one of them.

If we need to make any of those final changes, we still have another shot of doing that because we can make changes in the SER and then put it in the NUREG. And that is the final.

So if you feel that that clarification is needed, I think we can still do that.

CHAIRMAN BONACA: Well, I think this is helpful, what you're presenting, then, because when I read it the first time, I pulled up this issue, to me, it was really like, you know, yeah, when I go down my highway, if I failed my brakes, I can still use my hand brake to bring my car to a stop. Yeah, you can do that, but that really is the sense I got.

And so I was saying, well, the primary means of cooling here is pressurizer head. Do we want to really present the operator with a situation where he doesn't have it?

I guess it's a bigger question than general. You made another example before of the -- what was it, the canal, the discharge canal, where still the ability of discharging groundwater through a collapsed canal.

I understand the license renewal is very specific and focused on the design basis, but we don't want to get to the point where you have plants which you are not taking care of.

So if you have spray head failing, for example, would you have loose pieces up there? Where would they go? You know, there are issues there that come up.

So that gives an impression that by focusing summarily on the design basis, in arguing about including or not including, there are almost some cavalier actions about the rest of the plant.

And none have been raised. It's just that that the impression it leaves.

MR. BURTON: I understand exactly what you're saying. And you're right because because something is not in scope or not subject to an AMR, that certainly does not mean that an applicant is just going to let it fall to pieces.

CHAIRMAN BONACA: Yesterday, we heard another applicant, who said that the reason why they were not put in the scope was a different one, was because they had looked at operating experience. And they had seen nobody having problems with the pressurizer spray head.

Well, to that, I can say, in 30 years of operation now, we are talking about 30 more years for other plants. How can you project the same performance in the future?

So there are issues there that leave you puzzled about it.

MEMBER ROSEN: Well, now that you have developed substantial expertise in the issue of crediting the pressurizer spray nozzle to meet Appendix R, along comes 50.48(d), risk-informed fire protection rules, which, by the way, changes the waterfront on this issue because now you don't have to go to cold shutdown. You can stop at hot shutdown.

And so now, whether or not you need the pressurizer nozzle spray to get to hot shutdown timely starts the debate over again for plants that take the voluntary road to use implementing 50.48(d).

MR. BURTON: You're absolutely right. As you well know, currently the whole license renewal is not yet risk-informed. But you're absolutely right. And it's something that we are all aware --

MEMBER ROSEN: But that's the current licensing basis. And the current licensing basis would be changed for a plant that voluntarily implements 50.48(d). So now you're going to have to go back when that happens.

And in some cases, like this one, I think it might relax this requirement of a pressurizer spray. In some other cases, it might have other impacts.

CHAIRMAN BONACA: Relax it even further. I mean, it's not in scope.

MR. BURTON: What you're saying, we

totally agree with, and the staff is aware of it. And P. T. may want to speak to it.

MEMBER ROSEN: The general message is that as regulations that affect the current licensing basis change --

MR. BURTON: Change, right.

MEMBER ROSEN: -- then one has to think what the impacts are for regulatory actions that have been taken in the past that were fundamentally based on the licensing basis.

MR. BURTON: Absolutely, absolutely. I agree with you. I don't know if --

MR. KUO: Mr. Rosen, whenever the licensee wants to change the current licensing basis, they have to submit an amendment for staff review. So it has to go through the regulatory review considering whether it would be a factor, what we impacted, before the licensing basis can be changed.

MEMBER ROSEN: That's right. And if they don't discuss this one, a plant that is adopting 50.48, you have an RAI.

MR. KUO: Correct.

MR. BURTON: Absolutely. Absolutely. So going back to Dr. Wallis, we will definitely go back and take another look at that and see if we can get that clear because we don't want to send the message that because the spray head is not in scope that, therefore, its function is not important.

VICE CHAIRMAN WALLIS: It says it has "no intended function." It doesn't say anything about importance. It says not at all.

MR. BURTON: Right.

VICE CHAIRMAN WALLIS: You may as well throw it away.

CHAIRMAN BONACA: Well, you want to add "in license renewal" into the --

MR. BURTON: We'll clear that up.

Okay. So, again, our conclusion after looking at the scoping and screening results, again, there are two things: whether all of the structure system and components that should be within the scope of license renewal have been identified. And that's 54.4(a).

We have found that all of them have been identified and that the structures and components that are within scope that should be subject to an aging management review again, passive long-lived components, that those have been identified. And, yet, the requirement is 54.21(a)(1). And we found that all of those had been identified.

Next, after scoping and screening comes aging management. I have this in two parts. First, talk about the aging management programs. And I've got basically what amounts to I guess just some statistics or whatever, but staff thought that its review -- again, it was supplemented by an AMR inspection and audit.

And what we have done, for those of you who were at the Robinson presentation, after Fort Calhoun, we re-engineered the process, where the confirmation of consistency with GALL is now done by a separate aging management program audit team that goes out, starting with Robinson.

We didn't have that. We actually tried to incorporate that consistency check in the AMR inspection. What we found was that it was really a really big burden on the inspection team because they had to do everything that they have always done, and then we added this on top of it.

It was quite a lot. And for that reason as well as some others, we decided to pull that out. That seemed to be a function that we could handle within projects. And so that's what we're going to be doing in the future.

VICE CHAIRMAN WALLIS: One thing these

inspectors looked at was the containment protective coatings. I just wonder how they handle something like this, which is sort of a matter of present concern. I mean, there's a bulletin out there. There is a NUREG guide. There is debate among the agency about how to handle sump blockage and all of that.

How do they deal with something which is a current issue like that, which isn't in GALL in the same way because GALL is based on what is done in the past or it was developed before these things were of current interest?

MR. BURTON: Okay. Let me answer it in two parts. First of all, let me talk specifically about coatings. OPPD did not take credit for coatings. Okay? What they said is the underlying metal and its management is what we're going to do. Having the coatings is a help, but --

VICE CHAIRMAN WALLIS: But it might be a hindrance. If they come off, they're bad.

MR. BURTON: Right. But what they are hanging their hat on is the management of the underlying component is what they are going to maintain. That is what they are hanging their hat on.

Now, again, this is right back to what you were saying before. That is not saying that they're not going to take care of the coatings and look at them and all that kind of thing, but for license renewal, in terms of what they are crediting, they are not taking credits for the coatings. They are credited with managing the component itself.

Now, the broader issue of issues that come up, that's part of what we do. That's part of what the ISGs are for. As we do our reviews and the reviewers who are working on the license renewal are the same reviewers looking at current operating issues, I mean, I don't see how you could do it any other way and still be on top so that license renewal would be relevant. So that same reviewers do both.

And that is how we identify the issues that may need to be addressed in license renewal. The documentation of that whole resolution process for license renewal is what the ISGs are. And we have 15 ISGs at this point, either issued or in draft, or --

MR. KUO: Total number, 20.

MR. BURTON: Twenty. So there is a whole range of issues that were actually identified by reviewers or sometimes by inspectors, like with the fuse holders I'm sure you all are familiar with, current operating issues that may have an impact on license renewal. And we have a whole process in place to try and evaluate and reach resolution and incorporate those resolutions into our guidance documents. Am I answering?

Okay. Aging management programs, 24 total. Fourteen of the 24 are what we call common amps. And by that, where we are now is we break up the systems into six broad what we call system structural groups.

There are some aging management programs that apply across those groups. The one that usually comes to mind is chemistry. Chemistry is a program that's applied to reactor systems. It's applied to auxiliary systems. It's applied to ESF systems. Each of those is a separate system group. Nonetheless, a common amp is something that applies across those system groups. We have 14 of those.

There were also ten system-specific groups. For instance, the reactor vessel internals inspection applies specifically to reactor systems.

Anyway, here is just a breakdown for each of the two major groups. We had five that were completely consistent with GALL common amps, seven that were consistent with some deviation, two that were non-GALL. Under the ten, you can see a similar breakdown.

We had a total of 22 systems that were consistent with GALL, either completely or partially. We had one aging management program, non-EQ cables, but when they initially submitted the application, it was a non-GALL amp.

This is one of those situations where we were issuing GALL and certain aspects of GALL. And one of them that came sort of on the back end was 11(e)(1), (e)(2), and (e)(3), management of cables.

And so we got into a thing where they were not really being consistent with the GALL amp. And through some discussions and interactions, they went and reformulated that amp. And now they are consistent with GALL.

Number of amps that are consistent but with some deviations, there were 13 of them. And this seems like such a basic thing. I am using the term "deviations," but specifically what you see in the application, the deviations came in three forms, clarifications, exceptions, and enhancements, something very simple. Well, what exactly do each of those mean? And that was never defined.

So we even had an RAI just to say, "Exactly what do you mean by these terms?" So we got that clarified. And, as you can see, these are the number of aging management programs that have one or more.

Number of GALL amps that are referenced in the LRA, total of 33. Sometimes you had a plant-specific amp that said they were consistent with one or more GALL amps. But when you totaled them all up, there were 33 of them.

We have 38 RAIs from the amp review, no open times, one confirmatory item. Again, that was resolved. We also reviewed for each of the aging management programs the USAR supplement, which ultimately is going to go into the USAR and what is going to be living on after license renewal.

One of the issues that always comes up is one-time inspections. Okay? At Fort Calhoun, at the time, the one-time inspection program had not yet been developed. So what we did was because it wasn't developed, what we had to look at was to make sure that when it is developed, that all the right things are there.

So what we did during the review and the inspection is to go through and say, "Okay. What is it that when it is developed needs to be there?" and make sure that their commitment tracking system had those elements in it. So that's what we did. And also those commitments are in Appendix A of the SER.

Staff will review fulfillment of commitments in inspection procedure 71003. This is where we talked before about these commitments that they make. How are we going to make sure that they actually implement them? It's going to be in this. And, actually, this procedure is being revised to --

MR. KUO: That procedure has been issued.

MR. BURTON: It's been issued. Okay. Good.

MEMBER SHACK: This is new, right? I don't recall this coming up in other license renewals. The one-time inspection programs were defined.

MR. BURTON: Yes. I don't want to say -- okay. Right. You're right. At some of the previous applications, the amp was developed more than what we saw at Fort Calhoun. And, frankly, we were a little surprised by that. But, nonetheless, that was a situation that was presented to us.

So we had to go back and say, "Okay. Given the fact that they are making a commitment to development, just having a promise that it is going to be developed is not enough. We need to at least have an understanding that when it is developed, what is it going to cover, such things as small-bore piping?"

You know, there are certain one-time inspections that from our own experience, we know previous applicants have committed to and that kind of thing, not to say that they weren't, but we had to be sure that it was documented.

So that's when we went to the commitment-tracking system. And we wanted to see something more than a commitment to develop a one-time inspection. We wanted to see what will be in there. And, in fact, that's what we did.

When all was said and done, we felt we were satisfied with that. And those commitments, those specific commitments, what will be in that amp, you see you can see in Appendix A of the SER.

CHAIRMAN BONACA: You have still 25 slides to go. I would suggest that whatever you have, just a counting of issues that --

MR. BURTON: Okay. Let me just go to the conclusions. Okay. Conclusions for the aging management programs, basically that the programs are adequate to manage aging. That's 54.21(a)(3).

54.21(d) requires that there be an adequate description of the programs and activities. We found that to be the case. So you're okay there. Okay. I will try not to be so long-winded.

MEMBER ROSEN: I think the point is you don't need to go through the accounting. You can do it, but you don't need to go --

MR. BURTON: You're all right? Okay. Good. Good. Okay.

CHAIRMAN BONACA: On this one-time inspection, however, wait a minute. I'm still reflecting.

MR. BURTON: Okay.

CHAIRMAN BONACA: I mean, they committed to the GALL approach. So we expect that that would have implementation of one-time inspection, as identified by GALL, unless they had made an exception already to you now.

MR. BURTON: Right. You're right. And that is basically what the commitment was. We're going to develop a one-time inspection in accordance with GALL.

CHAIRMAN BONACA: So you have some idea. I mean, the GALL, the ten attributes, et cetera, is already somewhat defined, which you expect.

MR. BURTON: But even beyond that, there were some other things where they were saying, you know, this can be covered in a one-time inspection, saying, "Well, okay. Let's make sure we get it in there."

CHAIRMAN BONACA: Right.

MR. BURTON: Okay. Skip to which one? I think I skipped to TLAA 16, slide 16. I put this up because I know it came up at St. Lucie. And it also came up yesterday at Robinson. So we thought it was important to put it in here.

One of the TLAAs, reactor vessel neutron embrittlement, upper shelf energy, and pressurized thermal shock, for both, we did independent calculations. In both cases, the applicant used TLAA option 2, which was to extend the analysis to the end of the extended operating period.

Minimum limit for upper shelf energy is 50 foot-pounds. We did independent calculations to confirm that they did not go below that minimum limit. We used reg guide 1.99. And the lowest value was 54.6 foot-pounds for 48 EFPY, which is the end of the extended term. So we did independent calculations to ensure that --

MEMBER ROSEN: What capacity factor is assumed?

CHAIRMAN BONACA: Capacity factor?

MEMBER ROSEN: To say that 48 EFPY is adequate.

MR. BURTON: Yes. I don't know the details of that. I don't know. Do you know, Barry?

MR. LOIS: Eighty percent.

MEMBER ROSEN: Isn't that an issue? I mean, this plant is running breaker-to-breaker whole three out of the last four cycles. So they're not going to be running 80 percent capacity factors. So they're going to get to many more EFPY by the end of the license term, the extended license term, 48, I would suspect.

MR. LOIS: Most likely they're making up for what they lost in the past. In the past, 25 years or 30 years, the load factors were much less than 80 percent. So most of them, it would come up on the average about 80 percent.

MEMBER ROSEN: How sensitive is this lowest projected value of 54.6 for 48 EFPY? What if you had 50 EFPY? Would you be below 50 foot-pounds?

MR. LOIS: My name is Lambros Lois, Reactor Systems Branch for the PTS.

In the case that they do exceed or do something different than predicted, they are required to come back and give us a report.

MR. ELLIOT: I would just like to answer the question about capacity factor. This is simple arithmetic. Sixty years, 48 divided by 50 is the capacity factor. That's what they're projecting.

It isn't the capacity factor that is critical here. It's the neutron fluence. They estimate the neutron fluence. And they have to keep track of it to see if there is a deviation from what they predict.

If there is a deviation from what they predict, they have got to do the calculations all over again. This is a projection based upon where they will be in 2033. If that changes, the numbers change.

Now, how much of an impact is this? First, can you go back to the previous slide? This is not a limit. This is a screening criteria. And as the fluence goes up, I don't have the exact number, but it's going to have to be a lot to go below 50. Even if it goes below 50, there are still things they can do. There is analysis they can do to show the plant can still operate below 50. So that's the critical issue here.

The next slide is probably more critical. And that's the PTS screening criteria slide. In this one here, they're just below the limit. So if they do increase the capacity factor for this plant as a result of better operation, they could wind up over the screening criteria.

But they have to tell us that as part of the PTS rule, that if something changes that significantly changes their result, they have to come back in here and tell us what the impact is.

VICE CHAIRMAN WALLIS: So if they have a PTS rule --

MR. ELLIOT: And this number is based on the fluence that they give us that they project. Now, if that number changes, according to the PTS rule, they have to come back in and do flux reduction or provide some additional analysis to show that they can still operate the plant.

My name is Barry Elliot, by the way.

VICE CHAIRMAN WALLIS: It would be really tardy of the NRC not to revise the PTS rule by them.

MR. BURTON: Okay. Dr. Rosen, are you okay with that? Thanks, Barry. Thanks, Lambros.

Okay. So, again, conclusions for the TLAA. For all of the applicants' TLAA evaluations, we found that they have demonstrated that it will be met by one of the three options given in the rule, which is that either the evaluation as it currently is is good for the extended period that they projected to the end of the extended period, found things satisfactory, or they have concluded that aging effects will be managed for the period of extended operation. We found that one of these three options for each of the TLAA evaluations and found them to be acceptable.

I will move faster. Okay. Inspections and audits.

VICE CHAIRMAN WALLIS: If this is just history, do we need to go through this part or --

MR. BURTON: Not if you don't want to. It's no problem. Again, the bottom line is all of the audits and all of the inspections, you know, if we did find some issues, we generally expanded our sample to get to the bottom of why we were finding anything that we found. Ultimately everything was found to be acceptable.

At the end, there were no loose ends that needed to be tied up in an optional third inspection, which you know is part of our process.

MEMBER LEITCH: I guess already I'm confused between this and Robinson, but the inspection to verify compliance with GALL was not done in the field, right? That was --

MR. BURTON: No, no. It was. It was. It was actually part of the aging management review inspection. This is where for Fort Calhoun, we checked their claim that they're consistent with GALL. We actually did that as part of the AMR inspection.

As I mentioned before, the inspection team had to do all of its normal work that it has traditionally done plus that. And we found that it really was a significant burden.

We had a very good inspection team, probably the most comprehensive we have ever had. Normally our inspection teams are four or five people. We had eight for one, nine for the other.

We have the current operating project manager. We have one of the current resident inspectors. We had two former senior inspectors at that plant, very comprehensive inspections.

But even with all of that talent, it was a lot of work to do what we normally do plus confirmation and consistency with GALL for the amps. And that's one of the reasons why we pulled it out and now we do that and have a separate amp audit. Okay?

MEMBER LEITCH: Okay.

MR. BURTON: I won't dwell on this, just to say I already mentioned the commitment-tracking system is one of the things that we looked at during the inspection. They actually have a couple of programs: an ongoing commitment program as well as a commitment-tracking system.

With regard to the aging management programs that had to have been fully developed, we looked to make sure that if ultimately these things were tracked in the tracking system, that it said all the right things in the system, it identified all the right things to be done.

These next few I can definitely skip over. Eleven open items, the breakdown for confirmatory items, breakdown, everything is resolved. The only issue was one open item, 3.0-1, which was open at the time of the subcommittee meeting.

What that was was when they responded to RAIs, they had also made a number of changes to some of the tables in the application. At that point in the review, we didn't have time to run all of those down before we issued the SER with open items. So we just put a placeholder there as an open item.

Since then we went back and were able to track all of those down and found everything acceptable. So at this point, everything has been resolved.

The next few slides, 22 through 25, I won't go into those. It's just a laundry list of exactly what all the open and confirmatory items are.

License conditions. Basically there were no plant-specific license conditions that came out. So the only ones you'll see we're going to have in the license are the two standard ones, which basically say that the next available opportunity, you're going to update the USAR to include the supplement and that any of the inspections that you have committed to before the end of the current term, you'll do it.

Okay. Lessons learned. First one. There were about five or six of them. I'll go through them real quick. The first had to do with linkage. During the development of GALL, including the demonstration project, we had worked with the industry and concluded that there didn't need to be a link between the plant-specific information in section 2 and the generic GALL information in section 3. And that is how the January submittal came in.

But when a lot of the reviewers saw that, they had a real problem. They said, "I cannot make a reasonable assurance finding if I don't understand how the plant-specific information is tied to a specific GALL AMR and AMP."

So we asked them to go back and put this linkage in, which they did. And that was submitted in

April. That's why there were two license renewal applications, one of the reasons that there were two separate submittals.

As a result of what we found with Robinson and Ginna and some of the ones after, they have this linkage now. So that was one of the lessons learned. And the applicants were able to respond quickly and actually make those changes.

The next lesson learned. There were some structures and components that were not addressed in GALL, but, nonetheless, the applicant found that they could take credit for managing those structures and components, take credit for GALL to do that.

However, when we saw the application, it wasn't real clear which ones they were and which ones they weren't. So we went back and asked them, "Those ones that you are going to take credit for GALL, even though GALL didn't address those structures and components, pull them out. Put them in a separate table." So they did that. And that was also part of that April 5th submittal of additional information.

Now, you won't see a third table for Robinson and all the folks who came after. What they did was they went back and said, "Well, we don't want to do a third table. Let's just try and make our first two tables, identify them better." And apparently that was done. So that's sort of a one-time thing that you won't see again.

Definition of what is consistent with GALL. When we first started, we all assumed that we were all on the same page in terms of what consistent meant. However, we found out that was not the case. And it wasn't even so much with Omaha Public Power but with some of the later applicants.

We found that, I guess in the worst case -- and I can't remember which one it was -- when they said, "consistent with GALL," that meant that they had the same structure or component. That's it. It might be a different material, different environment, different aging effect, but, yet, they called it consistent. So right away we said, "We've got a problem here."

Since then we have had some interactions with the industry. We have reached agreement on exactly what consistent means. And certainly with Farley, which has just come in, this problem has definitely gone away or should have definitely gone away. But you may still see some issues with Robinson, Ginna, Summer, Dresden, Quad because they were too far in the queue to really address this.

And yesterday when you were asking about why Robinson had so many RAIs, some of that was because of this, because we still had to ask RAIs to get all of that consistency sorted out. And you may see that with some of the other applications. Okay?

Another lesson learned. The environments were not always clearly defined, even what's internal versus what's external. So we had at least one RAI having to do with that. They responded. We got it all clarified.

Since then, part of the LRA format more clearly defines the environments. Again, Farley was the one that you should see the full implementation of that.

Okay. This is what I already mentioned: the verification of consistency of the applicant's aging management programs with GALL. We tried to do it with the AMR inspection. We got through it.

The actual result of that is that of the 24 aging management programs, we only had time to actually look at 19 of them, which is unusual for us because we try to get through all of them.

That was one of the indications where we said, "Well, we're going to have to think about doing this a little bit differently." And one of those is that now we have these audit teams. I think, as mentioned yesterday, the audits need to work to look at all of the aging management programs.

Okay. Overall, usefulness of GALL. We found that GALL basically did work. As Mr. Leitch pointed out at the subcommittee meeting, though, the benefits weren't as extensive as we had originally hoped for some of the reasons that I have already mentioned.

So it was obvious that further process improvements were needed. We have already --

VICE CHAIRMAN WALLIS: These sweeping statements, like the first one, we have heard that about other things that the staff has done. It's not clear what metrics you are using or whether this is a kind of a hopeful statement. You had a bigger inspection team than usual. You had a longer SER than usual. Maybe there was more work than usual. Maybe it was less efficient in some ways. What's the --

CHAIRMAN BONACA: More RAIs than usual.

VICE CHAIRMAN WALLIS: Right. More RAIs than usual. What's the measure of efficiency?

MR. BURTON: You're absolutely right, like I said. And that's why we said it wasn't as effective as we had hoped. But what we found is that GALL --

VICE CHAIRMAN WALLIS: Maybe they were happier, but does that mean it's efficient?

MR. BURTON: Well, let me explain that. And we gave a little bit of ground on this review. Because it was the first time, we were using a very different approach. With some of the reviewers, the truth is that they were a little skeptical about the process.

So we gave them a little bit of leeway to say, "Okay. If there is something that you are really not convinced that GALL is really addressing, we will let you go on and explore that a little bit."

And that's why, at least in the Fort Calhoun case, we have probably more RAIs than I certainly think we could have had because we did give them some leeway. Even with that, we could see that GALL will work. And I think probably the best evidence for those folks who were here at Robinson, the next plant, where people were now more comfortable with GALL and how to look at it and that kind of thing, were really starting to see some benefits. So that's what I mean.

So in terms of metric, we are ultimately looking at the reduction in the number of RAIs, the review times perhaps, the number of open items. I think you all see that now we're coming to you, even at the subcommittee stage, with most open items resolved. So we are seeing progress. But, like I said, there is still room for improvement.

A lot of the implementation's improvements we have already begun with Robinson. We expect all of the benefits we should see with Farley. And we really expect to see a lot of improvement there. So we think we're heading in the right direction.

CHAIRMAN BONACA: Could you go back one?

MR. BURTON: Back one? Sure.

CHAIRMAN BONACA: I'm still concerned about this one here, verification of consistency. I mean, take the one-time inspections. They have not defined when they are going to do them, how they are going to do them. Okay?

How can you verify consistency of these one-time inspections with whatever is in GALL? For example, small-bore piping, I mean, you want to inspect to determine whether or not you have aging effect, irrespective of risk significance.

Okay. So where does that come in later on with a problem that says we are going to use purely ISI and that's based on a risk-informed approach and you disagree with that now?

I mean, you say now we are going to verify later on and discuss it later on. When are you going to do all of this work?

MR. BURTON: When? Are you saying when?

CHAIRMAN BONACA: Yes.

MR. BURTON: Well, that's part of that bow wave that you guys have kind of put out in front of us.

CHAIRMAN BONACA: Yes. But it used to be a bow wave, and now it seems to be like an enormous bow wave because everything is being put off.

MR. BURTON: Everything is being put off.

CHAIRMAN BONACA: Who is going to do the verification? Who is going to --

MR. BURTON: You're right.

MR. ELLIOT: I just want to talk about the small-bore piping.

CHAIRMAN BONACA: Yes. Just an example.

MR. ELLIOT: Specifically, when Butch did the audit of the small-bore piping, he came back with the audit results. We reviewed those audit results.

What they were doing was they were consistent with GALL for small-bore piping. And what it says is for the small-bore piping, you ought to do a volumetric examination, in addition to the regular

ISI.

So they were committed to that. Where we found that they were short was that they didn't say where they were going to do it. So we were concerned about that. In fact, the GALL is sufficient in that area.

So we went back to them in this area. And we told them they have to do an evaluation of where their susceptibility is, stress corrosion cracking or thermal fatigue-type problems.

They committed to do that as part of their future evaluation. That gave us the assurance that they would be picking the right location. So they are going to do an engineering evaluation as part of it to pick the right location.

CHAIRMAN BONACA: But do you feel comfortable that you looked at all of the issues?

MR. ELLIOT: Well, the two issues that we were concerned about were small-bore piping with the thermal fatigue issue --

CHAIRMAN BONACA: I understand.

MR. ELLIOT: -- and the stress corrosion cracking.

CHAIRMAN BONACA: But there are other one-time inspections. And for each one of them, you have to go back and do this kind of communication. And then it's back to --

MR. ELLIOT: I can't speak for all. I just can speak for the small-bore pipe.

CHAIRMAN BONACA: I understand.

MR. BURTON: But what you're saying is true. What Barry just expressed in terms of small-bore piping we did with other things as well.

CHAIRMAN BONACA: Yes.

MR. BURTON: And that is what we have documented in Appendix A of the SER in the commitment table. And what we confirmed is in their commitment-tracking system, to that level of detail for small bore as well as other systems.

CHAIRMAN BONACA: Now, GALL doesn't specify that. Do you feel that at some point the GALL has to be revised to include more detail since --

MR. ELLIOT: We are revising GALL to have a small-bore piping separate document.

CHAIRMAN BONACA: It seems to be generally appropriate because there is such a reliance on GALL for a description of programs such that they can say, "Yes. We'll meet GALL." Then there has to be some definition of the concern that staff has. And we'll continue to use --

MR. ELLIOT: And this came up because of the audit and the inspection. And we fixed it, I think, fixed it for this application. And for future ones, we're changing GALL to include that type of direction.

MR. KUO: And, Dr. Bonaca, this is also one of the ISG issues.

CHAIRMAN BONACA: Okay.

MR. KUO: It's being developed.

MR. BURTON: That's basically it in terms of a summary of the safety inspections. Very quickly, we did the environmental review. We found everything to be okay. We didn't find anything that we saw could be a problem to prevent them from pursuing the license renewal option.

As I mentioned before, there were no requests for a hearing or petitions to intervene. So we met 2.758. And, last slide, -- we actually made it -- where I started off, the three conditions for granting a renewed license. All three have been met.

CHAIRMAN BONACA: I have a question for the applicant. We heard before that at some point, you will have all of these commitments and procedures.

And Mr. Rosen here pressed for the issue of, will you have a person who coordinates that and keeps the memory of this program? And you said no, maybe yes, you will have some.

It seems to me that there is a lot of work to be done still. So do you have a project right now that would stay alive until everything is in place?

MR. GAMBHIR: Yes, we do have that. As a matter of fact, I have a copy of all of the actions that we have identified. And in there, there are hours that have been identified, the duration, how long it will take. We are supposed to do that.

CHAIRMAN BONACA: The project will continue. Right now --

MR. GAMBHIR: Right. The project will continue. What we are calling on is now -- I didn't mention that earlier, but my responsibility is to run all the projects that we are doing, all the big ones we're doing.

And one of the new projects that we have identified is we are calling that a license renewal implementation project. So it has its own budget for next year. The idea is that I am aware of the fact that people walk away when the project is done. We have celebrated success. And then we will move on.

The dirty work still needs to get done. Somebody has to update the drawings and those kinds of things. So the answer is yes. The project will continue next year.

As a matter of fact, Ken Henry, who works for Dr. Gasper, has responsibility to get all of these things done and implement the project.

CHAIRMAN BONACA: What do you do with the requirements for license renewal in the procedure? Do you flag it as an LRA requirement?

MR. GAMBHIR: Yes. That's our normal process.

CHAIRMAN BONACA: You press it back to this master document that you keep with that so that you have an understanding of where it came from?

MR. GAMBHIR: That is correct. What we do is you bracket the commitments. And then there is a reference on the back, simple thing that works for us.

VICE CHAIRMAN WALLIS: Can I ask the applicant if they have found that this GALL-centered process was particularly helpful or was it a pain or what?

DR. GASPER: It was certainly a learning experience.

MR. VAN SANT: It was helpful in that it did make clear on a lot of the programs that we use what the expectations of the commission are. So from that aspect, we knew going in what our programs needed to do. And it did help from that aspect.

Being the first plant, it was a lot of lessons learned coming out of it. But it was definitely worthwhile.

CHAIRMAN BONACA: One last question I had would be, do you find that GALL was helpful to you, not the process itself but just the whole GALL report, in clarifying issues, for example, the expectation that the staff has that?

MR. VAN SANT: Yes. Like I said, it made it very clear what the expectations were for the programs.

CHAIRMAN BONACA: And insofar as the discrepancy in scoping determination, I mean, you had a methodology and you concluded that the component is not in scope. Staff came in using the same methodology and concluded that the item should be in scope.

Do you feel that there is a problem there in general or more guidance should be needed for you to converge?

MR. VAN SANT: I think every plant is going to have gray areas. We're not a standardized design.

CHAIRMAN BONACA: I understand that. Yes.

MR. VAN SANT: That's where these come up.

CHAIRMAN BONACA: Yes.

MR. VAN SANT: Our position was essentially not to argue over the gray areas. And it came up as an issue with the commission. We basically accepted their position and went forward with it.

CHAIRMAN BONACA: But you find that the guidance is adequate?

MR. VAN SANT: Yes.

CHAIRMAN BONACA: Thank you.

MR. BURTON: Thank you. I appreciate it.

CHAIRMAN BONACA: Any other questions?

(No response.)

CHAIRMAN BONACA: None? I thank you for a very informative presentation, as always.

MR. BURTON: A little too informative.

CHAIRMAN BONACA: No. You really stayed within the time. We gained five minutes. So we will now take a recess for lunch. And we will meet again at 1:00 o'clock.

(Whereupon, at 11:56 a.m., the foregoing matter was recessed for lunch, to reconvene at 1:00 p.m.)

CHAIRMAN BONACA: We are resuming the

meeting. The next item on the agenda is Interim Review of the AP1000 design and Dr. Kress will lead us in the presentation.

MEMBER KRESS: I don't know if "lead through" the presentation is the right word or not, but this is another one of our interim meetings to be sure we keep AP1000 certification on our front burner and in front of us.

It's to deal with some of the items that we had asked for additional information on before, in particular, squib valve reliability and containment lambda and a few other things like remind us of the design features and some of the open items in the SER.

But at this moment I don't anticipate a letter, unless one of you guys come up with some sort of burning issue that you think has to have a letter to document it.

VICE CHAIRMAN WALLIS: It's more likely to be a cooling issue rather than a burning issue.

MEMBER SHACK: If there's a failure of cooling, then it will be a burning issue, won't it?

MEMBER KRESS: But anyway, with that unless some of you fellows want to make statements, I'll turn it over to -- Mike, did you want to say a few words first?

MR. CORLETTI: No, today's presentation is going to be Ron Vijuk, our Engineering Manager, on the AP1000.

MR. VIJUK: I'm Ron Vijuk. It's nice to be here. What we plan for today, to give you the status report on where we are on the design cert. review on AP1000 is first to go quickly through an overview of the plant design to refresh our memories there and then get into the design certification status and in particular, talk about the open items that we're working on with the staff to get resolved in the near term.

And finally, a couple of technical presentations on specific topics that we've heard there's interest on from ACRS, one on the ADS4 squib valves and one on post LOCA aerosol deposition calculations.

A little bit about AP1000, I think the main thing here is that the AP1000 -- we've tried to keep the design, the plant design and its features as close to the AP600 design as possible. And this allows us to take advantage of all the engineering work that went into the AP600 in the 1990s and apply it to the AP1000. So we view the AP1000 essentially an uprate of the AP600.

It is an integrated plant design. That is, we're looking at the total plant, not just the nuclear side of the plant, but the total plant and that's important as a design to plant and especially in the way they do the physical arrangement of the plant.

The AP1000 has a simplified reactor coolant system loop compared to our traditional PWR plants by using canned motor pumps and we keep all the primary loop piping above the reactor core.

We use simplified, passive safety systems which you've all heard about in previous meetings and I'll go over it briefly. Of course, in the control room and in the I&C area we're using digital technology. An important aspect of the passive safety systems are that we have no requirement for outside AC power. Everything is either self-actuated or powered from batteries, AC powered.

MEMBER KRESS: Just one question on your canned motor pumps?

MR. VIJUK: Sure.

MEMBER KRESS: Have you used canned motor pumps this size before? Have they been in use?

MR. VIJUK: The history on canned motor pumps is that they are used extensively by the Navy and we're even using some of the early plants like Shippingport. The size of pump we're using in AP1000 is bigger than the size we've applied in those applications.

Yes, so it is --

MEMBER KRESS: Does their PRA have a reliability number?

MR. VIJUK: The pump really doesn't come into the PRA. It's a normal operating thing. The pumps are actually, when the safety systems are actuated, the pumps are tripped.

MEMBER KRESS: I was thinking about a loss of coolant just by losing the pump itself as an initiating event.

MR. VIJUK: I guess in that sense it does come into the PRA and a loss of flow event, these kind of things and there's a probability assigned to that, but yes, it's factored in in PRA in that way, yes.

CHAIRMAN BONACA: We are resuming the meeting. The next item on the agenda is Interim Review of the AP-1000 design and Dr. Kress will lead us in the presentation.

MEMBER POWERS: You still have the problem.

MEMBER KRESS: How do you know what the

reliability is?

MEMBER POWERS: How do you get that probability? Pull one out of the air?

MEMBER KRESS: I guess that's a PRA issue and we'll bring it up again when we get to the PRA, if we haven't viewed it.

MR. VIJUK: Shall we go on? Okay. The control room is a compact control room taking advantage of digital technology there as well.

Another important feature of the design is that we've made extensive use of modular construction techniques, so the way we put the structures together is a bit different than previous plants.

The primary system is made up of convention components, if you will, but in a slightly different configuration in the typical Westinghouse PWR, with the canned motor pumps and the loop piping above the core, but the basic components, the reactor, the steam generators, the pressurizer are all basically the same as today's plants with the upgrades, if you will, from lessons learned over the years.

The canned motor pumps, of course, as we've just discussed is a new feature on modern plants at least.

The reactor design is -- we use 14-foot fuel and it's very similar to South Texas in that sense and to the two plants in Belgium that use exactly this core size, 157 assemblies and 14-foot fuel.

Steam generators are bigger than a typical Westinghouse --

MEMBER ROSEN: Before you get off that point, you're still on a bullet of proven reactor design fuel. You've got no bottom mounted instrumentation. What do you do about -- you need to do plug profiles and things like that?

MR. VIJUK: We have fixed in-core detectors. They come in from the top. This -- a typical Westinghouse plant has moveable in-cores coming from the bottom, but in this design there's no penetrations in the bottom head.

MEMBER SIEBER: What kind of detectors are they, gamma thermometers or fission chambers?

MR. VIJUK: These are -- I want to say the material, but -- rhodium or vanadium. The combustion engineering plants use these routinely.

MEMBER SIEBER: Okay.

MEMBER KRESS: Does anybody use gamma thermometers at all?

MEMBER SIEBER: Pardon?

MEMBER KRESS: I didn't think anybody used gamma thermometers.

MEMBER SIEBER: They use them in Europe, but they were trying to market them here and I don't know whether anybody picked up on it or not.

MR. VIJUK: The basic story here is that this equipment is basically the same, very similar to operating plants, except the canned motor pump.

MEMBER KRESS: Was the canned motor pump to get rid of the pump seal LOCA problem?

MR. VIJUK: Well, actually, it's driven more by reliability.

MEMBER KRESS: Reliability.

MR. VIJUK: And when we were first putting the design together with the utility people, there were a lot of people with Navy experience and at that time, at least, people were having problems with the shaft shield pumps and there was a lot of influence from these people to adopt these kind of pumps for this redesign. That's where it came from.

AP1000, just like the AP600, uses passive safety systems and we use passive processes only, so we don't need diesel generators and big equipment, rotating equipment to operate the safety systems.

This reduces the dependency on operator reactions and with these passive systems, we can mitigate the design basis accidents, but we still have the backup from the active systems as another level of defense for beyond-design-basis accidents.

MEMBER SHACK: Actually, if you could use the backup systems, an operator would prefer to do that rather than go through the passive?

MR. VIJUK: That's right, and for most kinds of events, the normal systems will reactor to an event and take care of the plant.

MEMBER SHACK: Right.

MR. VIJUK: And the operator will use those. These are the normal operating systems.

MEMBER SHACK: Right.

MR. VIJUK: And some of the features of the passive system, this is the passive decay heat removal system which is a heat exchanger located in the large IRWST in containment refueling water storage tank. There's inside containment and it operates by natural circulation from the hot leg and returning to the channel head of the cold side of the steam generator to set up a natural circulation loop to remove decay heat for transient events, basically, non-LOCA type events.

MEMBER KRESS: Now what does your active system look like for doing that same function?

MR. VIJUK: It would be the emergency feedwater system, feeding the steam generator and removing the heat through the steam generator.

MEMBER KRESS: Steam generator?

MR. VIJUK: And we do have an active, we call it the start up feedwater system.

We do have a normal feedwater and what we call a start up feedwater system that functions in much the same way as an emergency feedwater system, but it's designed mainly for normal conditions.

MEMBER SIEBER: You also have diesels, right?

MR. VIJUK: Yes, we have two emergency diesels that power the loads in a blackout situation or a loss of off-site power situation.

Safety injection systems is made up of a series of tanks at different pressures. The core make up tanks is two of these. These are large tanks, inside containment at full system pressure and can naturally circulate to the primary system in the event you need emergency makeup. In a LOCA situation, if the level drops down to the level of the cold legs, then they will drain by steam flowing up this line and water flowing into the vessel. So this is both like an emergency boration system for transient events and high head safety injection make up for LOCA events.

And then we have two accumulators, very much like traditional plants that provide rapid reflooding of the vessel after a large LOCA and these are at 700 psi.

And then we have a very large tank, the in-containment refueling water storage tank which provides a low head safety injection by gravity feeding to the reactor vessel. This is longer term makeup from this tank to the reactor in a post-LOCA situation.

And we get the pressurization through the ADS system which is -- there are four stages. Three are under pressurizer where these are opened up sequentially. Once you have a signal that there's a LOCA, you get that by the core makeup tank starts to drain and it reaches a set point and actuates the ADS. And this brings the pressure down in a controlled fashion so the accumulators can help inject and finally the fourth stage of ADS coming off the hot legs brings you down to near the containment pressure so that the head of water in the IRWST can feed the reactor vessel.

MEMBER KRESS: Does your IRWST have a closed lid?

MR. VIJUK: There's a floor on top of this with vents in it, so it's a covered tank.

MEMBER KRESS: It's a vented --

MR. VIJUK: It's open to the atmosphere of the containment essentially through the events. It's a big pool with a cover.

MEMBER KRESS: And you have ways to duct the containment condensate back into that tank?

MR. VIJUK: Yes. And ultimately the containment floods up, the design can flood up so that the level in the containment in the long term and this is several hours after a local is up to about the reactor vessel's flange level and then this pool can continue through these recirc screens, continues to feed the reactor from the pooling containment and this way you set up a -- you're steaming the containment through the ADS pads, condensing in containment. We have a gutter system that drains the water back to the pool in containment or the IRWST. So we set up a continual process of feeding the core.

MEMBER RANSOM: Have you done anything special as far as possible debris plugging in the IRWST and also the research screens?

MR. VIJUK: Yes, these are designed specifically to address the potential for debris plugging, yes, and they're much bigger than current plants, sump screens and this is one of the items we've been discussing with the staff and we are basically following what's happening with the operating plants, but we're in much better condition because of the bigger screens and lower velocities that we had in this design.

MEMBER KRESS: You have all reflective insulation?

MR. VIJUK: We have all reflective insulation in areas that can be affected by LOCA.

MEMBER KRESS: That's what I meant.

MR. VIJUK: The ultimate heat sink is the passive containment cooling system and we had the containment for this plant is a steel pressure vessel and we cooled the outside of this pressure vessel with gravity flow of water from a tank on the roof of the chill building that puts a film of water on the outside of this steel vessel and then natural circulation of air flowing up through, alongside the containment vessel, sets up an evaporative cooling process that removes heat through the shell that's coming from the decay heat steaming into the containment and condenses. And then the steam condenses on the inside, flows back into the IRWST or the pooling containment.

MEMBER ROSEN: How do you provide normal containment atmosphere cooling?

MR. VIJUK: We have fan coolers, conventional type system. A little bit about PRA, just like most plants that have been through design certification, the redundancy and diversity and reliability that we can design into the plant and give us a very good result in terms of the core damage frequency.

We've addressed severe accidents in AP1000 just as we did in AP600. We had to do some extra work for AP1000 to configure the insulation. In fact, this is a little bit out of date. We have run heat transfer tests to improve the heat transfer capability on the bottom of the vessel by streamlining the insulation designed to get a good flow path for water cooling on the outside of the vessel. And the automatic depressurization system helps with issues like high-pressure core melt. We have igniters in the system dealing with hydrogen and the ADS and in-vessel retention also help deal with the issues of steam explosions and severe accidents.

MEMBER POWERS: Can I understand better about in-vessel retention? That means that you're going to try to keep the core debris on the lower head?

MR. VIJUK: Yes, the idea is that the core debris, if you lose all cooling on the inside of the vessel, core debris will eventually end up in the lower head and with the cooling on the outside, the heat transfer is sufficient to maintain the thickness of vessel head here to support the core debris.

MEMBER POWERS: How do you determine what heat flux you need to be able to extract with that water?

MR. VIJUK: By analysis of the molten pools.

MEMBER POWERS: I see. And what does that analysis entail?

MR. VIJUK: I'll have to ask Jim Scobel to speak to that a little bit.

MR. SCOBEL: Hi, this is Jim Scobel. We looked at two different debris -- lower head debris bed configurations. Our base case was metal over oxide debris bed, similar to what we did for AP600 and as a sensitivity case we looked at a debris bed with heavy metal uranium-zirconium-steel configuration at the bottom with a large fraction of decay heat in that lower layer and also concluded that that would not fail the lower head.

MEMBER POWERS: What did you use for the heated solution?

MR. SCOBEL: It was assumed to be much less than the amount of decay heat that we had in the --

MEMBER POWERS: I'm not sure what that means.

MR. SCOBEL: Bottom metal layer. We made a very strong assumption of the amount of heat that was from the decay heat and the other heat sources were considered to be secondary to that amount of heat that was from the decay heat.

MEMBER POWERS: I guess I don't understand what you mean by that. Decay is being produced at some rate, right?

MR. SCOBEL: Yes.

MEMBER POWERS: And what did you take at the rate at which heat was being generated by materials dissolving in the melt?

MR. SCOBEL: Well, you have an oxidation reduction reaction which is going to --

MEMBER POWERS: Where is this oxidation

reduction reaction taking place?

MR. SCOBEL: It would be in the oxide layer.

If you had metallic zirconium and molten U02 in contact with each other, you would have an oxidation reduction reaction which is at most mildly exothermic.

MEMBER POWERS: I would be more concerned with the heat evolved as I dissolved my lower head.

MR. SCOBEL: Well, that was not considered.

MEMBER POWERS: That's where your critical phenomenon on cooling is taking place, isn't it?

I mean it doesn't matter what's going on really in the oxide.

MR. SCOBEL: I'm sorry, say that again?

MEMBER POWERS: The critical issue is what's going on at the lower head and so if you have a metallic metal attacking a metallic solid and dissolving that solid and that is involving heat, that gives you the chance for self-propagating attack and that's the thing you need to worry about and I'm asking what you took for that?

MR. SCOBEL: Nothing.

MEMBER POWERS: That's probably not conservative, is it?

MR. SCOBEL: Well, there were additional analyses done to support ex-vessel steam explosion core-concrete interaction and those --

MEMBER POWERS: That's not the issue here, is it?

MR. SCOBEL: No, but it's --

MR. VIJUK: The issue is whether a crust forms on the pool?

MR. SCOBEL: No, you don't have a crust forming on the pool in the metal layer.

MR. VIJUK: In the bottom metal layer.

MR. SCOBEL: In the bottom metal layer.

MEMBER POWERS: You'll get a metallic melt down there and it could crust, but won't last very long and it would self-dissolve or in dissolving the metal, you're paying the price of heat of melting, but you're getting it back from the heat of dissolution, except you didn't in your calculation, because you only paid the price of melting the vessel head metal.

MR. VIJUK: It seems like we might want to talk about this off-line a bit.

MEMBER POWERS: Or we could talk about it on-line.

(Laughter.)

What's the metal you had down there? You told me that you took a uranium-zirconium rich heavy metal and put it down.

MR. SCOBEL: Right.

MEMBER POWERS: What does the phase diagram look like on that system?

MR. SCOBEL: It didn't have a phase diagram for that system.

MEMBER POWERS: Well --

MR. SCOBEL: We made some conservative assumptions with respect to melting temperature for the vessel head.

MEMBER POWERS: I guess there are what, five primary papers and at least one review paper on the system in the literature and they'll show you have a very, very large inter-metallic lattice phase there with a very strong heat of reaction. So now what's the justification for taking no heat of solution?

MR. SCOBEL: As I said, we assumed that it was much, much less than the amount of decay heat in that metal layer which we took a very high value for.

MEMBER POWERS: It seems like you have a pretty strong assumption here. Are you going to do an experiment to validate this?

MR. SCOBEL: No.

MEMBER KRESS: Decay heat is distributed

through the melt and dissolution heat is localized right at the interface so even if it were smaller, it could have a bigger effect on whether or not -- the issue is whether or not in-vessel retention is actually a reality or whether you penetrate the vessel.

I think Dana has really a legitimate point. I don't know how much credit you're taking for in-vessel retention in terms of -- of course, it never arises in design bases accident phase at all, but it arises -- comes about in PRA space and risk space and I guess we were wondering what effect that would have on your LERF, for example, calculation.

If your CDF is in need of 4 times 10^{-7} it may not make any difference. But I think it's a legitimate question if you're really relying on in-vessel retention.

MR. SCOBEL: Well, in terms of LERF, it really doesn't make an impact just because from an ex-vessel steam explosion point of view which would be the primary method for filling the containment early.

MEMBER KRESS: That's another issue. I'm not sure we know how to do ex-vessel steam explosions very well and so I'd have to look at your calculations for that also.

But in risk base it may not be an issue because you have such a good CDF and I guess it would arise as a potential issue if we had rules that talk about balance between LERF and CDF.

MEMBER ROSEN: Things like rules called defense-in-depth.

MEMBER KRESS: Yes, but we don't have any rules. We just have some main guidance.

MEMBER POWERS: The question I'd ask you, Tom, is suppose that I came in and said F + 1/2 MA.

(Laughter.)

But it's okay, it doesn't make any difference in risk base. But it's offensive to the soul.

(Laughter.)

MEMBER KRESS: I can understand that very well.

MEMBER POWERS: There's a point where you say, look, you've got to do a technically defensible job on these things. I don't care what the risk is.

CHAIRMAN BONACA: We are resuming the meeting. The next item on the agenda is Interim Review of the AP-1000 design and Dr. Kress will lead us in the presentation.

MEMBER ROSEN: One of our Members once

made a distinction between things that were nonconservative and things that were just plain wrong.

(Laughter.)

MEMBER KRESS: Was that Graham Wallis?

MEMBER ROSEN: I believe it was the professor on the ACRS staff.

MEMBER KRESS: Anyway, the thought we'd like to leave with you. We won't have a letter on that at this time. We'll have it in the notes.

MR. VIJUK: I think we understand the question.

MEMBER FORD: At the last July meeting, I brought up four related questions, two of them have been answered.

There was another part that relates to this diagram. The core shroud barrel is presumably going to be made, as I understand it, from 316L cold wet, serial welded which in the high flux areas increased high flux areas is likely to crack or could crack. That in itself would maybe not be so bad, but I understand the diagrams correctly, during a severe accident, we'd have a lot of cold water impacting on that maybe cracked core shroud.

I know you've addressed this question. Could you give us the answer very briefly?

MR. VIJUK: I'm not sure I really understand the question. We're cooling the outside of the reactor vessel in this scenario.

MEMBER FORD: From some of the diagrams. It's not shown on this diagram. But during an emergency cooling situation --

MR. VIJUK: During a LOCA situation --

MEMBER FORD: You've got a whole lot of cold water impacting on that core shroud. Is that correct or was I misreading the diagram.

MR. VIJUK: The core barrel injection comes in here and there's a core barrel --

MEMBER FORD: Core barrel. I was using PWR -- sorry. Core barrel.

MR. VIJUK: Yes, the injection water impacts on the core barrel.

MEMBER FORD: Which could be cracked. What's the impact of that severe accident situation?

MR. VIJUK: I don't have the answer to that and I don't think we have the material expert here to deal with it right now.

MEMBER FORD: But I know you are addressing that issue.

MR. VIJUK: This is the last one on the plant. This is just to show a comparison to the

Sizewell plant in terms of what the passive systems allow you to do in terms of getting the safety systems into a compact arrangement.

Now we'll move on to where we are in the design certification process and what issues we're doing with. These first 5-mile stuns as you can see we've been through and this is pretty much the schedule that we sent out at the beginning of the project back beginning of 2002.

The staff issued their draft SER on June 16th with 174 open items and we're now in the process of working through those open items to resolve them and the next few slides we'll go through the particulars of that.

The key issues are listed here. Thermal hydraulic issues associated with small-break LOCA and I'm going to go through that in more detail. The rest of these I'll just talk about from this slide.

Structural design of nuclear island critical structures, the open item was to do more detailed analysis of some of the structural and seismic analyses. We've completed that. There will be a meeting with a technical audit meeting with the staff next week in Pittsburgh to review the results of that.

Acceptance of leak-before-break for AP1000. The basic issue here was the amount of piping analysis necessary of design certification stage to be able to identify which piping systems were eligible for leak-before-break and we have submitted some additional analyses of certain piping areas and provided the rationale for evaluating the rest of the leak-before- break piping arrangements. And this will be discussed in a technical meeting tomorrow with the staff.

Miscellaneous PRA items. There were a number of open items in the PRA and mainly clean-up items but some involved additional sensitivity studies and evaluating sensitivity to squib valve reliability which we'll talk more about today.

Sump performance. This is the issue we talked about a little bit before about the current on-going issue for the operating plants with regard to potential sump blockage and we've responded to these items and are continuing to follow what's happening with the operating plant discussions.

Security. The new design basis threat came out earlier this year. In AP1000 we've tried to deal with the items that could impact the plant design itself and factor that into our design certification documentation. Most of the security issues are related to the plant operator and will be dealt with at the combined licensed stage.

Dose analysis. The control room methodology, the staff recommended methodology has changed since AP600 and there's a NUREG guide on that with a different methodology. We have redone our analysis for AP1000 with that methodology and submitted it to staff. 10 CFR 50.44 is the hydrogen combustible gas rule which we had anticipated actually in the AP1000 design documentation in that we don't have recombiners for design basis accidents, but we do have some passive recombiners in the system.

And then there were miscellaneous ITAAC items where there were open items on addressing specific comments about how the ITAACs were written or their content.

I'll get into the thermal hydraulic items which was a main topic for the subcommittee meetings we had in July in Pittsburgh.

And then there's three basic issues involved in the open items in this area: upper plenum and hot leg entrainment which has been an issue in this area; COBRA/TRAC modeling for long-term cooling and boron precipitation during long-term cooling and we'll talk about what we're doing on each of these items.

The entrainment issue derived from when we were doing studies before we submitted our design certification application, we did precertification review, if you'll recall where we looked at the testing and codes that we used for AP600 and assess their applicability to AP1000. And in particular, we looked at the test programs that were done for AP600 and assessed their scaling relative to AP1000 and concluded that the AP600 tests were appropriately scaled even for the AP1000 conditions, but the issue that came out at that time and we'd been working on since was basically with the higher power in AP1000, we could higher steam velocities above the core and in the upper plenum hot legs and this could affect the amount of liquid that gets discharged through the ADS system and therefore have an effect, potentially have an effect on core cooling.

So ultimately the staff wrote a letter saying we want to see test data and we've completed some testing at Oregon State University in a facility called APEX-1000. This is the same facility that was used for AP600. It was modified to represent the AP1000, more heaters put in. Or bigger heaters put in to represent the power and some of the components were changed to reflect the changes that were made in going from 600 to 1000 in the real plant.

We have submitted to the staff a series of reports describing the facility, the scaling assessment test reports and data for five tests and our conclusion from these tests is that the behavior for APEX-1000 is essentially the same as it was for APEX-600 in terms of the overall performance of the passive systems.

And we've also submitted to the staff NOTRUMP simulation of two of the APEX-1000 tests and the simulations show good agreement like we had on AP600 and these tests showed no core uncovery for the design basis accident testing.

Several other things we've done and discussed with the thermal hydraulic subcommittee at the last meeting and we submitted these to the staff and the staff is having the chance to review them. We did a sensitivity study with our small break code, NOTRUMP, where we assumed that all of the flow beyond the core exit going through the ADS core pipe behaved in a homogenous way and this way tried to bound the effects of entrainment in the upper plenum and hot leg so that you get as much water out of the system as you can.

And even with this assumption, we got no core heat-up from -- in the analysis.

Kind of a side validation, the question came up about what's the void fraction profile in the reactor core under these low pressure conditions when you're making up from the IRWST and from the sump and so we looked at the void fracture models that's used in the NOTRUMP code and compared it to the full scale rod bundle data from years past to validate the void model used in NOTRUMP.

And then we did kind of a first principles analysis that we called the simple model or the Bill Brown Model, some people call it, to assess what is the quasi-steady condition after you depressurize the primary system and you're feeding by gravity on one side and discharging the decay heat through the ADS four paths on the other side, what is the quasi-steady condition that you would expect the system to come through based on just looking at conservation of the energy and mass and momentum?

And this simple model allows us to look at that and during the conditions when you're going from -- when you open the final stage of ADS on the hot legs and the pressure is coming down the last little bit and you're starting to get injection from a head of water stored in containment.

And we did some sensitivity studies with this to -- some parameters in the model that represent the void equation like a ZC row parameter and recently we've done one to look at the effective of slip ratio, the base model used homogenous flow and then we looked at some slip conditions to see the impact of that and the conclusions from this is that the system behavior that we're seeing in the test and in the NOTRUMP code is to be expected based on the first principles --

VICE CHAIRMAN WALLIS: Now in this interesting period of time, the pressure has dropped in the detection line, the pressure head valve for that is balanced by the pressure drop through the ADS4 system, head of water and pressure drop in the lines, pressure drop out of the break. And to get this pressure drop out of the break you've got to get the pressure drop through this rather strange set of pipes that has Ts and bends and all those things which we don't how to model very well.

I think one of our issues was how do you assess the behavior of that kind of strange geometry that you have between your hot leg and your actual ADS4 valve.

MR. VIJUK: Yes. A couple of things we're doing to address that is one, we have test results now from APEX-1000.

VICE CHAIRMAN WALLIS: So APEX-1000 has tried to model really well, all these details of those bends and Ts.

MR. VIJUK: It represents the geometry in the plant. Whether we have it to the level of detail that would make you happy, I'm not sure, but we do have the riser pipe and the horizontal and the exit -- the basic geometry is there, yes.

So that gives us some information to deal with what is the pressure drop through the ADS4 under various two-flage conditions.

The other interesting that we've done recently is looked back at the ATLAS test that Steve Bajorek and company ran at OSU, also where they did air water tests with feeding water in the hot leg and you have restriction on the other end so you can have a wave coming back and look at the entrainment they measured in those tests and the phenomena occurring there. And we found some other data that supports the idea that bi-modal operation where you have vapor for a while and then it cycles and you have liquid for a while.

VICE CHAIRMAN WALLIS: It's an oscillatory behavior.

MR. VIJUK: Right. So we have data to deal with the issue.

VICE CHAIRMAN WALLIS: Does the APEX have two ADS4 valves?

MR. VIJUK: It simulates the two pipes as one.

VICE CHAIRMAN WALLIS: In one, doesn't it. So the flow division between the pipes is not simulated in any --

MR. VIJUK: On each side. On one side, it's --

VICE CHAIRMAN WALLIS: On the one side, coming out of the hot leg you have the vertical riser and then there's only one valve at the end of that system?

MR. VIJUK: On each side, yes.

VICE CHAIRMAN WALLIS: So it's not duplicating the flow distribution.

MR. VIJUK: It doesn't duplicate that aspect.

VICE CHAIRMAN WALLIS: But you're going to handle that in some impressive way that it's going to be all right?

MR. VIJUK: I believe so, yes. Yes, I think so.

MEMBER RANSOM: Well, have the issues of scaling between the subscale model and the full scale been resolved in that bimodal situation?

MR. VIJUK: That's something we're looking at too, and we've submitted some new information to the staff on that that we plan to go through tomorrow. We have a meeting planned for tomorrow to talk through our responses to the most recent round of question son these issues.

And we have looked at some scaling effects as well. Yes.

VICE CHAIRMAN WALLIS: I think your argument is going to be that if you've got water going through the fall line, even if you don't model it very well, then it must have come from the core and therefore, there has to be water about the core, because there's a continuous flow process going on.

MR. VIJUK: Yes, I think what we conclude from all the -- we've run RELAP. We've run COBRA/TRAC. We've run NOTRUMP. We've run test at 600. We run test at 1000. We've run test in ROSA, test is SPEDS and they all do the same thing. They spit water and steam out of the ADS4. And it gets it down to the pressure you need to inject. So I think the evidence is pretty strong that the system works.

So to resolve this item, I mentioned we have a meeting planned for tomorrow to work, talk through with the staff, these various issues associated with entrainment.

VICE CHAIRMAN WALLIS: I'm just wondering, when do we get to see the details of this? When is an appropriate time for say, the subcommittee to look at the details?

MR. VIJUK: A lot of the details have been sent to the staff and certainly those details --

VICE CHAIRMAN WALLIS: So maybe in three or four months or something?

MR. VIJUK: -- Can be made available. I think we'd be ready before that as far as -- to discuss. A good assessment would be after our discussion tomorrow.

VICE CHAIRMAN WALLIS: I'll see how you resolve things with the staff, yes.

MR. VIJUK: So we've submitted the additional test information. We've validated NOTRUMP against the new test. We've done the sensitivity analyses and simplified models.

And we believe this demonstrates that our

DCD analysis is appropriate.

Next issue has to do with the long term proving analysis. This is after you're on to injection from the gravity systems and you're sitting there feeding the vessel on one side and steaming from the ADS4, pulling out into the long term when the containment floods off and you're feeding from the sump instead of the IRWST. So you have a lower head of water, several hours into the event.

And the issue that came up was relative to the sophistication of the COBRA/TRAC modeling that was done initially in our DCD submittal. We have revised that model with more noting. It's more like our large break COBRA/TRAC model now to evaluate this phase of the performance. So we've done that and completed the plan analyses. We've provided a model description and it incorporated the results into Chapter 15 of CDC.

The results are, I would say, on a global basis very similar to the results we had before, except now we can get a much better picture of the void profile in the core and this kind of thing during this period of time.

The boron issue is related to -- it's kind of the flip side of the entrainment issue. Entrainment says well, maybe this ADS4 is going to take more water out than you put in and create a core cooling problem. This is the other side that says well, maybe you can't get any water out and only steam comes out and therefore over the long term the boron concentration will build up in the reactor vessel.

So in dealing with this, we've run the COBRA/TRAC model, this long-term cooling model out at 14 days after the power is way down, trying to get to a point where you have less steam and less chance with the steam to entrain water out. We're looking at lower power levels.

And this shows that you continue to get lots of water out of the system. In fact, as the power goes down, you get more and more water out of the system.

We've applied a first principle analysis here to look at the amount of liquid flow and compared the simple model to the COBRA/TRAC model and then used the Simple Model to calculate over a very long term what the flow is to the system and therefore have a way to calculate how the concentration and inlet temperature change as during the event.

VICE CHAIRMAN WALLIS: Did you find this boron steam water phased diagram which we were looking for?

MR. VIJUK: No, we didn't find it.

VICE CHAIRMAN WALLIS: You still haven't found that?

MR. VIJUK: We have not been able to find --

VICE CHAIRMAN WALLIS: Don't you need that in order to make these calculations?

MR. VIJUK: I don't think so.

VICE CHAIRMAN WALLIS: Do you need to know how much boron goes off with the steam and how much stays behind in the water?

MR. SCHULZ: This is Terry Schulz from Westinghouse.

We found some test data where some measurements were taken of how much boron would leave in the steam, so some direct, physical test data and that's what we have used in our calculations. That's what we had been using in our calculations.

MEMBER ROSEN: You've qualified these ADS4 valves for long-term passage of liquid at high pressure?

MR. VIJUK: We're going to talk about the squib valves later. Maybe that would be a good time to discuss that, but it's basically like an open pipe. But we can show you the details a bit later, if you can hold that.

The overall status on the thermal hydraulic items is that we've -- we responded to the items like the end of July and early August. The staff has looked at our initial response. About two weeks ago we got a set of 30 additional questions related to our responses and we've just yesterday sent in responses to 27 or maybe even a few more of the 30 questions and that's basically the agenda for tomorrow's meeting is to go through those and make sure we're coming to a meeting of the minds here on these issues.

That's the path forward on the thermal hydraulics.

And looking forward to the rest of the design certification review, so we have three -- in the next week and a half we have three key meetings, if you will, on resolving items. The one tomorrow on thermal hydraulics. Another one tomorrow on leak before break issue and then the structural audit at Westinghouse next week. And we're targeting having a technical resolution and ready to talk to the full committee again, possibly as early as December.

I'm going to move on to the next topic now and introduce it. This is the topic on the ADS squib valves. So today, we're going to talk about --

MEMBER POWERS: Mr. Chairman, could I interrupt the speaker a little bit?

I looked ahead in the vu-graphs and found that there was some work being done by Sandia here. Trust me, I know nothing about it, but since I work for them occasionally, less and less often lately, I bring to your attention that I know nothing about this and although I'm intensely curious --

MEMBER ROSEN: The Chairman has granted you a waiver to participate in this discussion.

MEMBER POWERS: Excuse me.

MR. VIJUK: Okay, so we're going to talk about the design itself and we have Dan Frederick here from the valve vendor, Conax, to talk about it and we'll talk about how we use the information we've developed relative to squib valves in our PRA assessment. And part of that was getting this independent evaluation from some folks at Sandia.

First, why are we using squib valves for this application and this slide tries to capture our logic for choosing these relative to a more conventional type valve like an air-operated value or a motor-operated valve and the real driving force was reliability and we believe we can engineer higher reliability into this valve than we can into an air-operated valve or a motor operated valve for this specific application.

And reliability to open the way the electrical circuitry can be set up, allows a more independent actuation circuit. This type of valve gives diversity from the other stages of ADS which do use motor operated valves.

It's essentially a closed system and only operated in an emergency. There's -- and the way you set up the circuitry, there's very little chance of inadvertent opening --

MEMBER FORD: May I address that one, plese. This is one of the other questions I asked and which was not so far gotten an answer to.

The very low change of an inadvertent opening, that's based on doing tests presumably on valves which are open to the air, etcetera.

They're not tests that have been done when the valve has been exposed to water and I brought up the question at last meeting that the design of the burst disk in this valve is such that you'd expect to have cracking or you could have stress corrosion cracking and therefore since it's pressurized and under normal situations, you could just get an inadvertent opening because of failure of that disk that is in the ADS4 valve.

I understand you have addressed this question. Is there a quick answer.

MR. VIJUK: The quick answer we designed this just like we designed pressure boundaries. It's ASME code Class 1 pressure boundary and that's why we don't expect it to fail.

But I think Dan Frederick can speak more to the specifics of the conditions for this valve.

MEMBER FORD: I'm sorry, does that, you mentioned a code situation. Does that take into account you could have environmental degradation occurring at that high radius curve that's on that last disk?

CHAIRMAN BONACA: We're having this specific presentation after this, right?

VICE CHAIRMAN WALLIS: We're having a presentation on the valves?

MEMBER ROSEN: Is he going to discuss this question?

So far he's just deferring our questions. That's fine.

MR. VIJUK: I'm not the materials expert.

(Laughter.)

MR. VIJUK: I'm not trying to avoid the
questions, but I think Dan can probably speak to it better than I can. He'll be up --

MEMBER FORD: Oh, he'll be up in a minute? I didn't understand.

MR. VIJUK: I was just trying to explain the reasons beyond choosing this type of valve as opposed to another type of valve, that's all. And another important factor was you have zero leakage during normal operation with an air operated valve or motor operated valve, you can expect some leakage.

The in-service testing and in-service inspection and maintenance is another aspect and I think part of this relates to your question as well as detecting cracks and so forth. That comes into the equation as well.

And our assessment was that after looking, we looked pretty hard at air operated valves and trying to make them perform this function and it got pretty messy from a design standpoint, from an engineering standpoint to provide the air, high pressure air and so forth needed for that. That in the end, we believe this is simpler and will be easier to implement than the more conventional type vales. And it ends up being less in size and weight and we made this choice back on the AP600 and at that time we had the utility people reviewing our design and leading the design and they were strongly in support of this decision.

This talks about some of the circuits and the way the circuits are set up they can be made highly reliable. We have two safety protection systems divisions to each valve and one diverse actuation system actuation circuit to each valve, all independent and this way it's two-way diverse because the protection system is diverse from the diverse actuation system.

And these have low probability of spurious actuation and two-out-of-four logic and the controller circuit minimizes the likelihood of hot shorts and basically the required voltage to actuate the valve is not available in the controller circuits.

MEMBER FORD: If it minimizes the likelihood, what is the minimum achieved?

MR. VIJUK: I think Selim will talk about that --

MEMBER ROSEN: How many of these in the plant, eight?

MR. VIJUK: There's two on each hot leg.

MEMBER ROSEN: Four.

MR. VIJUK: Four.

MEMBER ROSEN: You only have to go one go open to ruin your day, right?

MR. VIJUK: One. That's considered a LOCA event, yeah, and we consider it and analyze it. Inadvertent opening.

So that's kind of the background and I'll turn it over to Dan Frederick from Conax who has the experience behind these valves.

MEMBER KRESS: Welcome back again.

MR. FREDERICK: Thank you. Okay, I'll go ahead and get started. Can you hear okay?

My name is Dan Frederick. I'm Vice President of Engineering for Conax and I'm here to give an overview for the squib valve.

We need to flip the page.

(Slide change.)

MR. FREDERICK: Okay, first of all, to give you some of the background on the squib valve itself, it starts off approximately about 10 years ago. I was with Pyronetics at that time and General Electric was very interested in going to use a 7-inch normally closed pyro valve. And so at that point they came to us and we were one of seven valve vendors that they had contacted in regard to trying to achieve what they thought was the best approach for their program.

And as a result of that, the valve design that we at Pyronetics at that time had provided as far as the basic cross sectional design concept was accepted by them as the best way to proceed with what they had intended to do.

And I'll just give you a little history to the Pyronetics, just some of you have heard it before, but others haven't, so I just want to tie it in. Pyronetics was a company that was part of OEA that was located in Denver in the same facility.

MEMBER ROSEN: What's OEA?

MR. FREDERICK: OEA, Incorporated, it's a separate company that was located in Denver. And that company, OEA, at one point transferred all the technology of the aerospace division to Northern California and it was part of the OEA Aerospace Group. What remained in Denver was the automotive side which mainly was the initiators for the airbag.

And then after getting to Northern California and becoming part of OEA Aerospace, I was there for about five years in Northern California and prior to that I started with OEA in 1980. Since that time, since I left there, UPCO has bought out the OEA division and presently right now, Conax is licensed to sell product, manufacture, design and sell product that had previously been designed by OEO, "Pyronetics" during whatever stage you want to start at. So right now, we have a license to do that. And therefore, that's how Conax ties in with the Pyronetics early design phase that I'm referring to.

And of course, the big issue at that tine is can you scale up a valve? What we had proposed was a 2-inch valve and similar here what we're talking about is scaling up a valve. That was the big issue at that time as well.

Then it was going from 2 to a 7 which was at that point a very huge increase in size and the present time we're talking about going from a 7 to a 9. So we provided GE a list of our customers at that point. They contacted several of those. They came back and gave Pyronetics the contract.

We went through. We built and successfully tested the valves.

MEMBER ROSEN: The 7-inch valves?

MR. FREDERICK: The 7-inch valve, that's correct. And so, of course, the application right now for AP600, as you can see on the bottom of the chart, it was to use the same 7-inch ID valve, originally, and now for the AP1000 it requires a 9-inch.

So that's a little overview of the history of where we're at.

(Pause.)

Sorry about that. I haven't used this before.

(Pause.)

This is a cross sectional view of the 7-inch valve which was scaled up to meet the 9-inch requirement with some changes, obviously as far as interface --

MEMBER ROSEN: The 7-inch is the minimum diameter?

MR. FREDERICK: Yes, the 7-inch is the full passage itself.

MEMBER ROSEN: That's the place where Peter, Dr. Ford, is concerned about the --

MR. FREDERICK: That's correct. There's a notch right here and that gets sheared out.

MEMBER ROSEN: High stress location, 9-inch diameter.

MR. FREDERICK: That's correct.

MEMBER ROSEN: Circumference high D, right, Dana?

MR. FREDERICK: Okay, as far as the operation of the valve, first of all, it's a fairly simply operated unit. You have some initiators on the top. Generally, what you do is you have the current come in, it fires one, two or three initiators, how ever many you choose. That then, in turn, fires into a booster charge that's contained within this cavity. That then fires, creates a pressure within the top part of the valve itself. When the pressure gets to a specific level, what happens is that this tension bolt actually breaks. This piston bend is driven down. The impact force of the piston on this, what I'll call a nipple section causes this thing to come down and get sheared out of this section and this particular part right here then is driven over center and opens up for full flow through the valve.

MEMBER ROSEN: If I were looking down, if I was standing on top of that thing that's driven down and flops over, what's the cross section look like?

MR. FREDERICK: This right there?

MEMBER ROSEN: No, go down, go down to there to that thing. What is the cross section of the top of that look like?

MR. FREDERICK: Like this.

MEMBER ROSEN: It's a rectangle.

MR. FREDERICK: Yes, it's more like a rectangle.

So you've got an impact force of a specific point here and then it rotates over.

MEMBER ROSEN: And it's hit by this piston coming down?

MR. FREDERICK: That's right. This piston right here, the bottom of that piston impacts right here. That generates enough force to shear that section and drive that valve down.

MEMBER ROSEN: All the way around 27 inches?

MR. FREDERICK: Pardon?

MEMBER ROSEN: All the way around 27 inches?

MR. FREDERICK: It's already been proven on the 7-inch. We've gone through several firing tests and every one of them were successful.

And so what we're talking here is going from a 7-inch ID up to a 9 which means obviously you've got a scale of the passage here and that correspondingly changes everything here accordingly because everything is getting bigger?

MEMBER ROSEN: What would it take to build one and do it?

MR. FREDERICK: What do you mean?

MEMBER ROSEN: Well, build a 9-inch and do it just like you did for a 7.

MR. FREDERICK: Are you talking cost, schedule?

MEMBER ROSEN: How hard would that be?

(Laughter.)

MR. FREDERICK: The first time around when we had the contract for the 7-inch, it took about a year and 3 to 4 months from start to finish before we delivered product.

So we built the valves, went through our development test program. GE went through a program on all the booster charges as far as the radiation environment, etcetera, etcetera. We built the valves. We tested some in our plant in Denver. We then shipped some to Wiehle in Huntsville at which time representatives from our company and GE were there for witnessing of the actual test with the actual steam that was put into the unit to fire it.

MEMBER ROSEN: About a year and a half, you think?

MR. FREDERICK: About a year and a half.

MEMBER ROSEN: Would that be the same for a 9-inch?

MR. FREDERICK: Yes sir, right. In fact, I say that because in my mind at least I don't see the problem with scaling it up because we went through a very large exercise, working GE previously on the design analysis associated with the requirements associated with this type of valve.

So the design analysis work has already been completed. So what we do is we take that, implement the new requirements and we scale it up accordingly.

VICE CHAIRMAN WALLIS: There are no new phenomena going from 7 to 9 inches?

MR. FREDERICK: No sir. Things are just bigger so of course, you'd have more powder in here obviously from a booster charge standpoint because you need more pressure here in order to actually drive that thing down because your cross section is bigger.

MEMBER ROSEN: Now in Pittsburgh, you did say that you were planning to do these tests of a development prototype, 9-inch valve, including charge sizing, looking at things like charge sizing, inspection, hydrostatically testing, hydrostatic and leak testing vibration, actuation with over-loaded boosters and actuation with underloaded boosters just to see what kind of sensitivity I presume the device has to the over or under loading of boosters.

And all of that is to be done at some

point and the question is when?

MR. FREDERICK: Well, that's really up to Westinghouse. Right now, we have no contract to do that.

MR. CORLETTI: This is Mike Corletti from Westinghouse. That activity is part of the COL application and as part of an ITAAC verification. That testing will have to be completed as part of ITAAC.

MEMBER ROSEN: In the meantime, we have to take it on faith that this valve has the same failure probability as the 7-inch valve and I'm taking it on faith that when you do the testing as part of the ITAAC after you have a COL, that it will turn out to be -- have the kind of failure characteristics and thereby the likelihood of failures is that E^{-4} numbers that you're quoting for demand -- in the meantime, we don't have any proof of that.

MR. CORLETTI: But the next presentation is the discussion of the reliability and I think I'll defer based on the reliability to that. But as far as on faith that we can do the type test, it's a condition of operation of the plant that these type tests are completed.

MEMBER ROSEN: Yes, I understand that. I

understand that. That's not where I'm pushing. What I'm pushing on here is in the meantime and before we have that test, we have to take on faith reliability that you're quoting to feed into the PRA.

MR. CORLETTI: The next presentation will provide you why we believe we have confidence in the PRA reliability numbers that we've provided.

VICE CHAIRMAN WALLIS: But to come back to my concern. Even when you're doing this for GE, for the SBWR, there was no concerns at all about environmental degradation of that high radius, presumably stress concentration at the point where you -- no one was concerned about that?

MR. FREDERICK: Well, this particular section, we went through the design analysis report for the 7-inch valve. At that point there was established by the customer at that time, they gave us a specific corrosion rate that they had anticipated to see over the life of that unit. Therefore, that corrosion rate value was input into the design analysis and therefore the size of that section was slightly enlarged in order to account for that.

VICE CHAIRMAN WALLIS: General corrosion wouldn't concern me. It's more that it's use for -- that's the stress components the high stress concentrator. I'm more concerned about --

MR. FREDERICK: Okay, well, I understand your point. The only thing I can say there is there's been an awful lot of valves built over the years where we have not had one that actually cracked from a condition we're talking.

Granted, we haven't had it in the conditions that we have here. I will admit that. But then on the other hand, there's been an awful lot of valves that have been delivered that had extremely high pressure requirements and have met a lot of environmental requirements on missile and satellite applications.

MEMBER ROSEN: What re the conditions up against the section that Peter is concerned about? Is that --

MEMBER KRESS: Stagnant, borated water.

MEMBER ROSEN: Stagnant borated water at 2,000 psi?

MR. FREDERICK: Well, I have a comparison chart here, I think, that gives that information.

MEMBER RANSOM: How often would that component be replaced?

MR. FREDERICK: That I'll defer, somewhat, to Westinghouse, because we've had discussions with regard to when you would do a, quote, "changeout." And so I'll have to defer that to you, Terry.

MR. SCHULZ: This is Terry Schulz. We would do an inspection in accordance with the ASME code, which means that every ten years you would be taking this apart and looking at it on some staggered basis. It's four valves so it wouldn't all be nothing for ten years, but sometime in between ten years you'd look at it. And then based on what you would see, you could replace that rather easily if need be; it's not a hard thing to do.

MEMBER RANSOM: I guess I'm bringing that question up because I -- mine which also refers to your question. I bring it up because it's an easy thing to remedy. Use a different material, put a coating on it, whatever. I'm bringing it up because no one's raised this question before and I hate to see it go into service and that potential problem never have been addressed. That's why I'm bringing it up.

MR. FREDERICK: Well, I appreciate your concerns. I know we've had some discussions with Westinghouse with regard to what material should be utilized, and that's still undergoing and has not been totally finalized yet. So we are moving in that direction.

MEMBER POWERS: May I ask you what you're using for the initiator in the charge?

MR. FREDERICK: I can't give you that information. It's proprietary to UPCO.

MEMBER POWERS: That's fine.

VICE CHAIRMAN WALLIS: But it can sit there for many years without doing anything, without deteriorating?

MR. FREDERICK: On the GE Program, the initiators and boosters were subjected to an accelerated aging test program to show that they were good in their particular case for a four-year requirement. So they did go through that program.

MEMBER POWERS: When you say good, you mean that they would after being aged do the function they were intended to do.

MR. FREDERICK: They were aged to simulate the time frame under the conditions that they would have been anticipated to be used. And after that time, we fired a bunch a hardware to substantiate that we were still getting the same performance that we had prior to that.

MEMBER POWERS: I guess the question that comes to my mind with squib valves that I have had the pleasure of using that the squib would work fine but the metal around it would be terribly badly corroded from products of decomposition of the squib initiator and charge itself. And that's specific to the material, and I don't know that yours is the same. Did that sort of thing get looked at?

MR. FREDERICK: Well, like I said, I can't give you the powder and materials used, but what it amounts to is that there was a requirement on this particular valve that had to be able to be refurbed, meaning if you fired it, you had to be able to get it back together, and it was 24-hour changeout in order to tear it down after it's fired, put in the new hardware and be ready to use it again. And that was demonstrated and proven that you could do it within a 24-hour period. And so you do replace some of the components, obviously, that are involved here because I mean obviously you're sharing metal and you've got a few things happening, but the key parts associated with the body is still the same part that you have in there to start with.

MEMBER POWERS: Yes. But what I was asking really about the corrosion of the body over a course of time around where your charge is located.

MR. FREDERICK: Right in here?

MEMBER POWERS: Yes.

MR. FREDERICK: Okay. Well, if that became an issue over a period of time and you could replace the members that you had a concern with.

MEMBER POWERS: It's just that those issues tend to find out when you go to use it, not because of an inspection program.

MR. FREDERICK: Well, I think you'd be able to see that. I think that the powder that we use in there is relatively benign to the environment itself because it is a refurbishable unit, and that was kept in mind during the design of the valve in its early stages. The one key feature about the valve itself as far as refurb, I mean you can take this whole thing apart, you know, this whole sections comes out, everything up here comes out and it's all easily removable. So anytime you chose to do a tear-down or a review or whatever you'd like to do with some period of time, we could easily do that.

MEMBER ROSEN: Is it welded into the pipe? I mean it's welded into the system, right?

MR. FREDERICK: No, no. This is metal seals, and the center faces right here.

MEMBER ROSEN: How is it -- here comes the pipe from your flange.

MR. VIJUK: A flange on one side, open on the other end.

MR. FREDERICK: Yes. Right here's the flange.

MEMBER ROSEN: Oh, okay.

MR. FREDERICK: And then there won't be anything over here; it will be just an open-ended.

MEMBER SHACK: What holds the gate in the vertical position before it fires?

MR. FREDERICK: Right here?

MEMBER SHACK: Yes.

MR. FREDERICK: This is all one metal, one piece of metal here.

MEMBER SHACK: Oh, yes. All right.

MEMBER ROSEN: And how thin is the minimum thickness?

MR. FREDERICK: I don't know the exact number offhand. I would have to look at the design analysis report. I can get that information and we can provide it later.

MEMBER ROSEN: Is it mils or tens of mils?

MR. FREDERICK: No, no. Off the top of my head I'd say at least a quarter of an inch, maybe three-eighths.

MEMBER RANSOM: Out of curiosity, was the breach-lock type design considered initially so that if the thin part did fail, you would get a small LOCA rather than a large LOCA or would that even be of any concern?

MR. FREDERICK: Well, this is the basic design that was originally proposed and no issues came up that would have caused us to go any other direction than we had proposed. Okay? Testing performed on the valve I've got listed over there. I think you can take a look at that. It went through an extensive test program.

VICE CHAIRMAN WALLIS: It's interesting, it snaps the bolt at the top?

MR. FREDERICK: Pardon?

VICE CHAIRMAN WALLIS: It snatches the bolt and it chops off the ring and it doesn't break the pin that across the bottom.

MR. FREDERICK: Right here?

VICE CHAIRMAN WALLIS: Right.

MR. FREDERICK: No, because the pin doesn't see any load. The pin is mainly there for a retainment.

VICE CHAIRMAN WALLIS: It gets hit by that thing coming down.

MR. FREDERICK: No, because you're hitting here.

VICE CHAIRMAN WALLIS: Oh, it's the -- the hammer's on the bottom.

MR. FREDERICK: You're hitting here so you don't see any impact load on the panel. So that allows it to freely go over it without any impact loads. Okay? I just want to point out that generally with any devices that we make at Conax, generally have to have high reliability because they're used in life support programs, aerospace programs and obviously any consequence of any failure would be an absolute disaster, whether it be human life or even high millions of dollars in satellite and missile applications. So high reliability is required, and I'll get into some of the things that we do to ensure that we have that.

Conax procedures, first of all, control high reliability. I mean we have a very detailed approach on how we make sure that we build things, and it goes through the various departments. Everybody's interacting in order to give their input on what needs to be done, and a lot of this is based upon a lot of factors that I'll bring out here in just a minute.

Custom valve designs and upscaling is a standard process, so there, again, what I'm saying is I don't see a problem going from seven to nine. Going from two to seven was a much bigger task. Simple valve designs reduce problems, and I say that because I think the key thing with any squib valve is that there's not that many parts that are actually going into the valve itself. So the moving parts are very minimal, and therefore your chance or likelihood of having anything go wrong is reduced because there are a substantial amount or a fewer amount of parts that have been utilized. The development process that we go through, I've mentioned that in the previous meeting and we'll touch that a little bit here in a minute.

Some of the reliability numbers, I got some information from an UPCO report that I then put down here and then the Conax reliability here.

MEMBER ROSEN: What's UPCO stand for?

MR. FREDERICK: Pardon?

MEMBER ROSEN: What's UPCO?

MR. FREDERICK: UPCO is Universal Propulsion Company, and they are now owned as part of the Goodrich operation that's headquartered in Arizona.

MEMBER ROSEN: And they've made 64,000 of these valves?

MR. FREDERICK: Valves total.

MEMBER ROSEN: Which are used in what service?

MR. FREDERICK: Mainly in missiles and satellite applications. Obviously not in commercial use like nuclear power plants.

MEMBER ROSEN: Missile and satellite operations. Just give me a feeling for what is it that they do in these applications.

MR. FREDERICK: Well, if you want to, let's say -- first of all, they're used to fire open if you want your propellant to start functioning your system. Without the valve opening, the satellite would not function, therefore it would be a loss. Okay? We have normally closed valves and normally open. We have others that when they get up there to wherever they want them they want to shut off the fuel flow. You can fire the valve, shut it off and therefore the satellite just continues its operation.

On other systems like missiles, for example, we have some pure gas systems that's used on some of the guidance type work that goes into some of the key missile programs. You have to fire a pyro valve to knock of the section that opens up the flow for the gas to go through, and that's used for locking on targets and doing the work. So, again, if that did not work, the missile would not work. It's also used on missile applications for, again, like satellites where things sit there for a long time, they're pressurized, they're ready to go, but until you actually fire that valve you have no fluid going through the system to drive the missile to its end state.

And so, generally, all the normally closed valves are used in a condition generally to take some fluid or pressure, we've got some valves that have 10,000 psi operating, or we've got nitrogen tetroxides or hydrozines or monomethyl hydrozines or any combinations of those type of fluids and gases that are used up-front on that section until the time you're ready to operate that valve, and when you do then that fluid or gas does its work in the system. And that's their intent, so if the valve doesn't work, you've got a major system problem with a missile or a satellite application.

MEMBER ROSEN: Okay.

MR. FREDERICK: So there, again, that's why it's so important that the reliability is built in up front, okay?

VICE CHAIRMAN WALLIS: But the aging isn't -- these don't sit around for ten years before they're used.

MR. FREDERICK: These don't?

VICE CHAIRMAN WALLIS: The ones that have been tested and used didn't sit around for ten years.

MR. FREDERICK: Some of the satellite valves are required to stay up there a long, long period of time, some around ten years before they're ever fire.

VICE CHAIRMAN WALLIS: Okay.

MR. FREDERICK: Because that's basically the requirements for falling down, and the length of time keeps increasing as time goes on because everyone wants to extend the life or the use of something that they've already got.

Squib valve design summary, squib valves have high inherent reliability, and I believe that based upon the thousands of valves that have been produced and functioned very well. Reliability for smaller valves is applicable for larger valves because, obviously, you've got to start someplace to get someplace else in which case that's how you get there -- you start small and you go large. I've had cases where I've taken valves and had to miniaturize them for some of the Star Wars programs years ago in which it was a case going the other direction. I mean there are cases where you want to go down.

The same design standards have been established as far as how to do the engineering analysis, the proof and the leak testing of the valves. Over and under testing of boosters and initiators is a standard practice. You need to know what your margins are associated with how the unit's going to operate.

The design concept for shearing metal is the same. I mean, obviously, one of the key things with the squib valve you've got parent metal throughout the entire life of whatever you're trying to use until the time you're ready to open it up, so you don't have to worry about any parent metal or any connections that leak. That would be a problem if you didn't have an all metal section to prevent that. And to date there's been no failures associated with shear sections cracking under pressure or temperature conditions for the valves that we have delivered.

And if you have any other questions, I'll be glad to take them right now or move on. Thank you.

MEMBER ROSEN: There are still a few questions on the table. One is the water, the design for water, passing borated water at high pressure.

MR. FREDERICK: Well, that gets back into again reviewing the material combinations that's being exposed to it over time, and I've got to work those details out with Westinghouse to fine tune what the plan is as far as material applications.

MEMBER ROSEN: So that's later also. I mean the proof that these nine-inch squib valves will pass water at high pressure for a long period of time, I guess that's their design function in long-term --

MR. FREDERICK: Well, I don't see any problem with the valves passing water over long term. I guess the issue mainly is is the concern about, let's say, water in contact with the surface over a long time.

MEMBER ROSEN: The seed.

MR. FREDERICK: Yes, in contact with the seed over a long period of time. That's the issue that we're still trying to work out with Westinghouse with regard to material selection. But can we answer that right now, I would say no because that hasn't been decided yet. And, further, it would still take some kind of test program in order to do that unless perhaps Westinghouse has some data already on the liquid in contact with the materials that are planned for use.

MEMBER SHACK: Stainless steel has worked rather well in PWRs, and when you weld you get rather high stresses in the weld. They may not be design stresses but I haven't cracked very many welds in stainless steel in PWRs. So I think they have a high probability of success. I mean you obviously have to pay attention to the details of the design, but I think there are materials and design considerations that you can use to give you a high probability of success.

MR. CUMMINS: This is Ed Cummins. Actually, if a valve opens, it's effectively a pipe, and the question is sort of equivalent to will a stainless steel pipe allow a two-phase flow, and I think that's --

MEMBER ROSEN: It doesn't have to reclose.

MR. CUMMINS: It does not have to reclose.

MEMBER ROSEN: It's different in that sense from a safety relief valve.

MR. CUMMINS: Yes.

MEMBER ROSEN: Which you expect to open, pass water and then reclose.

MR. CUMMINS: That's right. This valve never -- you have to replace the actuating part of the valve in order to put it back in service.

MR. SANCAKTAR: My name is Selim

Sancaktar. I work for Westinghouse in Reliability and Risk Assessment. Earlier this year, we gave you a presentation on AP1000 PRA and during this presentation you have brought up some questions about the squib valve reliability, same questions that were already discussed today. So what we did is we went back -- since we are very much interested in the health of these valves, it's in our interest to make sure that the design will not cause problems later on. And anything that you say we wanted to make sure that we look into. So I'm going to kind of summarize what we tried to do.

What we did was we went to Conax, a vendor with considerable experience in this area, and you already heard Dan Frederick summarize his position on that. Whether he convinced you or not, I leave it to you, but I was impressed and I bought it. But we thought that you may need a little bit more proof than that, so we said where else and we went to Sandia. We thought that we are not on the same side of the fence with Sandia most of the time, so that should be a good check on our design and what we want to obtain.

So we went to Sandia and we told them what the questions were and what we are trying to do. We told them about Conax and we made sure that they contacted each other and talked with each other. And I have four slides that I want to try to very quickly summarize the Sandia report. You're right, we didn't make these slides, we just took these slides out of Sandia's presentation, and I hope that I don't butcher it. If I do any injustice to Sandia, I apologize up-front.

MEMBER POWERS: These guys do injustices to Sandia enough that they probably applaud.

MEMBER ROSEN: All the national labs are treated equally here.

MR. SANCAKTAR: Also it's vice versa.

MEMBER KRESS: I've heard that first question asked many times.

MR. SANCAKTAR: Why Sandia?

(Laughter.)

MEMBER POWERS: And you've seen that answer to, "Sandia has successfully."

MR. SANCAKTAR: No, that's their answer. My answer, Westinghouse answer is because we thought that Sandia would be --

CHAIRMAN BONACA: Okay. We need to move on. We have to reach our time and we there's another presentation, I understand, after this.

MR. SANCAKTAR: So Sandia with some basis to talk about this subject. They are not neophytes in this area. Here are the reasons for it, and they looked into this and they also provided us with their current test data, which is better done -- I'm going to show you on a slide on the next one, that they are more experienced now than they gave us data previously that we used for AP1000.

MEMBER KRESS: Now these are pretty small valves, right?

MR. SANCAKTAR: Excuse me? Yes. Yes.

MEMBER ROSEN: Now what is this NMLT/SLT? What are all those abbreviations?

MR. SANCAKTAR: I have no idea about what these acronyms stand for. The thing that I wanted to emphasize here, there was another slide we removed, is they have more experience now than they gave us in 1996 when we actually used their data. See, at the time they gave us this number based on data available at that time. Now, after six years, they have more data and the trend -- that's the only thing I wanted to emphasize -- the trend is even in a better direction. But I wanted to --

VICE CHAIRMAN WALLIS: So two in ten to the minus four is one in 5,000? They tested -- one failed in 5,000 tests?

MR. SANCAKTAR: Actually, it's zero in 4,000 for this one, and this is zero in 5,000 something.

VICE CHAIRMAN WALLIS: So it's zero really.

MEMBER SHACK: Well, you have to compute your confidence on that.

MEMBER ROSEN: It's never quite --

MEMBER SHACK: Zero out of 5,000 is zero.

MEMBER ROSEN: It's never quite zero.

VICE CHAIRMAN WALLIS: So there's a confidence on these numbers.

MR. SANCAKTAR: So their -- this is, again, Sandia conclusion. The AP1000 valve design is a basic design that has been used extensively for many smaller squib valves, so there's nothing new here. And environments -- environment was one of the questions brought up, and they're pointing out that the valves that are built so far are used in very harsh environments. The scaling, they are basically scaling is not an issue, they don't see that as an issue, and that the reliability is maintainable. The number that has been assessed at this point is maintainable. So they are basically concurring with our current position.

MEMBER KRESS: And you actually paid for this? Bill Shack could have told you that for free.

MR. SANCAKTAR: So that's the bottom line and this is their slide.

MEMBER KRESS: Okay.

MR. SANCAKTAR: Now I'm going to just summarize things very quickly. These are just going back through numbers, we have this EPRI number, and then we have two Sandia sources which we used to calculate the AP600 and AP1000 reliability. We got new numbers now based on even more tests, and the trend is in the right direction. And what we have used is very reasonable. Just as a point, the EPRI data is really based on MOVs. They didn't have data, they just used MOV data. MOVs are considerably more complicated than these valves.

And we, of course, are aware of the fact that the AP1000 CDF is somewhat sensitive to the value of the squib valve. It should be. And we are aware of it, so we want to make sure that this area is covered well, and we have taken all the design operational conclusions to make sure that we are using a reasonable, maybe a little bit even conservative reliability and that we will try to maintain it throughout the operation.

So the bottom line is recent information from different sources would point out that the failure probabilities are reasonable, consistent with operating experience. This can be achieved for the AP1000 specific design. Upscaling isn't a problem, operational environment is not a problem, according to people whom we've discussed the subject with, and we told you who they are, and that this really is answering your question about -- it may not be obvious from the way it's stated but it's saying that the concern is -- we don't think the concern is a major failure mode. However, we note of course your point and it should be made sure that it has been covered in the design. So that's all I have to say.

MEMBER ROSEN: I guess the weakness of this -- could you go back one slide?

MR. SANCAKTAR: Certainly.

MEMBER ROSEN: To me, might be -- that one there. The first bullet, the sensitivity analysis, you doubled the failure probability.

MR. SANCAKTAR: Yes.

MEMBER ROSEN: But one perhaps could argue that doubling is a minor change in this thing. Would you consider a tripling, a quadrupling?

MR. SANCAKTAR: Certainly. If you triple

it -- I mean as long as we are going in small steps like that, it would go from 15 percent to 30 some percent. I'm not sure exactly what, maybe 31 or 32. I don't know how linear it is, you know, in that range.

MEMBER KRESS: Increase it by a factor of ten and go to 75 percent, roughly.

MR. SANCAKTAR: Right. I mean if these squib valves are a factor of ten worse, and we are really off the mark, we may as well use MOVs and we don't need to go to them. The whole purpose of this design is to stay away from MOVs because MOVs are not as reliable. So we have to assure that --

MEMBER ROSEN: Go back another slide and let's take a look at that.

MR. SANCAKTAR: Okay.

MEMBER ROSEN: If -- back.

MR. SANCAKTAR: Oops. I don't know where I am. I went to --

MEMBER ROSEN: You're going the wrong way.

MR. SANCAKTAR: Oh. This slide?

MEMBER ROSEN: So if it's a factor of ten worse --

MR. SANCAKTAR: Right. We'll back to --

MEMBER ROSEN: -- the failure to open in

demand would be 1.3 to the minus three. Take that Sandia 2002 data.

MR. SANCAKTAR: If you want to go from here, right, we will be going in this range.

MEMBER ROSEN: You're almost back to the EPRI motor-operator valve data.

MR. SANCAKTAR: Right. Exactly. I mean if we truly believe that we are really that far off, then we wouldn't have done this way, because already have MOVs --

VICE CHAIRMAN WALLIS: Well, I don't think MOVs have anything to tell you about squib valves at all. They're completely different things.

MEMBER POWERS: And what he's saying is he would design an MOV into the system if he wanted to be that bad.

MR. SANCAKTAR: We are living with them in many areas. Yes?

MEMBER RANSOM: All of these data are failure to open. Is anything known about the inadvertent actuation of different kinds of valves in these circuits?

MR. SANCAKTAR: The inadvertent actuation is a very -- will depend on the properties of the actuating design. We are not privy to how these valves are used in various applications. However, in our application, we have done -- we tried to design it out, not number it out or not try to hand write it out but design it out as much as possible. And one of the important points is we have a arm and -- separate arm and fire circuits. And if you arm it alone, the accidental, it doesn't go. If you fire it by itself, it doesn't go. You have to do both of them, and you have to do them in a certain very short amount of time, within seconds. So accidentally arming doesn't make it go, accidentally firing it doesn't go. Doing these two at two different considerably different time frames, like a minute apart or something, doesn't do it. So we tried to design it and it's very specifically designed.

MEMBER ROSEN: And all of that's embedded in the circuitry.

MR. SANCAKTAR: Yes.

MEMBER RANSOM: Well, can you put a number to that?

MR. SANCAKTAR: Yes. We did, actually.

MEMBER RANSOM: I mean do you know what --

MR. SANCAKTAR: Yes. Yes. The number to that actually is like -- that slide has disappeared due to the shortening of this -- is 5.9 minus five.

It's calculated by fault tree analysis, assigning various failure combinations and common cause and this and that.

VICE CHAIRMAN WALLIS: Can we move on?

MR. SANCAKTAR: Anything else? Okay.

MR. CORLETTI: This is Mike Corletti from Westinghouse. I guess I'd like to ask what you'd like to see in the next presentation. This is a subset of what we presented in Pittsburgh. The question had came up what do we do for a post-LOCA aerosol deposition. We went through in Pittsburgh how we did an AP1000-specific calculation analysis, similar to what was done for AP600, and I'm leaving it up to the Committee here whether you want to see the entire presentation or --

MEMBER KRESS: Well, I don't think we have time for the entire presentation.

VICE CHAIRMAN WALLIS: The results were interesting.

CHAIRMAN BONACA: How long would be the NRC presentation?

MEMBER KRESS: That's a good question.

MR. COLACCINO: This is Joe Colaccino. We expect the staff presentation to be less than 15 minutes.

MEMBER KRESS: I'm looking at your slides to see --

MR. SCOBEL: Well, in a quick summary, I would say that we used the AP600 value for lambda and then later showed that AP1000 is expected to have a significantly higher lambda than AP600. So we did the analysis conservatively. That's the quick and dirty summary.

MEMBER KRESS: Now, lambda is a variable in time.

MR. SCOBEL: Yes.

MEMBER KRESS: I was looking at one of your slides that says you took a dominant core damage sequence from PRA?

MR. SCOBEL: Yes. We used a core damage sequence to generate the environments to calculate the lambda.

MEMBER KRESS: And you used MAAP to get the environmental conditions?

MR. SCOBEL: That's correct.

MEMBER KRESS: Which, basically, consists of the steam condensation rates and the thermal gradients --

MR. SCOBEL: Yes.

MEMBER KRESS: And the aerosol

concentrations come out of MAAP also?

MR. SCOBEL: No. Actually, they didn't. They came from 1465.

MEMBER KRESS: Okay. You standardized --

MR. SCOBEL: We used 1465 --

MEMBER KRESS: You use the standardized source term.

MR. SCOBEL: Yes.

MEMBER KRESS: Timing also?

MR. SCOBEL: Yes. Which is based on a similar sequence from what we used for generating the environment.

VICE CHAIRMAN WALLIS: So the lambda is higher significantly but you're going to go back and still use AP600 lambda?

MR. SCOBEL: That's correct.

MR. CORLETTI: No. Excuse me, this is Mike Corletti. Dr. Wallis, we initially had used the AP600 lambda but I think the staff had requested us to perform a detailed AP1000 calculation. Once we had paid for that, we decided to use the value of the AP1000. So we are using the AP1000 value now.

MR. SCOBEL: Oh, okay. I didn't do that part of the analysis.

MEMBER KRESS: Yes. I noticed at one of

your slides that the dominant contributor of the lambda was thermophoresis. I have a question about that. Was there any hydrogen combustion involved in this?

MR. SCOBEL: There was hydrogen combustion involved in the environment for the lambda calculation.

MEMBER KRESS: So at short periods you had high thermal gradients?

MR. SCOBEL: Yes.

MEMBER KRESS: Dana, does that raise any flags with you?

MEMBER POWERS: Yes.

MEMBER KRESS: Because it takes a while for thermal gradient lambda to be developed, and I'm not sure you have in a hydrogen combustion --

VICE CHAIRMAN WALLIS: Isn't it the condensation that does it?

MR. SCOBEL: It's a combination of the heat transfer and the condensation heat transfer, but the hydrogen combustion is occurring at ignitors so it is sustained over periods of time during the releases.

MEMBER KRESS: Oh, you're sustaining it over a period of time.

MR. SCOBEL: That's correct.

MEMBER KRESS: And you feed that into a thermal gradient at the wall? Because this is thermophoresis to the walls.

MR. SCOBEL: Yes.

MEMBER KRESS: So what that does is raises the temperature of the environment?

MR. SCOBEL: Yes.

MEMBER KRESS: Okay.

MR. SCOBEL: If you look at the temperature plot that's in there, you can see that even on this title heat transfer rate you can see the spikes that are occurring as you have hydrogen burning at the ignitors.

MEMBER KRESS: Those are overall mass balance temperatures of the containment volume; is that what those are?

MR. SCOBEL: I'm sorry, I don't understand.

MEMBER KRESS: Are those average temperatures for the whole containment --

MR. SCOBEL: Yes, it is an average --

MEMBER KRESS: -- sort of a bulk average temperature.

MR. SCOBEL: Yes, it is an average.

MEMBER POWERS: Is this a one-node

problem?

MR. SCOBEL: The aerosol calculation is a one-node problem.

MEMBER KRESS: So your delta T there looks like -- you don't have a wall temperature there.

MR. SCOBEL: I do not, but the wall is the passing containment cooling system, which would be -- because it has the evaporation on the outside of the wall, it would be significantly cold.

MEMBER KRESS: Pretty cold. So you're looking at temperature differences of like 100 degrees C in these.

MR. SCOBEL: Yes, that's correct.

MEMBER KRESS: And that translates into what value for lambda did you actually end up with?

MR. SCOBEL: The average value, I believe, is 1.1 per hour.

MEMBER KRESS: Does that factor in the full surface area of the containment?

MR. SCOBEL: Yes. Yes, it does.

MEMBER KRESS: Dana, do you have any other questions about that lambda?

MEMBER POWERS: I don't know very much about this particular calculation. I'm a little surprised you say the whole containment volume. Do you really take the dome into account for this calculation?

MR. SCOBEL: Yes. In terms of volume?

MEMBER POWERS: Yes.

MR. SCOBEL: That's correct. Yes, we do.

MEMBER POWERS: That probably explains the difference between this and 600, because I don't think they did for 600; I think they left the dome out.

MR. SCOBEL: I think -- I don't think that's correct for AP600. We left out volumes that were inactive like the dead-ended compartments, the PXS compartment, the CVS. But the entire offered compartment was accounted for.

MEMBER POWERS: I mean what I know is what's written down here, and the issues that come up on this is it looks like they used a fairly small particle size but it's not very important here because thermophoresis and diffusophoresis are dominant, and in this size range there's not a whole lot of size sensitivity to that. There is a sensitivity to the shape factors that you choose to use for these particles which are not fully dense. And so the question comes up what shape factor did you use? Now, NAUASTAR tends to treat everything as though it was a sphere.

MEMBER KRESS: Yes. I think they used a density factor of 0.8 of material.

MEMBER POWERS: So that would give you like a 1.2 shape factor, which is a pretty small shape factor. That's essentially a sphere. That's not even a very fluffy sphere. So you raise questions about that. Since AP600 was done, there's now been some measurements of shape factors under diffusophoresis, and you can get some substantial shape factor effects for what nominally look like spheres under diffusophoresis just from the double it, triple it kind of thing. And so you'd ask questions about how do you treat shape factors?

The devil is a lot in the details here because although the lambda they're getting out of here is not an outrageous lambda, I mean it's kind of what you'd expect, but what you've got is a substantially higher inventory. And so for the 10 CFR Part 100, you're asking what's the worst two hours here because you're leaking out, and though you've got a substantial lambda, it's not like 75 percent bigger. So you've got the worst two hours where you're very close for AP600. You've got a higher inventory, so you've got to ask what's happening in the worst two hours here, and it's not in this particular thing. A little bit surprises me that they're getting so much thermophoresis if they're not looking at internal structures. I don't know whether you are or not.

MR. SCOBEL: Well, the heat transfer is dominated by the passive containment cooling system, especially after an hour or so when you're expecting to get the releases of the fission products from the core. So you expect your internal heat syncs to be more or less saturated compared to the passive containment cooling system.

MEMBER POWERS: Sure. Sure. When you're going to the wall you've got a temperature gradient and you've got a steam flux going the same way. It's real easy to double count, so now the question is how are you adding together the two effects, and you really have to do that with Fokker-Planck equation. You can't just fumble around with it. Now, there are various ways to add and I just don't know how NAUASTAR does that.

MEMBER KRESS: I thought they just calculated them separately and added them linearly.

MEMBER POWERS: No. See now they double count because you've got a volume that's moving like this and then you're adding on to it. Well, this volume has not seen the total thermal gradient and so you're effectively depositing particles twice. It's a real problem in these combined phoretic environments. You have to do that really -- you have to go really do that. At this size, you're in the transition between the Newton regime and the continuum regime, so you've got to figure out how you're going to solve continuum mechanics and the Boltzmann equation and make them match because you can't solve them there. There's some guys that have done that in the literature mostly down in Texas, and they have some nice answers to that that they run against tests, and I just don't know how they would compare it against the straightforward addition. I'd have to look at it, but it's -- I mean it's a tough question.

I notice in the viewgraph that it says, gee, we neglected all these things and the experiments show that aerosols tend to form sticky material to either be retained in narrow path or fall quickly to the ground. Well, the LACE tests they pick some materials and when we look at what the fuel evolves when it degrades we don't get stuff that looks like LACE. LACE, as I recall, use cesium hydroxide and of course that's one of the great results that comes out of the Phebus Program. We don't have any cesium hydroxide. We have cesium-molybdates and things like that. And, in fact, in the tests we're doing now seem to say these reactor aerosols just are not hydroscopic and so this has neglected the hydroscopicity. That may not be a great conservatism there.

My point being is the devil's in the details on this, and I'm not sure how much of the detail you can go into without actually pulling apart the NAUA code and you never know where it stands right now because it's an evolving code. I mean it keeps -- it reacts to the changing technical environment.

MEMBER KRESS: Well, I'm not sure how to proceed with this question then. Did you want to pose some specific questions you'd like answers to and they'll come back to us later on this or do you want to look into it as a Committee ourselves?

MEMBER POWERS: Well, I mean you're clearly going to have to look at the Part 100 analysis on this plant, and that's where this thing comes forward.

MEMBER KRESS: Yes.

MEMBER POWERS: I mean just on the face of it, I look at this lambda 1.1 and I say, well, okay, it's a larger than what they got for AP600. I don't have any reason to doubt it. I mean if they'd come in with ten, I would have said, well, they probably haven't got that right. If they'd come in with 0.1, I would have said, well, they probably haven't got that right for another reason. It's this combination of the lambda and the inventory and what the worst two hours are and do you survive the Part 100 scrutiny? And that's where we want to look at this stuff.

I mean you can say specific things: Okay, what did you do about the diffusophoretic shape factor, and we kind of know what that ought to be now. We've got some measurements. How do you combine the diffusophoresis term and the thermophoresis term? You've got a problem with double counting here when you do phoretics at the same time.

You would ask what did you do about the non-radioactive mass, because you put 1465 in. That only gives you the radioactive mass in there. So what did you do with the rest of it? Well, they probably didn't do anything with it. They probably just took the particle size. Because they're coming in a little bit small on the particle size, which, by the way, is -- it's not a huge conservatism but it's definitely not non-conservative, you know what I mean? I mean if you were dominated by gravitational sedimentation, it would be hugely conservative. But since you're dominated by phoretic processes which are very size-dependent at 0.1 microns but not very size-dependent in this range, it's kind of a wash sort of thing there.

To the extent that diffusophoresis is important, you really come down to what your condensation model due to the non-condensable gases in there, more of a thermohydraulic question than anything else.

MEMBER KRESS: That comes right out of four, I guess.

MEMBER POWERS: Yes. And I don't know what you're using.

MR. SCOBEL: Off the top of my head I don't know either.

MEMBER POWERS: One of them.

(Laughter.)

VICE CHAIRMAN WALLIS: So how would you reassure that they've done it reasonably? Would it require that Dr. Powers read all your stuff and review it or that Dr. Powers examines the staff about how well they have assessed all these phenomena or how would we be sort of reassured that everything is good enough? What's the means for us to get to that state?

MR. SCOBEL: Is that up to me?

(Laughter.)

MEMBER ROSEN: Most assuredly, not.

MEMBER POWERS: Traditionally, the staff has done independent calculations in this area.

VICE CHAIRMAN WALLIS: So we'd go after the staff for reassurance.

MEMBER KRESS: I think we could ask this question of the staff. They're probably not prepared to address it today, but it's a question we could put to the staff and see how they dealt with these issues and their view and proceed from there.

VICE CHAIRMAN WALLIS: So the staff has got a message now, I hope.

MEMBER KRESS: Yes. It's strictly a question of do you meet the regulatory requirements of 10 CFR 100 from the various DBAs. And they have to address those when they look at their SERs. So when we get to evaluating the SER, I guess we'll bring that question up.

With that, I'd like to turn it over to the staff and hear their presentation. I'm going to postpone the break until we hear from the staff.

MEMBER ROSEN: How long is the staff's presentation?

MEMBER KRESS: They said about 15 minutes.

VICE CHAIRMAN WALLIS: That's for their

presentation; 35 minutes for questions?

MEMBER KRESS: Right.

MR. COLACCINO: This is Joe Colaccino. Each of our slides -- we each are going to present a status and we only have one slide for each of us. And so I know mine I can do in one or two minutes just on the status of the overall project.

VICE CHAIRMAN WALLIS: Do you have any technical content?

MR. COLACCINO: Yes, sir. We're going to talk thermohydraulic issues. With that, I'd like to introduce Jennifer Uhle to do that, Section Chief in the PWR Section.

MS. UHLE: Professor Wallis -- is this on? My slide doesn't really have any technical content per se because it was a repeat of what was said at the Subcommittee meeting. At this point, we raised some more questions to Westinghouse and they submitted about 20 -- I guess 28 of the responses to yesterday, and we're having a meeting with them too, so that's where we're really going to get down into the details.

At this point, what we thought the staff would do today would simply be to summarize to the full Committee what our concerns are. Now, you've already heard that because of what Westinghouse has already presented to you, so I don't know exactly what you want me to get into today. So what I had done was just put together a one-page slide that discusses the overarching issues.

But, first, I want to introduce the NRC Review Team. We mostly have everybody here today. We're getting some help from Research with Steve Bajorek. Gene Hsii is in NRR, he's in my section, he's in the back there. Walt Jensen, Lambros Lois, Summer Sun and Len Ward. So the independent analysis that the staff is doing is extensive. We are comparing NRC code calculations and we are doing some data comparison as well as some independent analytical modeling. I was going to put my slide up but we figured we'd be faster because I only have one slide because we have to get the projector set up, so I'm just going to speak from my slide here.

At this point, we have some open items that were identified in the draft SE. One that came out as part of the discussion with the SE was the identification of the limiting small-break LOCA transient that was discussed to some degree at the Subcommittee meeting, and the limiting small-break LOCA had been the DEG or the DVI. However, they're getting very similar collapse liquid levels for the

ADS -- inadvertent ADS-1,2,3 as well as with the cold leg break. And so we wanted to verify that they have identified what the limiting small-break LOCA transient is because our review is focusing on that particular transient.

We've also noticed that with our review that containment back pressure that's been credited for the small-break LOCA transient before was 14.7 and now it's increasing to some degree, so we wanted to get a better review or do a better review of that to make sure that the back pressure that they are crediting is not, I would say, non-conservative. So we've addressed that in a question. We'll be discussing that with Westinghouse tomorrow.

We have an open item that was raised by the Subcommittee, and that is the NOTRUMP/RELAP5 comparison. If you've compared the two calculations, we're getting somewhat different collapse liquid levels, and we're also seeing it looks like a period of time right around before the ADS4/IRWST transition where there is a bifurcation between the two codes where the NOTRUMP calculation shows an increase in collapse liquid level, the RELAP 5 shows a decrease. And after that point in time, the slopes are pretty similar, so what we're trying to do is narrow our focus to look at that period of time. At first, NRC staff was going to do that review ourselves here. Looking at staffing and the logistics of things, Westinghouse may in fact do that comparison and then NRC would independently confirm that. We're going to discuss that tomorrow as well.

We have, of course, the outstanding issue on the core -- the level swell during the ADS4/IRWST transition phase. And in that I should say that it's not just a level swell but it's also the entrainment, so any of the phenomena that are occurring during this period of time it gets difficult to review because there are so many phenomena that are in some way competing. The higher the level swell you have the more entrainment you would get. So to say that you're conservative in level swell you'd want to say that NOTRUMP underpredicts level swell. But then if NOTRUMP is underpredicting level swell, then that's not conservative with respect to entrainment, because you're going to be keeping more water in the core.

So Westinghouse has set up a variety of calculations that demonstrate that looking at each one of these phenomena individually that they have calculated conservatively the prediction of the transient, and we're going to go over that with them again tomorrow to make sure that we're in full agreement.

VICE CHAIRMAN WALLIS: Now, let's see now. We had a meeting in July and both you and Westinghouse knew that there were these questions. I'm a little surprised that the answer is Westinghouse submitted something yesterday.

MS. UHLE: Westinghouse had submitted information to us at an earlier period of time, okay? We then went out with an additional set of questions that are then questioning their answers. And what we found was that we could sit there and go back and forth --

VICE CHAIRMAN WALLIS: But no one was saying, "We're going to resolve this before we meet with the ACRS on October the 1st"?

MS. UHLE: At the time in the meeting, we thought that we would have -- that the Subcommittee meeting would be canceled and that we may have a full Committee meeting and at which point in time we would discuss what we had resolved at that point. So for us Westinghouse had submitted responses to our original questions. They thought that they had --

VICE CHAIRMAN WALLIS: But we're no further ahead than we were in July. You haven't told us anything new since then.

MS. UHLE: To the degree that we're further ahead, we're further ahead in the comparison of NOTRUMP to the --

VICE CHAIRMAN WALLIS: Well, maybe you are but we haven't been told.

MS. UHLE: Okay. I can tell you where we're further ahead.

VICE CHAIRMAN WALLIS: Well, you probably don't have the time to do that now. Maybe you want to tell us where you're further ahead.

MEMBER POWERS: Jennifer, could I ask a question. Now, you've spoken mostly about thermohydraulics and the piping system and things like that. How about this issue that was just raised, the condensation rates in the containment?

MS. UHLE: Yes. The containment review, that's in a different branch.

MEMBER POWERS: I see. And similarly --

MS. UHLE: That's in the Containment Section.

MEMBER POWERS: -- hydrogen blocking of the dome and things like that --

MS. UHLE: Yes. That's in a different branch, but Joelle and Joe are writing down your questions, and I believe that they would get those concerns to the appropriate group. So in reactor systems what we focus on is the --

MEMBER POWERS: Looking at reactor systems where you have this effluent coming out of your AD4 valve --

MS. UHLE: Yes.

MEMBER POWERS: -- do you get a lot of water droplet?

MS. UHLE: That is an open issue that we have. Westinghouse, again, says conservatively that they would -- during the ADS4/IRWST transition time where it's conservative to assume a lot of water is going out, they have done an analysis that shows that with a homogenous situation that they're taking out a lot of liquid and that they're slowing the depressurization rate but they're still getting poor covered. And, okay, that's something that we're, again, looking at. We recognize that, but our question then turns out to be when you get into the long-term cooling analysis, you need to take liquid out, so it's now non-conservative to assume liquid is being taken out in a transition where you turn from one assumption for conservatism into another. That's our question. That's what we'll be discussing with them tomorrow.

I mean based on back-of-the-envelope calculations that we have at this point, if you're talking a long-term cooling, we are concerned about the assumption that they are entraining as much liquid as they say. So on the last bullet, you'll see on boron precipitation RELAP5 or WCOBRA/TRAC sensitivity studies. We want to address that by either running a RELAP5 deck to completion into the long-term cooling stages but we have to model the sump, and there's, again, questions about the pressure drop through the lines in the sump and the configuration, and RELAP doesn't do multi-demodeling of pipes whereas WCOBRA/TRAC can where they can get a gradient and then donor the appropriate void fraction up into the ADS4 lines. So we're going to work out tomorrow sensitivity studies that we would like Westinghouse to run to determine if we feel that their calculation of the entrainment during this long-term phase is conservative for the boron precipitation.

MEMBER POWERS: It would be useful, if you can in the course of doing these analyses, to report the water droplet emissions into the containment in the, say, 200 to 1,000 micron range.

MS. UHLE: See, we're not -- I mean we're not going to have any idea of what -- we'll have an idea of the mass coming out, but to say we know the interfacial area exactly and therefore the diameter of the droplets, there are no models in the code that have been validated to determine that. But, of course, you would think the higher the velocity of the vapor, the smaller the droplets you're going to --

MEMBER POWERS: That sort of information, because that may be one of the hidden conservatisms in this aerosol calculation, is those kinds of droplets are usually pretty good at sweeping out aerosol and just knowing what it is so you get some quantification would be a useful thing to do if you're trying to do a realistic source term analysis.

MS. UHLE: I mean we can certainly go and come with a correlation that looks at what the size of the droplets that are entrained, but it's not going to be validated in any way. And it's not given by the code; it's going to be just based on our view of --

MEMBER KRESS: Normally, those droplets are long gone before the source term comes out.

VICE CHAIRMAN WALLIS: They've all fallen out, those big ones.

MS. UHLE: But, Dr. Powers, you're indicating you want a lot of interfacial areas. You want very small droplets.

MEMBER POWERS: Well, I'm just struggling around for trying to understand all that's going on with the aerosols in this containment, and what's conservative and what's not conservative. And that's just one thing that came to mind. I mean if there isn't any, then that's fine too.

MEMBER KRESS: I suspect, for example, that those droplets may not be well treated in the thermal analysis of the containment.

MEMBER POWERS: There are droplets all over this system. What we rather suspect is the dripping off the roof if there's any condensation up there -- inconsequential. They're just too damn big. But these flows and things like that and bubbling and popping --

MEMBER KRESS: But those sprays they put in really sweep out the aerosol.

MEMBER POWERS: But now if they would just put a spray in there would be no problem at all. We could all go home and not have to agonize so much.

MEMBER KRESS: Sorry about that.

MR. CORLETTI: You want another spray system.

(Laughter.)

MEMBER POWERS: We love spray systems around here.

VICE CHAIRMAN WALLIS: On the boron precipitation, did you find this mysterious phase diagram which seems to be a trivial thing to find with boron water steam?

MS. UHLE: We did not. That question was posed to Westinghouse. We thought we would --

VICE CHAIRMAN WALLIS: I think it was promised that someone would come up with one of these. Now, Westinghouse said that they're going to meet with you and then they're going to meet with us again in December, but since there seems to be no progress --

MS. UHLE: There is progress.

VICE CHAIRMAN WALLIS: Well, I mean nothing to -- no progress reported to us that's technical on any of these issues. There would have to be probably a Subcommittee meeting between now and December that's going to --

MS. UHLE: Right. And that's what we thought was discussed at the Subcommittee meeting, that there would be a later Subcommittee meeting when Westinghouse and the staff --

VICE CHAIRMAN WALLIS: Well, we can't have it until you have something to present to us which is ready.

MS. UHLE: Right. And it was not -- we felt or the staff's position was that it wasn't the point of today to provide progress to you. We thought that that would be at the later Subcommittee meeting.

VICE CHAIRMAN WALLIS: That's right. So when is that going to be? When is a reasonable time to schedule this time when you will actually show the real progress made in resolving these issues with Westinghouse?

MR. CUMMINS: This is Ed Cummins. I think we can answer that better after tomorrow, and I think that we could communicate with you based on the progress tomorrow.

VICE CHAIRMAN WALLIS: So it seems to me that your idea to come back to the full Committee in December is really rather premature because there's no --

MR. CUMMINS: Well, if you're Westinghouse, you think you've answered all the questions, but it's unfair to say that without the interaction with the staff that that's the case. So we feel pretty good, but I don't think you should rely just on that. I think we could communicate to you within a week when we would be ready to have a

Subcommittee meeting.

VICE CHAIRMAN WALLIS: Well, it's a two-sided thing. The staff should be doing work too.

MEMBER KRESS: May I put that on your list?

VICE CHAIRMAN WALLIS: Maybe the staff has been doing work that concludes that your work is wrong, I have no idea.

MEMBER KRESS: We'll work that out. We don't need to discuss that here.

MEMBER POWERS: I'll just inject, I found the presentations and the information very useful since I wasn't at any of the Subcommittee meetings. Even Jennifer's zero viewgraph presentation was interesting.

MS. UHLE: I have a viewgraph, they just didn't put it up there. In fact, I have two. One is entitled with my name on it.

VICE CHAIRMAN WALLIS: Really, your viewgraph says that you're looking at the things that Westinghouse presented this morning, so that's it.

MS. UHLE: Yes. If you want me to go into what we have done in addition to what we had done from the Subcommittee meeting, then I can summarize that briefly for you. And that is we've been looking more at the comparison of NOTRUMP to the APEX tests. We've done more back-of-the-envelope type calculations of the level swell. We've looked at during the long-term cooling and the ADS4/IRWST injection phase. We feel that Westinghouse has, although I'm not saying for sure, appropriately compared data for the level swells in both cases. We have made -- we're starting to reduce the data from the APEX-1000 test to get a better idea of what the quality is going out the ADS4 and comparing that to what is predicted by NOTRUMP during the ADS4/IWRST transition phase.

We've, in addition, loaded up a simplified RELAP model to do the long-term cooling. What we need from Westinghouse was the information on the L over Ds for the pressure drops and get a better idea of what the flow paths are in the system as a whole with respect to the connection to the containment. And that's when the question came up, well, why don't you just tell us what sensitivity studies to do for WCOBRA/TRAC because they already have a model put together. So that's what we're putting forth there tomorrow at the discussion.

And, of course, we've studied the responses that Westinghouse has provided so far and came up with the 30 additional questions, and we felt that we could go back and forth for quite a while doing questions and answers, and we thought that a workshop would be a more effective way of resolving the problems, or I should say concerns. I guess they're not problems.

MEMBER KRESS: Questions?

MS. UHLE: Questions. And also I should put we have looked at the containment back pressure determination and got our hands around exactly what type of back pressure that they've been crediting for each of the cases. We looked at the -- the containment analysis is done in another branch but looked at the assumptions that went into the calculation to determine if they were conservative for the small-break LOCA transients. But I would say the majority of our work has focused on the boron precipitation concern.

VICE CHAIRMAN WALLIS: And you still don't have any phase diagrams for this boron precipitation process? How can you do it?

MS. UHLE: Well, your phase diagram is -- my feeling that your question is how much boron is taken into -- going into the steam.

VICE CHAIRMAN WALLIS: Right.

MS. UHLE: And so we're conservatively

assuming none is going into the steam and it's all staying in the water. So that's conservative. And we checked to see what the inlet condition or the inlet temperature coming into the bottom of the core is and looking at the solubility as a function of time to see if there's going to be precipitation or not. And it all boils down to how much you're ripping out, and, again, we are very skeptical about the Westinghouse analysis and we're therefore meeting tomorrow to take a look at it, because when we at this point in time say is this -- are you precipitating, okay, we would probably be more concerned than Westinghouse is.

CHAIRMAN BONACA: Well, this will just have to come to a Subcommittee meeting and look at where we stand. It seems is if there is a lot of work that has been done.

VICE CHAIRMAN WALLIS: Well, we'll still be here on Friday and you've had this meeting with Westinghouse tomorrow? Perhaps we can get together on Friday?

MS. UHLE: Only if you pay for lunch.

(Laughter.)

VICE CHAIRMAN WALLIS: I'm not sure I'm allowed to pay for your lunch.

MS. UHLE: Oh, yes, you are.

MEMBER POWERS: You can. She can't pay for you.

MS. UHLE: We're not allowed to pay for you. I'll buy you dessert to sweeten you up.

MEMBER POWERS: An impossible tour.

CHAIRMAN BONACA: Do we have another presentation?

MEMBER KRESS: Yes.

CHAIRMAN BONACA: Let's move on to that.

MEMBER KRESS: Let's move on. Thank you, Mr. Chairman.

MR. COLACCINO: Okay. I know we're pressed for time, so I will also talk from a slide on the status that's just right in front of you. Just go over real quick where we're at with the DSER, it's progress on our supplemental DSERs. What we on the project team look at are the technical issues and what our schedule is. I didn't think I said it at the outset, my name is Joe Colaccino. I'm one of the three project managers that's working the AP1000.

We did issue the DSER on time, on June 16, 2003. We did have 174 open items. We have been -- I guess I would say we've been aggressively -- Westinghouse has aggressively been engaging us and we've been responding to them on virtually all of the open items that they can have response. We are carrying some open items that really they're staff open items that we need to complete certain actions, and Westinghouse understands that.

As of yesterday, we had 24 of the open items that we consider resolved, we have reviewed and resolved, and we have no additional technical issues. We have 36 open items that we have gotten commitments from Westinghouse to change in a particular way, and we just have to verify those commitments and DCD changes, sorry, design control document, or in their actual response to the open item.

We have had some additional questions, and I think you've touched upon some of those that we have passed down to Westinghouse. We're not tracking them as open items per se, we've given them numbers. What we are really sticking with the 174 open items that we had at DSER so we don't lose track of anything.

We did in the DSER have five supplemental reviews that we did say in the DSER that we expected to issue supplemental draft safety evaluation reports, and I've listed the five over here. Notice in particular we have a public meeting scheduled tomorrow on leak-before-break. We have staff members here today who will be leading that discussion with

Westinghouse. It is a public meeting. We're making significant progress on this issue. We don't see that -- we're moving forward on this issue. We don't right now, at this point, the progress that we've made hold this as one of our significant technical issues. There has been at least one other public meeting, several calls between the staff and Westinghouse on this.

The security review is not done. We did not have a security section except to say that the security review would be completed at some portion, and we would issue a supplemental DSER. We still expect to do that. That review is in progress and NSER is conducting that review.

The initial test program at Westinghouse has been provided a number of additional questions, and that review, that's an active review, Westinghouse has responded to those questions and we're in the progress of evaluating those. The testing and computer code evaluation, Chapter 21, we're in the documentation really. This is mostly on the staff to document the changes, how the AP600 codes are valid for AP1000. That effort is ongoing also.

With regard to the significant technical issues, Jennifer -- and you've heard most of this presentation -- discussed the reactor systems issues, the entrainment, long-term cooling, core swell and boron precipitation. I would hold up as the other pole in a two-tent, you know, the long poles, is the structural and seismic issues, specifically the containment design and the basemat uplift. The staff did conduct an audit and public meeting at Westinghouse in early April. The containment design was not -- the calculations associated with the containment design were not available for the staff to review then. They are available now, so next week the staff will be going and looking at that. They'll be seeing that for the first time.

With regard to basemat uplift, there are a number of open items that are associated with base mats that were outstanding from the April audit. Westinghouse has come back and has tried to address those questions. We've also had discussions with them, conference calls on that. So we look to next week in the structural and seismic area. We carried at the DSER phase on the order of 53 of the open items, roughly one-third of the open items in the DSER. We look at that as pretty significant activity next week, which folds into the last one, discussion of the schedule.

Back in July of 2002, we set out a preliminary schedule which stated that -- which gave our DSER date of June 16, 2003, our FSAR issuance date of September of 2004. That schedule is stipulated on us having minimal open items. We still believe we can meet that schedule unless some of the other technical issues present are more trouble than we think they are. We have in that schedule, in that July 2002 schedule, we had scheduled then to come back to ACRS full Committee in July of 2004.

Now, we are going to reassess the schedule after -- we feel that we have three important activities coming in the next couple of days, this being one of the, of course. The other one is being the workshop that's taking place tomorrow with reactor systems, and also the audit next week. So after the audit next week, we should be able to have a better idea of where we stand on our schedule, and we plan to issue some milestones, I think, as Westinghouse told you, as to how we can complete -- if September of 2004 is still a good date and what our milestones that we need to meet, both NRC and Westinghouse, to meet that date. Other than that, I have nothing else. If you have any questions, I'll be glad to answer them.

MEMBER KRESS: Seeing none, I guess we'll turn the meeting back to you, Mr. Chair.

CHAIRMAN BONACA: Are there any more questions? If there are none, we'll take a recess until quarter of four.

MEMBER KRESS: Do you want to say something, Mike?

MR. CORLETTI: I think thank you very much.

MEMBER KRESS: Yes. Well, thank you.

(Whereupon, the foregoing matter went off the record at 3:29 p.m. and went back on the record at 3:48 p.m.)

CHAIRMAN BONACA: We're back in session, and we have interesting presentation now on this NRC research program on materials degradation. And Dr. Ford is going to walk us through this and introduce the presenters.

MEMBER FORD: We were originally billed to be hearing about a program that you've all heard about informally -- the material degradation program. In fact, it's going to be wider than this. Mike Mayfield is going to present a wider range of materials degradation aspects that are being covered.

It will be of relevance to the research report, Dana. It will also be -- give us some good background for the presentation tomorrow to the Commission.

MEMBER SIEBER: I've got to change it now, because I said we would be anxious to -- or eager to hear from the staff. Now --

MEMBER FORD: You've heard.

MEMBER SIEBER: -- we've heard, so now I've got to rewrite my speech.

MR. MAYFIELD: Well, we'll be happy to come talk to you some more.

(Laughter.)

MEMBER FORD: So, Mike, it's all yours.

MR. MAYFIELD: Well, thank you. Some months ago the committee had been briefed on the staff's efforts looking at the response to the Davis-Besse lessons learned passport and the program that addressed the Davis-Besse issues.

When I looked at the committee's letter, I said, "Well, that's interesting. I'm glad to see the support. But, oh, by the way, we have a much larger scope program than was briefed to the committee." So I had asked Dr. Larkins for some time to sit with the committee and just give you a snapshot of what we're doing and the scope of those activities. And it turns out now that with the Commission briefing, the timing, maybe we were late by a month, but at least we're a day in advance.

So with that, I have with me this afternoon Joe Muscara from the Materials Engineering Branch.

MEMBER POWERS: Is he qualified to talk to us?

MR. MAYFIELD: Sir?

MEMBER POWERS: Is he qualified to talk to us?

(Laughter.)

MR. MAYFIELD: You know, there have been doubts.

(Laughter.)

But in --

MEMBER POWERS: I never get an answer either.

MR. MAYFIELD: In this specialty, yes, sir, I contest that he is qualified.

What I wanted to do was to, again, talk fairly quickly about a broad range of subjects, not to do a specific technical briefing, but rather to try and illustrate the range of areas where we're working, and that we are producing some results, not just plans.

Our environmentally-assisted tracking research is a long --

MEMBER POWERS: Mike, can I interrupt and --

MR. MAYFIELD: Sir?

MEMBER POWERS: -- tell you where I'm struggling? And it may be a little unfair to the other members, because I've looked into some of this stuff here. But I'm trying desperately to understand the bound between what's the NRC responsibility to understand about these units that -- in order to fulfill its mission of protecting the public health and safety versus what is the responsibility of the owner or operator --

MR. MAYFIELD: Right.

MEMBER POWERS: -- of the machines.

MR. MAYFIELD: If I can, let me address that as we go, because actually I think there is a pretty good story in this area in particular. By and large -- and part of the answer to your question goes to the second bullet. This is a long-standing program. It goes back to the early -- or, I'm sorry, mid '70s.

Over time, what we've been doing is responding to degradation that's been identified in service. You can look at the stress corrosion cracking in the BWR piping, and it morphed itself into irradiation-assisted stress corrosion cracking. We've been worrying about fatigue life in piping; subsequently, fatigue crack growth in pressure vessels and piping, the steam generator tube's activity --

MEMBER SHACK: What about embrittlement of cast stainless steel?

MR. MAYFIELD: Embrittlement of cast stainless steel. There is one laboratory that --

MEMBER POWERS: Did you guys do any work on that at all?

MR. MAYFIELD: There was one laboratory that did some kind of cheesy work, but we subsequently got that straightened out, and a good piece of work evolved.

MEMBER ROSEN: And actually, that bullet, steam generator tube degradation, really has 11-teen sub-bullets under it. But it --

MR. MAYFIELD: Yes, sir.

MEMBER ROSEN: -- starts with something called denting, if you're old enough to remember that.

MR. MAYFIELD: That's correct. And so the point about the steam generators is that activity was one that started out under the EAC program, and then as it blossomed became a program unto itself. And I think we've briefed the committee on that a couple of different times.

The primary water stress corrosion cracking is sort of the in vogue thing today, and now the boric acid corrosion. One of the things that has kept happening to us over time, as well as to the industry, is where we're responding to identified degradation, often times we're responding to the degradation being identified by water in the floor.

We're tired of it. The industry is tired of it. And so this has been a time where we have started putting some serious emphasis on a proactive research program looking forward, not to solve the problem, but to see what we can do to develop as research tools to do what is necessary to look forward.

The industry today has a major program in this area. That program materials -- I think it's just materials degradation. The chief nuclear officers, it's my understanding, have voted unanimously to form this and support the program with dollars as opposed to just moral support. They are pulling staff members online to staff the activity, and then there is research work looking proactively at what can be done. That's one major element of their program.

They are the ones putting, if you will, the serious money into it at this stage, and Joe will talk more about what we're doing on the proactive program as we go. But the industry are the ones that are putting the money into solving the issues. Our role is more one of confirmatory, once they've put something forward; anticipatory, in trying to get our arms around, is what the industry doing credible? Are they missing something?

There is no -- well, I think the one guarantee in this is that we will not guess about everything that could go wrong in a nuclear powerplant in the materials system. It's just not practical to say we would do that.

Hopefully, we can get further along than we are today. One of the things --

MEMBER POWERS: If you were king, what would we have?

MR. MAYFIELD: I'm sorry. Say it again?

MEMBER POWERS: If you were king, what would we have? If Joe were king, what would we have?

MR. MAYFIELD: In terms of?

MEMBER POWERS: The ability to predict

what's going on.

MR. MAYFIELD: We'd have first principles models that helped us where we could understand the degradation mechanisms, identify the susceptible locations, and be able to predict quantitatively what was going on and where and when.

And then, we would have the inspection tools necessary to go out and confirm that, indeed, that was happening, that -- and that we could reliably detect and quantify the degradation and make sound predictions about, when do you need to react? You, the licensee, when do you need to react to -- to make the run/repair/retire decisions? I think that phrasing has fallen --

MEMBER POWERS: I mean, what you describe sounds like a wonderful thing for a license to have.

MR. MAYFIELD: Well, you said if I was king.

MEMBER POWERS: Yes, I know. No, I said if Joe was king.

MR. MAYFIELD: Ah, well. Okay.

MEMBER POWERS: I'm never going to make you king. I know what you'd do.

(Laughter.)

MR. MAYFIELD: I agree. And I think the

NRC's role -- and, in fact, when we were here a couple of weeks ago talking about the sump blockage issue, one of the issues that came up there was the, if you will, tension between the staff's role and the industry's role. And that I think by its very nature, a confirmatory research program, brings about that tension.

What is our role? And when do you trade off or hand off from the staff to the industry and back? It is a difficult issue. It comes up repeatedly. I came to work for the NRC in '85. We were discussing exactly that issue for the budget that year. And we have had that discussion actively every year since, and it's -- it changes a bit with time and cycles a bit with time. And it cycles with issue.

MEMBER POWERS: I mean, what I can tell you is that there is an ACRS position, de facto in one of our research reports, that says, yes, it's the industry's responsibility to take care of nearly all of these problems.

But the problem that you run into is they can make mistakes, they can leave things out, and it's NRC's responsibility to make sure that their proposed solutions are: a) in fact, solutions; and b) do solve the problem completely. And to do that, NRC has to be an active participant in the field. I mean, that's basically what the ACRS has said in the past.

MR. MAYFIELD: And that's pretty much what we're doing. And I think this program area is actually an excellent example of that, and one of the things we'll talk about is some of the interaction we are having with the industry cooperatively.

MEMBER POWERS: Well, Joe has put another spin on that, and one that I'm enormously sympathetic with. He says if I'm an owner or operator of these things, I'm so anxious to devote all my efforts to getting rid of the problem that I really haven't got time or inclination to go into the fundamentals.

And if you're just looking over people's shoulder and watching, then you do have a chance to go into the -- into more fundamental perhaps than other people. And that, too, seems to be a good idea to me. I mean, I don't have any trouble with that.

MR. MAYFIELD: And I think that perhaps prior to the V.C. Summer and Davis-Besse events we were seeing -- and I don't want to make this sound too definitive. But generally, we would see issues or approaches to, well, let's make the problem go away and move on, rather than really understand the problem, and look for, where can something similar happen to us?

I think that what we're seeing now is an industry that has decided, one, it's a safety issue, so we need to do something about it. Well, they've always dealt with the safety aspects of it. But now it's getting to be a bigger and bigger economic impact, and there is plainly an economic advantage to being able to run the plant rather than having to stop and fix it.

So there is now both pieces coming together -- the safety interest and the economic interest. And it's --

MEMBER POWERS: I get --

MR. MAYFIELD: -- creating a situation where in this area we are I think in the kind of environment we'd like to see.

MEMBER POWERS: I get the sense that there is a feeling toward this like there -- like TMI. Another Davis-Besse incident impacts not just that plant but the entire industry.

MR. MAYFIELD: All we were trying to really illustrate with this slide is that degradation continues to evolve with time. One of the things that we have found is just about the time we think we've fixed one problem another one creeps up. And it may simply be a variant on the problem we think we've solved.

And that's something that we've -- some of us have wearied of. And we'd very much like to try and get our arms around it a little bit better than we have today, and to be able to deal with some of these things.

MEMBER SIEBER: Are there real solutions other than just changing materials? For example, your program really looks at detection in a timely fashion and adequate repair methods or replacement, you know, and --

MR. MAYFIELD: I think there are some good examples where there have been mitigative strategies put in place. For example, in the BWRs. The hydrogen --

MEMBER SIEBER: Chemistry.

MR. MAYFIELD: -- water chemistry I think is an excellent example. Some of the stress improvement techniques, the weld overlay repair technique -- while not really a mitigator, allowed them -- many of the plants to avoid large-scale replacements.

So there are things that had been put in place. The technique --

MEMBER SHACK: Well, the attention we pay to water chemistry is a relative --

MR. MAYFIELD: The attention we pay to water chemistry today is a huge --

MEMBER SIEBER: On the other hand, you can develop mitigating strategies and say, "Well, this will solve this problem." In the meantime, you've created another problem. For example, steam generator chemistry in PWRs.

MR. MAYFIELD: Yes.

MEMBER SIEBER: The first inclination was to make the water as pure as it could possibly be, which happened to be the wrong thing to do.

MR. MAYFIELD: That wasn't all that great an idea.

MEMBER SIEBER: Right. And so, where do you lead yourself? By the time you're done, you've probably solved the problem. But the plant is now in really bad shape.

MR. MUSCARA: If I may make a comment on the water chemistry.

MEMBER SIEBER: Okay.

MR. MUSCARA: And our role and the industry's role. If you remember back in the mid '70s, a lot of work was going on, EPRI-sponsored work, on BWR pipe cracking.

MEMBER SIEBER: Right.

MR. MUSCARA: And most of that work was done with high stress and high oxygen levels. That's it.

MEMBER SIEBER: That's right.

MR. MUSCARA: We came in with our EAC work at Argonne and started doing work with the effects of impurities, and sure enough we found that impurities had a big effect, maybe even bigger than the oxygen. And this led the industry, which were developing the water chemistry guidelines.

MEMBER SIEBER: Okay.

MR. MUSCARA: So, again, there is a role for us in identifying and understanding problems, and then there's a role for the industry to respond.

MEMBER SIEBER: Well, there's no doubt in my mind that that's the truth. I think you bring something to the table, that it represents a little bit of a different viewpoint than the manufacturers and licensees might have. And I think it takes all three.

MR. MAYFIELD: I agree.

MEMBER SIEBER: Okay.

MR. MAYFIELD: The one thing that we are, have been, and continue to push is to not just deal with the problems of the day but to try and understand what's under that problem, what caused it.

MEMBER SIEBER: Right.

MR. MAYFIELD: And it has been difficult in the past to really be able to pursue that at the level we thought was appropriate. There's budget challenges, and there's all kinds of new things happening.

One of the things we're pushing on -- we have a commitment from Ashok Thadani to keep pushing in this area. He is very supportive of trying to get ahead of this. So this has become an element of the program that we anticipate continuing and continuing fairly aggressively.

MEMBER SIEBER: How much do the Commissioners, other than the Chairman, know about this?

MR. MAYFIELD: Probably fairly little.

MEMBER SIEBER: Until tomorrow.

MR. MAYFIELD: We have briefed the Chairman on at least the broad strategy, not on the specifics. I think the committee, far and away, has received more information, at least informally, and what we'll talk about this afternoon.

MEMBER SIEBER: Okay.

MR. MAYFIELD: But the Chairman I think knows in sort of broad brush direction where we're going.

MEMBER SIEBER: Okay. So I can expect when I talk to the Commissioners tomorrow that three of them won't know very much about it.

MR. MAYFIELD: I think that's a fair expectation.

MEMBER SIEBER: Okay.

MR. MAYFIELD: Major activities in the materials degradation program look at environmentally-assisted cracking and lightwater reactors, corrosion of pressure boundary materials in concentrated boric acid solutions.

You'd think this was something we would have addressed many years ago, but it turns out there are fundamental aspects of it that even today we don't really have a good handle on. And then, finally, looking -- examination of the North Anna 2 nozzles and J-welds, and I'll talk a little bit more about what we have acquired.

We've got ongoing this week a vessel penetration conference, and we'll talk a little bit more about that. There's an Alloy 600 issues task group. That's an activity that's collaborative with the industry.

We're looking at forming an international cooperative program looking at primary water stress corrosion cracking and non-destructive examination techniques. The NDE piece we'll say a little bit more about, but you really need to have the tools that have been validated and that are highly reliable for detecting and characterizing the degradation.

That's going to be, I believe, essential to get ahead of this problem. And then, finally, we'll talk some more about the proactive materials degradation initiative.

Just to -- without going through the slide in detail, the reliability of the NDE program has been a long-standing program. It started at about the same time the environmentally-assisted cracking work did. We have a major activity looking at ISI reliability and ASME code requirements.

We are looking at surface roughness effects, how smooth does the surface really have to be, how does that impact the reliability of the inspection. We're looking at techniques for inspecting for stress corrosion cracking and reactor internals.

One of the big things that, frankly, Joe had a large hand in several years ago was getting in place in the ASME code, and then the industry moving forward on performance demonstration programs to demonstrate that the inspections that were being performed really were reliable.

That's an area we continue to follow and be interested in, and looking at how sample sets are developed, how many inspection tests have to be performed, addition of -- additional training of the inspectors.

And, finally, we follow fairly closely some of the parallel international research activities.

MEMBER FORD: Mike, could I ask a question to follow up on that? At the last meeting that we had, the subcommittee meeting on the Davis-Besse issue, we brought up questions about probabilities of detection, inspection techniques used for the VHP and also the bottom head.

The answers we got back from the utilities, the MRP, were quite honesty rather woolly. They weren't crisp and to the point.

MR. MAYFIELD: Yes.

MEMBER FORD: That does not -- first of

all, in reality, what is the case? And do you feel as though there's a need to move forward, a need to push more?

MR. MAYFIELD: Well, I think that there plainly is a need to move forward and have additional mockups that deal with a broader range of issues and --

MEMBER FORD: I guess my more specific question was: was that just a bad communication from the speaker? Or is that --

MR. MAYFIELD: No. I think that the -- where the industry has been, they were doing this on the fly.

MEMBER FORD: Right.

MR. MAYFIELD: It was I think to their great credit. They were taking a serious attempt at quickly putting together inspection mockups, so they would have some sense that, indeed, these inspections were being effective.

Doing that on the fly is always a challenge. And do you have enough sample sets? Do the range of flaws adequately capture what you would like to have? The answer to those things are no, and so there is interest and I think need for additional work in that area.

Where they are today I have to admit I haven't --

MEMBER FORD: Well, for example --

MR. MAYFIELD: -- specific. I don't know.

MEMBER FORD: -- along this same line of questioning, V.C. Summer -- I mean, they failed to identify these cracks time and time again. They were there. But then they used eddy current to identify where there were, in fact, superficial indications. And then, when they tested those with volumetric, they found the cracks.

It seems as if they -- there was a discovery that a combination of eddy current and volumetric would be an improved technique to identify cracking.

Now, given that it is an improved technique, are they using it now after V.C. Summer? Or is it simply something that is now being done?

MR. MUSCARA: They are using it now.

MEMBER FORD: They are using it now.

MR. MUSCARA: Let me give you a little bit of perspective about this work that has gone on for a number of years on performance demonstration. We initiated the work at Battelle Northwest Laboratory, have come up with some recommendations, and, in fact, a draft reg. guide to require performance demonstration.

The reason was that the techniques are in place, cookbook procedures, didn't seem to work. And every time they changed a parameter thinking that this would solve the problem, it still wasn't working. So we decided we needed to have a performance demonstration.

And when we started working with the code, the initial document in fact required that any inspection that's conducted per the code should be conducted using qualified techniques, procedures, and personnel through performance demonstration.

Well, people realized that some of these inspections were not very effective -- for example, cast stainless steel, dissimilar metal welds. And so the words were changed a little bit. It said that you should use qualified procedures if you have a supplement.

So the code developed several supplements for those components and materials that were inspectable. The ones that were difficult they've left behind -- work in progress. And so what's happened is that because the problem is difficult there has been no performance administration supplement developed.

I've been pushing that if the problem is difficult, do some work, resolve it, get the performance administration process in place. So what has happened with some of these inspections is that there wasn't a qualified procedure. And there wasn't a qualified procedure because it was difficult.

But, in fact, if the code insists that any inspection that's conducted should be conducted according to a qualified procedure, then all of the inspections should be effective.

MEMBER POWERS: This is one of those areas that elicits some of my challenges that I'm facing here. If the code requires that there be a qualified procedure, and the licensee doesn't have one, why is it that NRC has any responsibilities other than to tell the licensee, "Go get yourself a qualified procedure."

Now, I can understand that that might not be a useful comment 10 years, 20 years ago. But today when we see this EPRI NDE Center, and things like that, why does NRC have any responsibilities in the NDE business at all now?

MR. MAYFIELD: Let me give you a case -- a specific example. And Joe mentioned the cast stainless steel and inspecting that material.

We were hearing from some of the industry folks that the material is uninspectable, the job can't be done, you just can't find flaws in it, so we should give up inspecting it.

We had asked Steve Doctor at PNNL to explore this. Is this true? Steve looked -- Steve, and I think with some input from Joe, looked at a low frequency SAFT system, synthetic aperture focusing technique, and took his equipment down to the NDE Center and inspected their cast stainless steel sample sets and did very well. In fact, it is inspectable, and they did a good job in characterizing the flaws that were in the sample sets.

So our role in this is to go back and say, "You know that story about not inspectable. Well, you may not like the speed of the technique, and economically it may be a challenge for you, but oh, by the way, the material is inspectable." Not as well as others, but it is inspectable.

MEMBER POWERS: And I think that's a really good example of where I think it's appropriate for the regulator to validate his contention that he thinks it's inspectable and should be inspected, and, you know, be a responsible regulator.

What I'm asking about is this -- should we have an ongoing capability to evaluate these NDE capabilities or not. I mean, that sort of thing.

MR. MAYFIELD: Okay. When V.C. Summer was down with their hot leg crack, we were asked to provide some support to NRR. And we asked Steve and Debbie Jackson from my staff to get on the airplane and go visit with the licensee. And Steve went down and looked at what the licensee was doing and said, "Gee, why don't you try a different transducer," and I don't remember the specifics, "and find cracks."

And that level of expertise isn't something that you go pluck off the shelf. Somebody has to pay for it to keep the technique sharp, to keep the skill set sharp. And that's a role that the region found extraordinarily useful.

I believe I can speak for Dan Archen sitting here, I think shaking his head yes, that the regulatory office found useful -- and ultimately I think the licensee found useful -- but it was a role that the Office of Research played to have that capability and skill set --

MR. VIJUK: I mean, that's --

MR. MAYFIELD: -- available to support the regulatory program.

MEMBER POWERS: I mean, that is one of the criteria we have for the research program is to have that expertise. And we concede the point that to maintain that expertise you've got to get them involved in something. You just can't say be smart all the time and we'll use you when we want to.

And so, I mean, it's an acceptable answer to me. I just --

MR. VIJUK: And, Dana, I don't pretend to tell you that I've got a formula that I can tell you exactly, "Here's how much I ought to invest in these various areas." But that's the initiative. That's what we're trying to do with this.

MEMBER POWERS: And we will not try to tell you that either, that -- I mean, that's a judgment call that you guys in management get the big bucks -- well, in some cases the little bucks.

(Laughter.)

MR. VIJUK: Some bucks.

MR. MUSCARA: I think it's important to realize that you just don't get this kind of expertise. We have been supporting this work for 25 years, and so we've developed people, we've developed technologies that we make use over and over.

MEMBER POWERS: We've already bought that.

I mean --

MR. VIJUK: Okay.

MEMBER POWERS: -- you've picked one of our boxes --

MR. VIJUK: Okay.

MEMBER POWERS: -- that we bought off on, so -- and that's all I was asking for.

MR. VIJUK: Okay.

VICE CHAIRMAN WALLIS: Mike, what I'm trying to formulate here is that all of this seems to be in -- all in the context of nuclear stuff and NRC. What is NRC doing in the nuclear industry? I don't see it in the perspective of, what is the whole community -- I mean, this business of degradation of materials occurs everywhere.

MR. MAYFIELD: Yes.

VICE CHAIRMAN WALLIS: And isn't there some kind of forefront university research, which has nothing to do with nuclear, which is still relevant to you which is going on?

MR. MAYFIELD: Absolutely. And that's --

VICE CHAIRMAN WALLIS: And I don't see that perspective here at all. I really think it's within the little club of nuclear people doing this stuff.

MR. MAYFIELD: Well, you see that perspective because that's the club I personally belong to. But what we are doing, and what we have, is input from many different sources. One of the programs that we belong to is actually an EPRI program, a cooperative program, cooperative international program on CIR -- I'm sorry, I've lost the name of the thing. But it's a cooperative program looking at irradiation-assisted stress corrosion cracking.

VICE CHAIRMAN WALLIS: That's still a closed club, though. EPRI is --

MR. MAYFIELD: It's a closed club, but they are reaching out to a variety of other people. One of the people Joe uses, or we use, as a consultant is Roger Staehle. And Roger's program today addresses a broad range of subjects, and it is not confined solely to the nuclear industry.

MEMBER POWERS: How in the world do you get Roger on the consulting fees that government will pay?

MR. MUSCARA: He's kind to us.

(Laughter.)

VICE CHAIRMAN WALLIS: But you need to have that perspective, and I don't quite know whether there's -- 90 percent of the understanding about this field resides in NRC and its club, or whether the -- maybe you've only got 10 percent of it, and 90 percent of it is out there somewhere else. I don't have --

MR. MUSCARA: Just a brief comment. We do make use of people that are involved in other fields. Of course, we hear about the work they're doing for us, but they're doing work in other areas.

But in addition, I'd like to mention also that when we're talking about degradation and corrosion, these are mechanisms that are environment-specific. And when you look at other industries -- petrochemical -- their environments are entirely different. So you wind up having to worry about, really, the nuclear core of people that notice the environment and work with these environments.

But their expertise goes beyond our area. Unfortunately, we cannot use much of the data that's out there, because it's for different systems, different sets of conditions.

MEMBER SIEBER: Well, even in the coal-fired powerplant industry, the materials are different.

MR. MAYFIELD: That's correct.

MEMBER SIEBER: As well as the

environment.

MR. MAYFIELD: Yes.

MEMBER SIEBER: And if you go beyond that to aeronautics and things like that, the materials are really different. And so I think it's sort of a natural phenomenon that you end up with these clubs of specialists in certain materials under certain environments.

MEMBER FORD: But if I could also just address your question, if I'm allowed to. You know, the NRC is also a member of this ICGEAC, which is 72 companies and national labs. And those individuals also work in other areas.

For instance, GE did work on chemical plants, and my ex-colleagues. So we do draw in from --

MR. MAYFIELD: Yes.

MEMBER FORD: -- other industries.

MR. MAYFIELD: And you mentioned that it's an international cooperative group. In its original incarnation, it was called the International Cyclic Crack Growth Rate Group, and the NRC was one of the founders of that group. It was actually an NRC initiative that got that going.

MEMBER SIEBER: Well, the interesting

thing is that if you look for reasons why the NRC should be doing this, it's that the ASME code under which these inspections are done names the NRC as the regulating authority -- in other words, the final decisionmaker as to what's right and what's wrong.

And so there is a responsibility that's laid on the shoulders of the agency in order to make sure that the latest data and information and correlations and techniques are in place and in use by the users of the code.

MR. MAYFIELD: That's correct. And we also, because we endorse the code in the regulations, we pick up a responsibility to look carefully at what's in the code.

MEMBER SIEBER: That's right.

MR. MAYFIELD: And the best way to understand that is to have participated along the way.

I won't dwell on this cooperative program. We are developing this, looking to leverage both our knowledge and our funds. We've had some informal meetings with several countries, found a fair bit of interest in pursuing this. And we have had a bit of a kickoff meeting at the conference this week, and the feedback is positive, at least informally.

When you ask them to sign the check is

when they get serious about their level of interest. But we think it's likely they -- that we will see participation in this program.

The elements of the EAC program at Argonne, we've looked at fatigue life evaluation in both PWR and BWR environments, looking at carbon and low alloy steels, as well as the stainless steels. We are looking at irradiation-assisted stress corrosion cracking for stainless steels in both BWR and PWR environments.

We're looking at crack growth rates in the nickel-based alloys and, finally, looking at how you reduce all of that information to practice through the code.

This is just to illustrate that there -- we have found, at least in the laboratory, there is an effect of the environment in reducing the fatigue life for the carbon steels and the low alloy steels. I think the committee has been briefed on this work in detail by both the staff and the industry.

When we look at irradiation effects on stress corrosion cracking growth rates, in the normal water chemistry BWR environment, crack growth rates in the present study come out about a factor of five for the irradiated steels higher than for the unirradiated steels. And this NUREG-0313 curve is the crack growth rate curve that the staff tends to default to when they don't have other information on stress corrosion cracking growth rates.

And so when we irradiate these steels in the normal water chemistry environment, we find significantly higher -- and, in my world, a factor of five is significant -- higher crack growth rates. However, when we lower the oxygen, we find that the crack growth rates go down well below -- down in here -- well below the NUREG-0313 curve.

Just to try and summarize that -- again, crack growth rates at these kind of fluences, for the normal water chemistry we're seeing fairly high growth rates compared to what we have traditionally used for unirradiated steels. But when you drop the oxygen, the crack growth rates come back down.

One of the other things -- people have speculated for many years that neutron irradiation lowers the fracture toughness of stainless steels. Then comes the great debate about, well, how much? How serious an effect is it?

Work that's being done is showing that, in fact, the J-R curve, the crack growth, ductile crack growth resistance, has been obtained, and we find there is a substantive effect, particularly in the reduction of the crack initiation resistance -- the infamous $J1_c$ parameter. And we find that we come from fairly high values down rather sharply with irradiation. And it appears that we're going to some sort of plateau effect.

Continued work in this area -- we're looking at going to some higher dose levels, out to 40 dpa, looking at using the BOR-60 reactor, temperatures around 300 C. We have completed the five and 10 dpa dose rate studies.

VICE CHAIRMAN WALLIS: The evidence for a plateau seems to be extrapolation.

MR. MAYFIELD: I'm telling you if it appears we don't have the data, that's why we've gone out to 40 dba, to see -- the other thing I would say is it can only go so low.

VICE CHAIRMAN WALLIS: Zero.

MR. MAYFIELD: Well, it won't -- it, by and large, won't fall apart on its own. But it's, how low does it go at the higher dose rates?

We're looking at effects of some of the chemical compositions. We're running a range of mechanical property kinds of tests, doing microstructural characterization of this, and we're looking to -- we talked earlier about if Joe was king, what would he do.

The notion here is to try and develop some modeling capability to predict this behavior, and then to make some projections for the PWR coolant environment.

MEMBER POWERS: And what is the counterpart industry program here?

MR. MAYFIELD: Very similar kinds of things coming at it from a somewhat different standpoint. They are doing test reactor irradiations. They are also getting components out of internals, getting samples from decommissioned plants. So there is a companion.

And, frankly, getting the samples out of the decommissioned plants is the big buck industry in the -- or initiative. Doing the BOR-60 irradiations, while not inexpensive, is certainly less costly than going and chopping chunks out of somebody's core bearing.

MEMBER POWERS: So, I mean, what you're seeing here I think is this point that Joe has made earlier, is that they are taking a somewhat empirical approach, and maybe you're taking a more academic or scientific approach on this?

MR. MAYFIELD: We're taking perhaps a more structured approach. They are going and getting what they can get and testing it with the uncertainties that come with, well, what is the fluence that that component saw? What does the spectrum really look like? What was the temperature, the irradiation temperature?

So there's a fair bit of uncertainty that goes with testing things that you acquire from an operating plant as opposed to the much less uncertain situation of a test reactor irradiation.

One of the things that we have seen over time is that, for example, in reactor pressure vessel embrittlement you see a fair bit of scatter in the material surveillance samples, because there is a fair bit of uncertainty as to what they actually see.

We get much less scatter, not insignificant, but much less when we do test reactor irradiations. And it goes to being able to control the conditions.

MEMBER POWERS: Aren't you just saying that the industry has a bad program?

MR. MAYFIELD: Not at all. I'm saying they are testing the real material with all its uncertainties, and we can then use that to test modeling. At some point you have to test -- the thing that's really of interest to you is the performance of the component in service, under service-irradiated conditions, and to understand the uncertainties that go with that service operation and to correctly characterize those uncertainties.

MEMBER POWERS: You know, what I see one could easily forecast is they come back and say, "Okay. Well, I've taken this trojan reactor apart, and I've looked at it, and it has these properties. And that's about like my properties, and so I'm okay."

And you come back and say, "No, you are 10 degrees colder or hotter or one way or the other. And I've run my model and it says you're not okay. And you just have catharsis here."

MR. MAYFIELD: One of the lessons that certainly the staff learned, and I'm pretty sure the industry learned, was from the Yankee Rowe experience, where they came in -- as you recall, they were one of the lead plants for license renewal.

And they came in to the staff and were doing the reactor pressure vessel assessment, and Neil Randall said, "What temperature do you run at?" Well, we run -- actually, we said, "Just a bit less than 500." And he says, "But the embrittlement correlations are 525 to 575. What are you doing about a temperature correction?" And the answer was, "Nothing."

"Well, maybe you should." And so when we started testing what was actually going on at that plant, not plant materials but pushing at exact conditions at the plant, their license renewal story started unraveling. Economic considerations ultimately took over, but it was looking -- the test was what's really going on and how well do your plant conditions match the models that are being used.

And I think that acquiring samples from albeit decommissioned plants, and testing those, and understanding what the plant actually saw and how that compares to the model, and how that actually compares to regulatory criteria and uncertainty levels that we would anticipate, I think that's a valuable --

MEMBER POWERS: But see, without your program, the industry would never know those things.

MR. MAYFIELD: I'm sorry. Say again.

MEMBER POWERS: Without your program, the industry would never know those things.

MR. MAYFIELD: Well, and that's where part of the cooperative activity comes. Rather than the staff simply sitting back saying, "Gee, you ought to do all of this stuff," and then ending up trying to argue our way through it, we are, in fact, doing the more structured aspect of this, which supports some other activities that the industry has ongoing. But it gives us the independent data set to test their results and their contentions.

MEMBER SIEBER: Well, even if you use actual decommissioned reactor test data, you still have a problem with the dose --

MR. MAYFIELD: That's correct.

MEMBER SIEBER: -- issue, because it is quite variable as you --

MR. MAYFIELD: Yes.

MEMBER SIEBER: -- travel around the core, and you have to know exactly --

MR. MAYFIELD: Yes.

MEMBER SIEBER: You have to understand and calculate what the fluence is at the location where you take the samples.

MR. MAYFIELD: With all due respect to my colleagues that do those sorts of calculations, I'll trust the sampling. Thank you.

MEMBER SIEBER: Okay.

MR. MAYFIELD: One of the things that we have done in the few other instances where we've been able to acquire samples from service is to go back to some of the national laboratories, and through various counting schemes tried to back calculate what the fluence really was and test that against the transport calculations. While not all that precise, it tells you if you're grossly in error. So it has been useful from that standpoint.

Rather than belabor it, we do have this conference ongoing. Just to indicate the level of seriousness that the national and international communities see this problem, we've got 220 folks in a Marriott hotel up here in Gaithersburg representing 11 different countries, significant industry participation to this thing.

We will put the proceedings out on CD as well as a NUREG conference proceedings. But this has been an extraordinarily well-attended conference covering a broad range of subjects and very active discussions.

VICE CHAIRMAN WALLIS: When the industry participates, do they actually present sort of significant technical work?

MR. MAYFIELD: Yes.

VICE CHAIRMAN WALLIS: Okay. Good.

MR. MAYFIELD: Yes.

MEMBER ROSEN: Are these licensees there?

MR. MAYFIELD: Yes. Some are licensees, some from EPRI, but there are a fair number of licensees.

MEMBER FORD: To me, that was the most significant factor. At this particular conference I think there were about 20 attendees from operating reactors as opposed to two or three from EPRI that you would get at a normal technical conference. I think that's about right, wasn't it, Joe?

MR. MUSCARA: Well, in addition, there's also a representation from --

MR. MAYFIELD: Make sure you use the mike.

MR. MUSCARA: I said in addition there's also a representation from Bettis and KAPL, so there's wide representation. And we're getting a lot of good, relatively new information.

MEMBER SIEBER: Well, actually, the Navy did a lot of work in the '50s and '60s which never seemed to make it to the commercial end of the business. And I guess perhaps I don't understand all of the deal about classification, but it seems to me that the Navy data is very pertinent to what the commercial people think is --

MR. MAYFIELD: Some is and some isn't, and you can go a lot further than that.

MEMBER FORD: The change with Rickover -- when Rickover went away, then the number of attendees from KAPL and Bettis increased dramatically.

MR. MAYFIELD: Yes. But they very often will attend, and that's -- they don't participate much, so we still fight that issue. But it -- rightly or wrongly, they have their classification rules, and so far at least I've been unsuccessful in thwarting those rules.

I mentioned that I think the committee has heard that we've been getting materials from some of the vessel heads. We've got nozzle 3 and then nozzles 2 and 46 from Davis-Besse, and we're doing a fair bit of characterization of those materials and looking at the cracking, how it initiates and how it propagates.

We have gotten samples from the North Anna Unit 2 head. Those were harvested by the industry and provided to us. Then, there is a collaborative coordinated program I guess is the phrase, looking at, what do you do beyond that?

One of the things that PNNL has done -- we shipped the samples to PNNL. They are characterizing them, and then the industry teams will come in and do inspections. Sort of an inspection round robin with PNNL arbitrating the program, so as sort of the independent arbiter of things.

One of the -- we've talked a fair bit about the inspections. We spend a lot of time worrying about how cracks initiate and grow and what they may look like. The point here with the crack tips is the way they bifurcate they create a particular challenge for the inspections and being able to correctly characterize and quantify the cracking.

They also can create some challenges for the fracture analysis, because you now have a bifurcated crack tip. And those don't behave quite the same way, so you -- if you treat it like it's a single sharp crack, you're going to get a conservative result.

So trying to find ways to characterize that historically has proven fruitless, and you treat them as a single sharp crack. You just have to recognize that there is an unquantified level of conservatism in that treatment.

VICE CHAIRMAN WALLIS: It's a rather strange crack there. It doesn't look like a crack. It looks like it's a chain of ponds connected by little streams. It's very different from the usual crack.

MR. MAYFIELD: I probably have never thought to characterize it that way, but those -- that's actually fairly typical of this type of crack and --

VICE CHAIRMAN WALLIS: It opens up that much.

MR. MAYFIELD: Sir?

VICE CHAIRMAN WALLIS: It opens up. That thing on the left, it opens up that much with a little --

MR. MAYFIELD: Well, the --

VICE CHAIRMAN WALLIS: Anyway, we don't really need to get into this. But it just looks strange. The one on the bottom there has got these very fine cracks, and then these very fat regions mixed up with it. It's strange.

MR. MAYFIELD: There are those of us, you know, fat people find fat regions. So --

VICE CHAIRMAN WALLIS: But those are ponds, isolated little ponds, too. Anyway, let's go on.

MR. MAYFIELD: We do have this new boric acid corrosion program going that's looking at the crack growth rates in the Alloy 600 and 182 from the Davis-Besse head. We're not all that fascinated with Davis-Besse anymore. We are, however, very keenly interested in how the Alloy 600 and the 182 materials that are still in service -- how they are behaving.

We're looking at a computational model and a probabilistic assessment of a number of things -- crack initiation and growth. Then, finally, we're looking at measuring the electrochemical potential and wastage rates for a range of solution compositions, temperatures, and pressure boundary materials. These are fairly basic bits of data that we were surprised we couldn't put our hands on when we started trying to characterize Davis-Besse. So --

MEMBER POWERS: And could I understand what you do with this, for instance, the corrosion rate of low alloy steels and concentrated boric acid. I mean, isn't it adequate just to know that that's a really bad idea, to have low allow steel and concentrated boric acid?

MR. MAYFIELD: It's a -- is it enough to know that if I knew exactly what I had, and that I always had really concentrated boric acid, and I knew what that meant, then I'd say, yes, that's just fundamentally a bad idea. Now you're left with, well, how bad an idea is it? And how long can I let it be a bad idea?

We had Sequoyah, I believe, that had a leaking valve or something up on the vessel head, and they had some minor cutting. How long had that gone on? We've had leaking seals for a very long time, and we've only had one Davis-Besse.

So the notion of understanding that and establishing appropriate inspection and regulatory acceptance criteria gets to be important. And to just say, gee, all boric acid is a bad idea, well, fundamentally I agree it's a bad idea. How bad an idea?

MEMBER POWERS: Yes. I mean, that's what I'm asking. Why do I need to know that? Isn't it the case now -- I mean, you saw drips of boric acid on the bottom of South Texas' reactor pressure vessel that were smaller than the eraser here. And that was enough to create a big brouhaha.

MR. MAYFIELD: Well, I think it was --

MEMBER POWERS: Isn't that the answer, that it demonstrates --

MR. MAYFIELD: No. I don't think the issue there was the potential for the boric acid to corrode away the low alloy steel. The issue there was it was an indicator that we had a leak in a place we really weren't anticipating one for other reasons. The issue here is when I've got boric acid dripping out on other things, how concerned should I be?

MEMBER POWERS: And so you're saying that if you go in and inspect a plant today, and it has boric acid leaking onto something, that you'll run back and do a calculation and say, "Oh, yes, you can run three more cycles and" --

MR. MAYFIELD: No. It's the other end. How frequently should I be looking, and with what reliability? Is it enough to simply do a plant walkdown? When I find boric acid in one place, how aggressively do I need to look in other places? Not that they were the source of the leak, but where there may be some consequential damage. And how frequently do I need to do that?

MEMBER POWERS: Isn't the answer always going to be if you see the boric acid, you're going to look aggressively?

MR. MAYFIELD: Absolutely.

MEMBER POWERS: And you're going to look every shutdown?

MR. MAYFIELD: I'm going to do some level of looking at every shutdown. Part of the issue here is predicting or getting a handle on how aggressively do I need to look at this, and how -- with what frequency. Do I need to do -- do I need to bring plants down in mid-cycle? I think that is unlikely.

But if the results come back and say, you know, it really doesn't take very much boric acid to create a really bad situation, which I don't think they're going to do, but if that's what they said, we may change inspection frequencies.

But right now we don't have the basic information to make those calls, and we think that where we are is adequate. That's the judgment. And this is a bit of confirmatory work to fill a technical hole, so that we can say that with higher confidence, or, if the judgment has been wrong, to revisit it.

Does that answer your question? Or --

MEMBER POWERS: It's an answer. I struggle with understanding it. It's a real good answer. Don't get me wrong, Mike. I really like the answer. I'm trying to figure out how I articulate it so it's limiting, because I think I could say the same thing about second quantitization of iron.

MR. MAYFIELD: And that's where a judgment call comes in as to how far do you go. I agree. I used to have this go-round with Jim Snezak when he was the Deputy Executive Director for Operations. Why are you doing any of these radiation effects? Why don't you just call it good? Well, we learned something new. Sam Collins has regularly characterized NRC as a learning organization.

I don't need to learn everything that I need -- you know, out there, but I -- there are some of this that we still think important.

Just to give you -- do this one very quickly. NRC is looking at the North Anna 2 discarded head pieces as part of an NRC industry collaborative program. We have seven nozzles that have been removed and shipped to PNNL, and there are going to be several NDE teams that will go examine those nozzles. And then, following that we'll do destructive exams.

Just to give you a sense of size, these are not trivial bits of steel that we've acquired. They are contaminated to varying levels. So we've had to set up a controlled area for them to be handled and to characterize them.

Our part of this is --

MEMBER SHACK: That's a distorted picture. How much of the tube is sticking out of that sucker?

MR. MAYFIELD: Quite a bit. I think by the time they shipped them I think they lobbed off a fair bit of the tube. This is when they were being harvested. So, but it's more than two or three inches.

MEMBER POWERS: All of those samples lost.

(Laughter.)

MR. MAYFIELD: Well, the --

MEMBER POWERS: That would keep Bill happy for months.

MR. MAYFIELD: The one thing I have learned about Joe Muscara and Bill Cullen is they don't waste much. So Joe ind his programs wastes virtually nothing, and Bill Cullen I think came to us with the same view in life. You don't waste valuable material.

The other side of that is you can only test so much Alloy 600.

There was a presentation to the committee years ago by one of Dr. Shack's colleagues, a gentleman by the name of Tom Kassner. And one of the committee members asked him, why does there appear to be so much data on Alloy 600 in all of these different environments?

And I remember Tom's answer was, oh, every graduate student loves to test Alloy 600, because everything cracks it. And we decided maybe that hadn't been the best choice of alloy.

Just to transition to the proactive program, when we look at how the NRC manages materials degradation, the box on the lower left goes to managing identified degradation, typically gets involved with the regulatory program, inspections, required inspections, code activities.

When we start looking at, where does the research program contribute and balance off against things that the industry is doing, we look at the evaluation of new materials, materials that are being proposed, Alloy 690 is a material that's being used regularly as a replacement alloy. We look at inspection procedures and techniques for testing assertions about what can and cannot be done. And then, finally, we are looking at new degradation mechanisms.

We talked earlier about what can be done -- mitigation strategies, looking at repair and mitigation strategies. One of the first tests is to make sure you do no harm, or at least to try and make sure you do no harm. Steam generators -- I think the varied history there is a classic example where maybe we should have looked a little harder before we moved forward.

So the research program contribution is really looking at the center and right-hand boxes to test this, not to develop the solutions, but to have sufficient information and technical data to support an assessment about whether a repair strategy really does hold up, whether a new material really is going to perform the way it's being touted. So that really is our role in this.

MEMBER SIEBER: Well, let me make an observation. You can agree or disagree with it. But I remember back in the 1950s -- and I am that old -- when Inconel 600, which is what we called it back in those days -- was considered the next best thing to Superman's kryptonite. And they had not observed primary water stress corrosion cracking, and so this was the miracle material which later on seemed to end up cracking no matter what you did.

MEMBER POWERS: Jack, it behaved just like kryptonite does to Superman. It damn near killed him.

(Laughter.)

MEMBER SIEBER: On the other hand, here comes 690, and it's being applied in a lot of different places -- steam generators, reactor vessel heads, and so forth. And to my knowledge, there isn't a lot of data.

MR. MAYFIELD: That's correct.

MEMBER SIEBER: And so where you are right now is here's kryptonite number two. And you won't know until all of a sudden these materials will start revealing sooner or later some of their imperfections.

MR. MAYFIELD: Left to their own devices, the materials and environments, you're exactly right. It eventually will -- if there's an operative degradation mechanism, it will self-reveal. Part of what we're trying to do, and I believe part of what the industry is trying to do, is to get ahead of that curve.

MEMBER SIEBER: Well, how do you do it, though, without a tremendous amount of testing before you ever apply to --

MR. MAYFIELD: Well, right now people had to move forward, and so there's precious little testing, and there are people making some significant financial gambles.

MEMBER SIEBER: That's right.

MR. MAYFIELD: Being followed up with additional testing, looking at what do we need to do in terms of inspection intervals, are there other mitigation strategies we need to put into place. And I think that's really where it's going.

MEMBER SIEBER: So you're relying on being able to predict and define what -- when to inspect and how often to inspect and how to inspect as part of the -- a major part of the strategy for new materials?

MR. MAYFIELD: Well, and then develop the understanding that would support that.

MEMBER SIEBER: Yes, okay. But without data, how do you predict?

MR. MAYFIELD: Well, you have to -- that's where you have to go get the data and develop the understanding.

MEMBER FORD: But I don't think the situation is quite as bad as you are proposing, Jack. Yes, we've had a whole lot of problems over the last 30 years. But at the same time, there has been a tremendous increase in the understanding -- the fundamental of understanding many of these cracking mechanisms for the existing materials.

If that understanding is any good, then you can extrapolate it from, for instance, 600 to 690 and no change in microstructure, etcetera. And if your predictive models are any good, then you should know where to look.

MEMBER POWERS: Peter, I'm willing to bet that when the guy came in to advance Alloy 600 over stainless steel in the steam generator tubes he made the exact same speech.

MEMBER FORD: I can't answer your question definitively, because I wasn't around at that time, and I haven't worked on PWRs. But I know you are wrong as far as BWRs are concerned. We were way ahead of the ball, because we understood the mechanisms on IASCC in the core.

MEMBER POWERS: I'm stunned that you say that, because I just saw a big thing up there that said, well, we don't understand IASCC at all.

MR. MAYFIELD: That isn't what it said. We're continuing to improve, but it --

MEMBER SIEBER: I hate to introduce something that would degrade old conversation, but -- and you may want to move on.

MR. MAYFIELD: Yes. Why don't we -- let me turn it over to Joe to talk about this proactive materials degradation initiative. Joe?

MR. MUSCARA: If you don't mind, maybe I'll follow up on the 690 issue just briefly. Clearly, when the plants were built, we all thought 600 was a wonderful material. There was data at the time that indicated otherwise. It wasn't widely publicized, and it came out a little bit too late.

But there was data early on that showed that this material could crack in primary water.

And with respect to the 690, we have some data, we have some understanding, particularly for the primary side. We don't really understand very much what's going to happen on the secondary side, where there's a lot of crevices and a lot of places for corrosion to take place.

We didn't discuss it today, because we've heard about the generator work before. But let me mention very briefly we are doing some work on evaluating the cracking susceptibility of both 600 and 690. Now, the reason we're doing 600 is so that we have a lot of field experience with 600.

If we're able to test 600 under the appropriate environmental conditions, we're doing some additional work to define what those conditions are. We're trying to define what happens in crevices, what is the water chemistry in the crevices.

Given that, we'll run some tests under those chemistry conditions, both with 600 and 690, and we see how the two behave. We know how 600 has behaved in the field, and hopefully they will -- we can build a bridge to develop an understanding how 690 is going to behave in the field.

And with this stage we do know that 690 cracks. We know some conditions under which the materials cracks, and those conditions could be in actual plants. One of the things we're trying to do is to try and bound -- get a feeling for under what conditions will 690 crack. And that work is planned and will be going on.

MEMBER SIEBER: Let me ask this question. You know the conditions and perhaps the chemical and environmental conditions where 600 cracks. So you get a sample of 690, and you recreate in a test lab those same conditions, and it either cracks or it doesn't crack.

If it doesn't crack, that doesn't mean that some other mechanism or some other combination of things that doesn't particularly disturb 600, wouldn't cause 690 to deteriorate, crack, or whatever.

MR. MUSCARA: Yes. This is why we're trying to determine what are the realistic conditions. And we're doing parametric studies with respect to the environment, the stresses, the dynamic or static stresses and strains. We're going to use samples that are typical of what's in the generator -- is it tubing or is it fracture mechanics specimens.

So we're trying to get a better

understanding of the degradation, both materials -- so, again, we can make effective use of the data we have on 600.

MEMBER SIEBER: I guess there is nothing else you can do.

MR. MAYFIELD: Well, but it's -- the potential that 690 is going to crack in situations that we hadn't anticipated is exactly why you work to have an effective inspection program.

MEMBER SIEBER: Right.

MR. MAYFIELD: And the challenge there is making sure that you've got inspection procedures and techniques that will capture things that you -- rather than fine tune them for the degradation mode that you're seeing today, you need to have something that allows you to do a little more general assessment to at least detect something that's newly forming. And that's the challenge is to look for that.

MR. MUSCARA: The big challenge with inspection at this point is that 690 is thought to be more resistant. Therefore, industry wants us to inspect less frequently. And we don't have the data, frankly, at this point to say how often do you need to inspect.

MEMBER POWERS: Well, why don't you just

tell industry, "Look, you want us to inspect less frequently. Good. Bring us the data to defend that position."

MEMBER SIEBER: To justify it.

MR. MAYFIELD: Well, you sort of start getting off into the regulatory policy that the agency has taken. And what's being done today is to make engineering judgments based on what limited information is available and making regulatory decisions on that basis, and then to come back and do the confirmatory research to say how good a story is this, and to either support the regulatory decision or to suggest, no, that wasn't quite right.

MEMBER POWERS: Let me ask another question on -- following along on Jack's line of thought there. He pointed out that 690 is the answer to a maiden's dream now, and it may not be true. Why in your program are you not looking at other alloys that are not so enthusiastically received by the U.S. industry but maybe are viewed enthusiastically by other industries? And I'm thinking of 800 right off the bat.

MR. MAYFIELD: I think that we have to start somewhere, and you need to make your investment. My understanding is our -- the U.S. industry has looked now at 800 and made a conscious decision to not go that direction. I think that --

MEMBER POWERS: They're wrong.

MR. MAYFIELD: Well, they may be. And that's something that as we look at some of the international experience and try and draw on -- in the steam generator world, certainly the German experience with the Alloy 800 has I think been very positive.

So the notion is rather than trying to do it all ourselves, let's look at where we can collaborate, where we can get information from other sources, and build on that.

MEMBER POWERS: I mean, here's -- you know, in the abstract, you know, that's a good answer. But I think Jack's got a point here, that you have this history that says, okay, everybody said this is great, and we're going to use it, and it turned out maybe not so great. It's not a total disaster, but it's not so great. And it's unfortunately not so great on your -- touching on your risk-dominant sequences.

Okay. So it's one of these things that you -- you know, you not only fence in the chickens, you guard the chicken coop as well, because it's high on your risk-dominant sequences.

Okay. Now the industry is coming in and saying, well, we've got another great thing. And you, NRC, you know, bless this, and so you're doing your research. But shouldn't you, just to protect yourself, be saying, okay, I'm going to also equally look at these other alloys that other people who are intelligent individuals and also have risk-dominant accidents if selected, and maybe I'll quit approving these 690 alloys.

MR. MAYFIELD: And if I could -- yes, you were talking earlier about kingdoms. If my budget went in the right direction, I would absolutely take on that kind of program. I live in a world where there are limited fiscal resources, and we look at how to leverage those resources by reaching out to the international community, building on what they have, and addressing the problem that is most prominent on our table today.

I'm not disputing that that would be a good thing to go do. Plainly, it would be. The practicality of it, given where we are today, financially is just not realistic.

MEMBER SIEBER: There is the additional question as to who is the designer. You know, should the regulating agency be the one that is developing materials and saying, "This is a good one; this one isn't"? Or should they be saying, "If you use this one, you have to have this inspection protocol, use these techniques, and be able to characterize these kinds of indications"?

MR. MAYFIELD: And, plainly, that's where we are is more in that role. We have periodically examined other materials in different context, but we have looked at some different materials and different approaches, just to see what else is out there. But those were in the days of much larger budgets.

MEMBER SIEBER: Well, that's sort of a policy issue, as I see it.

MR. MAYFIELD: Yes.

CHAIRMAN BONACA: For Alloy 690, isn't there experience coming from France and every place there has -- some of the heads --

MR. MAYFIELD: They have.

CHAIRMAN BONACA: -- in the early '90s.

MR. MAYFIELD: And my perception is that the service data we have so far is positive. We haven't gotten any of those heads through 40 years yet, but it's positive. I don't think there's -- from the information that I have seen, I don't think there's any question that 690 is a better alloy than

600, and the associated weld melts.

And for the materials that were available today, and that the licensees in this country chose to use, I don't think there's any question that 690 is a superior choice to 600.

It is not impervium. It will crack given certain sets of conditions. And the test now is, how realistic are those sets of conditions, and how much --

CHAIRMAN BONACA: I guess what I was referring to is if there is enough experience, even a few years. I'm sure that they're reflecting the frequency of their inspections based on what they find, and that may be interesting to you --

MR. MAYFIELD: Absolutely.

CHAIRMAN BONACA: -- in setting up expectations for the frequency of inspections here and being different for the one for Alloy 600. I mean, that should --

MR. MAYFIELD: And we've maintained continuing dialogue with the French and others on exactly these kinds of issues, both through the regulatory program and through our research program.

VICE CHAIRMAN WALLIS: Everything you said is empirical. This wine is better than that wine, you know, and this year is better than that year. And there's no kind of theoretical or intellectual structure to understanding the mechanisms or following why this is better than that, getting --

(Laughter.)

I don't see any of that in here.

MR. MAYFIELD: Well, if you go back a few slides you'll see some hint that indeed we would like to try and develop some of that.

VICE CHAIRMAN WALLIS: I heard water chemistry mentioned. There must be mechanisms for what happens in these cracks.

MEMBER SIEBER: Well, it's not a simple problem to solve.

MEMBER POWERS: My favorite story in that regard with respect to stress corrosion cracking is when I joined Sandia National Laboratories I came in to a group of about 11 scientists, and I was the only one not working on stress corrosion cracking. And they hadn't figured out the mechanism.

MR. MAYFIELD: We've had -- Peter mentioned this international cooperative group on environmentally-assisted cracking. There were some raging debates in that community -- and these are the serious-minded technical experts -- is it anodic dissolution, or is it hydrogen embrittlement?

And I do believe one of the committee -- at least one of the committee members, actually two of them, were active participants in those discussions, on opposing sides of the issue as I recall.

MEMBER POWERS: No wonder we -- I mean, and nothing has changed, by the way.

MEMBER FORD: Okay, guys. We've got 15 minutes. We should -- this gets a lot of attention, because it is part of the Commission --

MR. MUSCARA: Well, I don't think I need to go into a lot of background why we look at proactive materials degradation. Clearly, the reactive approach has been inefficient and costly and, in fact --

VICE CHAIRMAN WALLIS: My point is that the intellectual mechanistic is the most proactive way you can do it. The list of criteria for proactive -- so don't -- I'm surprised not to hear more of it mentioned.

MR. MUSCARA: I guess we had not discussed the steam generator program with you, because we felt we had covered it. But in that program, we are being -- it's been one of the few proactive programs we've had in recent years. And in that program we will be looking at some of those issues to try and understand better the cracking. And the first place to start is to understand better the chemistry that the material experiences.

MR. MAYFIELD: But there are ongoing activities in some of these other cooperative programs that go to exactly the kinds of modeling and fairly basic approaches to this. And just in the interest of time, I hadn't explored those. We would be happy to come back and tell you in more detail about what's going on, if you'd like.

VICE CHAIRMAN WALLIS: It's significant to me that you chose not to mention that.

MR. MUSCARA: Well, I was going to mention it in my viewgraph.

MEMBER POWERS: Unfortunately, Graham, I suspect if they had come in and said, "We're focusing heavily on the mechanistic," one of the committee members would have said, "5,000 people are doing that, and they haven't made progress in the last 20 years. What makes you think you will in the next five?"

MEMBER FORD: Well, let's move on.

MR. MUSCARA: Okay. So we -- over the last few months, we've been thinking about this proactive materialistic relation, mainly because there has been a concern or a question asked from our chairman that effectively challenges us to decide or determine what is the next big problem, and are we ready? What are we going to do about it?

So we've been thinking about how to approach this problem. How can we be more proactive?

Clearly, the first step is to identify the materials and the components that are susceptible to various cracking or degradation mechanisms. So in the first step we want to identify locations where degradation could reasonably be expected in the future.

To do this, I was looking for a structured approach. Clearly, we need to depend on expert opinion, expert elicitation. But I wanted to have some structure to this approach, and I've looked at the PIRT process and decided that this process can be used for evaluating locations in the plant where we could expect degradation.

MEMBER SIEBER: Isn't that part of the Davis-Besse action plan?

MR. MUSCARA: No.

MEMBER SIEBER: No? Okay.

MR. MUSCARA: Now, we do need to make some changes. At least we need to adapt the PIRT process for this issue. It's somewhat different than what PIRT has been used for in the past. In the past, in fact, PIRT has been used for very focused -- evaluation of a very focused problem, and here is a fairly broad problem.

But there are a lot of similarities. For example, when one looks at the phenomenon in the standard PIRT, and in those generally related to thermal hydraulic phenomena, a similar situation for us is the degradation mechanism themselves. So the phenomena become the degradation mechanism.

If we look at the scenario from the traditional approach versus what we need, in our case the scenario is really the stressors that these materials would experience. So the scenarios for us would be things like the material, the environment with respect to chemistry temperature stresses, irradiation embrittlement, and so on. So our scenarios are the stressors.

At any rate, we decided that this PIRT process could work. And because of its structure I think it would give us a disciplined way to go about this. And our thoughts are that we would have a panel. Within this PIRT panel, we're thinking about seven members with a PIRT technical leader.

Amongst these seven members I would like to have five materials degradation experts, a systems expert, and an expert that has materials experience but also comes from the operating plant. So he has operating plant experience with knowledge and materials.

We foresee running about six meetings. Three meetings would be concentrating on the PWR and three meetings on the BWR. We plan on developing a lot of information before hand, background information, that the experts need to have. We don't intend on developing information degradation mechanisms, because the experts have this information. They know this.

But we need to develop information on what the component is, what its function is, what are the stresses that it sees, so that they can decide from those parameters whether there's a potential for degradation. So before we start the panel, we plan on pulling together a lot of information on the components, the materials, and the stressors.

There is information available that we can start, for example, from the GALL report. One thing that we want to do beyond GALL is -- the GALL report is based on experience of the past. We're trying to look forward, so we'll start with GALL, but we need to think about potential for cracking in the future, because initiation times may be longer -- we just haven't experienced them yet -- or maybe because of some new degradation methods that are operating.

So in our work we look at past experience, but are also trying to project forward and consider other potential degradation mechanisms and longer initiation times.

The results of this will then be reviewed by an international group of experts. Clearly, we cannot have too large of a panel, because we wouldn't get anything done. And, of course, it's quite costly. But we do want to have the results reviewed by a broader group. So we will have some independent review of the results.

But given that we have identified the materials and the components of interest, we then want to determine what can be done to proactively predict degradation and be able to manage it. From our side, we want to be able to develop the database or the foundation for having regulatory activities in place that would keep the degradation from becoming a safety issue.

From the industry side, of course, there would be interest in even avoiding the degradation. If you're now identifying the potential, there are things that can be done to avoid it. So in that context, we want to review and evaluate in-service inspection and continuous monitoring techniques for the combinations of materials in geometries where we expect the degradation.

If we find that the inspection techniques are not reliable, then there is a need to do new work. You know, what needs to be done to develop the appropriate inspection techniques?

If we find that the periodic in-service inspection techniques are not adequate to detect a particular problem that may be progressing more rapidly, then there may be a need for continuous monitoring. Those kinds of things will be determined, evaluated, and recommendations will be made.

We also want to review and evaluate techniques that could ameliorate the stressors to prevent the expected degradation. That is, it's quite possible for a particular component that by just changing the temperature a few degrees that you may not expect a problem. So we want to identify those kinds of things. Can we do something with the stress state, maybe the residual stresses?

In addition, assuming that the degradation occurs, then one would need to consider replacement materials. And so within our work, we would plan on reviewing and evaluating potential new materials for replacement. Of course, if the industry does not intend to use new materials for replacing the component, and they use the same material, then we need to have guidance on, well, then, maybe you need to have a different in-service inspection program.

So given a more resistant material, maybe the inspection program does not need to be as rigorous. But with the old material, which is still susceptible to cracking, then there may be more requirements with respect to in-service inspection.

In addition, when one repairs a component, we find clearly from our experience that degradation often occurs in repaired areas. And that's because we wind up leaving the material in a -- with a poor microstructure and high residual stresses. So there's a need to review and evaluate fabrication techniques.

Will the fabrication techniques that will be used for replacing a component be adequate for the future operation of the component? I believe there will be a need to do additional work on really the welding processes, so that you control the welding to minimize stresses and to optimize microstructures.

These kinds of things can be done. We've done some work in the past with respect to trying to predict sensitization of stainless steel. We found that you could do this. We were really studying how different welding procedures would sensitize the material, but we found that by varying the parameters you could -- in effect, anneal inside surface, and the resolution of the material, which would have left it not susceptible.

So the stresses could be minimized, and the microstructures could be optimized. So that's something that needs to be looked at, review and evaluate, and then make recommendations for developments. It doesn't say that we will do those developments, but we would like to make the observations and the recommendations.

MEMBER POWERS: I guess, once again, I come back to saying, how far do you go in trying to teach the industry how to make good welds?

MR. MUSCARA: Well, again, from our point of view, if industry comes in and repairs a component, and leaves it in worse condition than it was, we need to make our own decisions. What do we require from those components? Do we require more inspection?

Less inspection?

So we need to understand if the particular repair procedures will leave the component in a good condition or not. Now, if it's not in a good condition, then it's our responsibility to indicate that you need to do better monitoring. And if they do use a better procedure, then we know that we don't -- we can accept a different inspection program.

So I think it's still part of our responsibility to know how well these techniques work.

MEMBER POWERS: But why isn't that one where you just asked --

MR. MUSCARA: I'm showing --

MEMBER POWERS: -- this repair that you've made has left the material in a better condition than it was?

MR. MUSCARA: Well, I think, again, if we're looking at the reactive approach, we wind up often making not necessarily the best decisions. Sometimes too conservative. But if you have a problem, and you have to replace a component, there's no time to start looking into a better or poorer repair procedure, or even making the case on how good the procedure is.

The fact is that the plant will be

repaired and it's going to go back out. And the problem we have left is, how do we deal with this? how do we deal for its future operations?

MR. MAYFIELD: Well, one of the other points to not lose sight of, Dana, is that -- and it goes to Joe's last bullet about the expected interaction with the industry on this. These are things that we believe need to be dealt with. I think you have gone to -- we necessarily think we're going to deal with all of them.

And where we are today, at least where I am, I'm not convinced how much of this is -- really falls to the NRC to fund, and how much of it is us trying to encourage others to spend the money to chase the subject.

MEMBER POWERS: I'm absolutely persuaded that it's useful and worthwhile for NRC to invest something in this area. What I'm struggling with is how to make it finite.

MR. MAYFIELD: I'm sorry. How to what?

MEMBER POWERS: How to make it finite. It's very clear to me that it's more -- they're not investing enough. Quite frankly, to be blunt, the Commission right now is vulnerable to an incredible -- if you have a Davis-Besse-like incident in a plant that you've given a license extension to, now I would expect the Commission would get an opportunity to explain that to the Congress in various subcommittee meetings and things like that. So it's clear they need to invest something.

But, you know, what's the limit on it? That's what I'm struggling with.

MR. MUSCARA: But, again, at this stage, as I thought I had stressed, our role right now is to review and evaluate and recommend. So, but the review and evaluation will have a feeling for --

MEMBER POWERS: But you see, Joe, we've conceded, we've mutually agreed that to review effectively, you have to be knowledgeable in the field. And you cannot become knowledgeable in the field simply by reading the literature.

MR. MUSCARA: That's correct. Yes.

MEMBER POWERS: And, I mean, that is an assumption that this committee has agreed -- not just with you, but throughout research. We've agreed that that is the case, and I think we understand why that's the case.

And so now how much do we have to do to become a knowledge reviewer of what the industry proposes?

MR. MUSCARA: Well, maybe let's put that off until I'm finished, because --

MEMBER POWERS: Sure. That's where I'm struggling with it.

MR. MAYFIELD: Very quickly, we don't have the answer either.

MEMBER POWERS: I'm sure we don't. I mean, I'm sure we don't.

MR. MAYFIELD: And that where it's in the eye of the beholder, what's -- you know, when is enough enough?

MEMBER SIEBER: One of the issues is that where you are right now is sort of an after-the-fact deal, whereas the repair procedures in the ASME code is before the fact. And the problem with dealing with the code is that it moves at such glacial speed none of us will live long enough to see them actually shape up the code, where, you know, you draw -- circumscribe what the appropriate repair procedures are.

And so you're forced to do something, and I guess I come away -- first thought -- that what you're doing is probably the right thing.

MR. MUSCARA: Second-to-the-last bullet, review and study potential new degradation mechanisms, this effectively comes partially from the results from the PIRT. We will, I'm sure, discuss and debate different components and environment combinations where we don't know enough. We have a suspicion that cracking may occur, but we don't know enough.

As part of the PIRT, those areas where we have a suspicion that degradation is possible, but we don't have enough knowledge, that's an area where we think we need to develop some additional knowledge.

Again, as examples, we don't have experienced degradation yet in a particular component, but that may be a matter of time. Do we know enough about the crack initiation times for particular materials and environments? So it may be that we will have to address this in getting a better understanding of particular aspects of different degradation mechanisms.

Finally, I had a bullet here on industry and international interaction. Again, we've only been looking at this for the last three or four months. But I've had the opportunity to discuss this issue with the two main international meetings and conferences. And there clearly is a tremendous amount of interest in the willingness to support work in this area.

We have also discussed this with EPRI, in particular doing the first step -- identifying the materials and components that are susceptible to degradation. They are effectively telling me, yes, we're interested. Now, I'm trying to go beyond that. I'm trying to get to the next step.

Just in the last couple of days I've talked with Mike Robinson, who is heading the technical committee for the industry developing this new degradation -- materials degradation program. And we are going to get together within a week or two to sit across the table and discuss what we are planning on doing, what they are planning on doing, but, in addition to that, how they can cooperate and help us do this work.

And so, in effect, we agreed that we need to go beyond "we're interested." They need to get to the point where they can make some commitments, and we've agreed we will start doing this. So that's going to go on over the next couple of weeks.

But I think with respect to identifying locations, in order to be proactive we have to do this, and we have to get going on that issue.

There has been so much interest, and in particular we had a -- one of our international meetings in Canada on the generator program two weeks ago. I was approaching the subject at a side discussion, and there was, again, some tremendous interest there in participating, wanting to cooperate in doing work in this area.

So the conclusion I've come to over this last week is that originally I thought let us do the first step. Let's identify the areas of interest and then start developing the programs around us. What needs to be done with reviewing and evaluating inspection and repairs and the materials, etcetera.

Well, it seems to me that with the interest that is available, you already know enough of some of the areas that need to be addressed that I need to start another group concurrent with the work that's going on to identify the locations, to start planning and exploring the research program.

So the thought here is to get together -- maybe I should mention numbers. At the first meeting I had 24 scientists and engineers and government agency people indicating that they had an interest in participating. And I've picked up additional support from the other meetings.

So there is a lot of interest. What I'm trying to do is pull together government agencies, international government agencies, funding agencies, and researchers to together work out a plan. What are the areas that need to be investigated? What would be the objectives of the work? How far can we take the work?

Develop the program and then to have a coordinated international effort to address all of the work. So each country's organization will do a small piece of the work, but together we can get all of the work done.

And I've approached several people with this idea. It seems to be something people want to do. So I want to explore this. So my feeling is that we should be able to identify the areas of interest.

We should be able to identify a broad program to address the issues -- whether it's interest from the regulator or from the NSSS vendor, from a fabricator, that the overall program would be defined and pieces of it will be done in different places, but coordinated cooperatively so everybody can take advantage of it.

So in my thinking at this point, this is where we're going. We do plan on starting the PIRT process hopefully this year. And we do hope to get contributions for that from the industry also.

MEMBER POWERS: Can I chat with you just

a little bit about the PIRT process? I come at it as a person who was extremely enthusiastic about the idea of taking PIRT, which had been devised initially in the thermal hydraulics realm, and applying it to some of these phenomenological issues, like the high-burnup fuel issue.

And we actually saw pretty good success when it was applied in the high-burnup fuel issue as the front end of their program to decide what areas should they pursue, because there is essentially an infinite amount that you could do. And so what were the things that you ought to do based on your best understanding? And I think they did an outstanding job.

Since that time, I've participated in a couple of these exercises, and the most recent one of which I came away just absolutely infuriated at the way it was organized and run, because despite the name -- Phenomena Identification and Ranking Table -- it became a structure identification and ranking exercise.

And in trying to think about how it could be done better, I hearken back to what I think was one of the discoveries in the expert elicitation process -- if Dr. Apostalakis was here, he would say it's an expert opinion elicitation process -- that one of the things that you will find is expensive about PIRT as you get these experts together -- and it takes them a long time to focus on your problem -- is you might find it useful, because you have a technically-skilled set of staff and a technically-skilled set of contractors working for you, to create a strawdog for them to work from, rather than putting the aspiration and say invent this out of whole cloth.

Because I think the formalisms that have been ascribed to phenomena identification and ranking can easily take over, and you can easily lose out, especially in the phenomena aspects of it, to this formalism. Because, I mean, quite frankly, the thermal hydraulicists had a wonderful idea on doing these things, and they carried it out very nicely. Well, sometimes it's been done very well for thermal hydraulics, but you cannot take that formalism exactly and translate it into this field. And you have to make some adjustments and --

MR. MUSCARA: I agree. And this is why I've said it's a PIRT-like process. We really looked at -- I spent a day with Brandt, and of course we had some differences of opinion a number of times. I'm trying to use as much of that process as I can, but, in fact, you know, it's a sophisticated expert elicitation process.

For that reason, we're doing a lot of legwork ahead of time. We're trying to get a lot of background information. And, in fact, we are going to fill out, you know, an example, so that our at our first meeting this will be discussed with the experts and --

MEMBER POWERS: That's going to pay off for you big time, because what they've done on the coated-particle fuel I think is just a waste of time, because it's all formalism. And, I mean, vast areas of phenomena are just hidden in curt little structural statements, and you have to be very careful about that.

MR. MUSCARA: And hopefully we won't get hung up on the formalism. But I'd like to take advantage of the structure. So --

MEMBER POWERS: I think it's a fantastic idea, and the greater diversity you can get in your panel without having it become unwieldy -- I think in the high-burnup fuel they got tremendous diversity, and it paid off very well. But I think they paid for having a certain unwieldiness to it.

MR. MAYFIELD: But that's, frankly, why I like Joe's approach of starting with a somewhat smaller panel, get something, and then vet that with a much larger audience.

MEMBER POWERS: Yes. I mean, that's probably a really good idea, because you really want diversity, but the unwieldiness will just kill you.

MR. MUSCARA: One of the aspects we discussed with Dr. Boyack was, you know, for PWR you want to have these other experts. For the BWR -- I said, no, for this problem, for degradation, I want the BWR guys to be there when we discuss the PWR, because it's experience that they could use.

So I've decided not to have two separate panels, but have the same panel, essentially with the same expertise, but taking advantage of both sides.

MEMBER POWERS: See, what you're seeing with Boyack is this structuralism here. You know, to find the reactor, just find the accident. And you don't have to do that, because you're working in a phenomenological area.

MR. MAYFIELD: And that's exactly where we've been trying to go.

With that, unless there are other questions, Mr. Chairman, that's all we have to say.

MEMBER FORD: Mike, Joe, thank you very

much, indeed. I understand that there is no request from you for a letter --

MR. MAYFIELD: That is correct.

MEMBER FORD: -- on this, and the information you give to us will be useful for the research report, I think. And it will also be useful background for the talk tomorrow to the Commissioners.

Are there any other questions from the committee? No?

MEMBER POWERS: I mean, have you got all day? I'm struggling heroically here.

MEMBER FORD: Thank you very much, indeed.

Mario, it's yours.

CHAIRMAN BONACA: Yes. Thank you very much.

Okay. I think we are going to go off the record now and take a break. We'll get back at 20 of 6:00. We need to go through the presentation, the slides for tomorrow. And the other thing I would have liked to do is to read Tom's letter on security and safeguards, give him some feedback on it.

(Whereupon, at 5:25 p.m., the proceedings in the foregoing matter went off the record.)

CERTIFICATE

This is to certify that the attached proceedings before the United States Nuclear Regulatory Commission in the matter of:

Name of Proceeding: Advisory Committee on Reactor Safeguards 506th Meeting

Docket Number: n/a

Location: Rockville, MD

were held as herein appears, and that this is the original transcript thereof for the file of the United States Nuclear Regulatory Commission taken by me and, thereafter reduced to typewriting by me or under the direction of the court reporting company, and that the transcript is a true and accurate record of the foregoing proceedings.

Rebecca Davis

Rebecca Davis
Official Reporter
Neal R. Gross & Co., Inc.

ACRS LICENSE RENEWAL FULL COMMITTEE

FORT CALHOUN STATION, UNIT 1
LICENSE RENEWAL APPLICATION

FINAL SAFETY EVALUATION REPORT

OCTOBER 1, 2003

WILLIAM BURTON
PROJECT MANAGER
NRR

OVERVIEW

APPLICATION SUBMITTED BY LETTERS DATED JANUARY 9 AND APRIL 5, 2002

COMBUSTION ENGINEERING PRESSURIZED WATER REACTOR

PLANT LOCATED IN WASHINGTON COUNTY, NEBRASKA

CURRENT LICENSE EXPIRES AUGUST 9, 2013. REQUESTS RENEWAL THROUGH AUGUST 9, 2033

SER WITH OPEN ITEMS ISSUED APRIL 21, 2003

ACRS LICENSE RENEWAL SUBCOMMITTEE MEETING HELD ON JUNE 11, 2003

FINAL SER ISSUED SEPTEMBER 5, 2003

COMPARISON TO PREVIOUS LICENSE RENEWAL APPLICATONS

FIRST APPLICANT TO FULLY IMPLEMENT THE GENERIC AGING LESSONS LEARNED (GALL) PROCESS

FIRST PLANT TO INCLUDE CONFIRMATION OF GALL CONSISTENCY IN STAFF REVIEW

- PART OF AMR INSPECTION

FIRST PLANT TO UTILIZE AN SER TEMPLATE

- TO AID IN THE PERFORMANCE AND DOCUMENTATION OF THE STAFF'S REVIEW

STAFF CONCLUSION

THE APPLICANT HAS MET THE REQUIREMENTS FOR LICENSE RENEWAL, AS REQUIRED BY 10 CFR 54.29:

- ACTIONS HAVE BEEN IDENTIFIED AND HAVE BEEN OR WILL BE TAKEN SUCH THAT THERE IS REASONABLE ASSURANCE THAT ACTIVITIES WILL CONTINUE TO BE CONDUCTED IN THE RENEWAL TERM IN ACCORDANCE WITH THE CURRENT LICENSING BASIS

- THE APPLICABLE REQUIREMENTS OF 10 CFR PART 51 HAVE BEEN SATISFIED

- MATTERS RAISED UNDER 10 CFR 2.758 HAVE BEEN ADDRESSED

SCOPING AND SCREENING METHODOLGY

METHODOLOGY USED TO IDENTIFY STRUCTURES, SYSTEMS, AND COMPONENTS (SSCs) WITHIN THE SCOPE OF LICENSE RENEWAL AND SUBJECT TO AN AGING MANAGEMENT REVIEW

METHODOLOGY SHOULD MEET SCOPING AND SCREENING REQUIREMENTS IN 10 CFR PART 54 AND BE CONSISTENT WITH THE LRA

STAFF REVIEW SUPPLEMENTED BY METHODOLOGY AUDIT

4 METHODOLOGY REQUESTS FOR ADDITIONAL INFORMATION (RAIs)

FUNCTIONAL REALIGNMENT

NO OPEN ITEMS

1 CONFIRMATORY ITEM (RESOLVED)

SCOPING AND SCREENING METHODOLGY

CONCLUSION

METHODOLOGY IS ADEQUATELY DESCRIBED AND JUSTIFIED IN THE LRA AND SATISFIES THE REQUIREMENTS OF 10 CFR 54.21(a)(2)

SCOPING AND SCREENING REVIEW RESULTS

STAFF REVIEW SUPPLEMENTED BY SCOPING AND SCREENING INSPECTION

69 RAIs ASSOCIATED WITH SCOPING AND SCREENING RESULTS

3 SCOPING AND SCREENING OPEN ITEMS (ALL ARE RESOLVED)

0 CONFIRMATORY ITEMS

CREDIT FOR PRESSURIZER SPRAY NOZZLE TO MEET APPENDIX R

STAFF ISSUE:	SPRAY PATTERN MAY BE CRITICAL TO DEPRESSURIZING RCS TO MEET APPENDIX R. THEREFORE PRESSURIZER SPRAY HEAD SHOULD BE IN SCOPE
RESPONSE:	SPRAY PATTERN NOT CREDITED FOR PRESSURE REDUCTION, AND PRESSURIZER SPRAY IS ONE OF SEVERAL MEANS TO COOLDOWN AND DEPRESSURIZE RCS. THEREFORE, SPRAY HEAD NOT IN SCOPE
ACRS CONCERN:	SER IMPLIED THAT BASIS FOR STAFF FINDING WAS REDUNDANT CAPABILITY TO DEPRESSURIZE
STAFF FIX:	STAFF REVISED SER TO CLARIFY THAT SPRAY PATTERN NOT MATERIAL TO MEETING PRESSURE REDUCTION FUNCTION. AVAILABILITY OF ADEQUATE VOLUME OF WATER IS CRITICAL, NOT THE SPRAY PATTERN (REDUCED EFFICIENCY). PRESSURIZER AND PIPING ARE CRITICAL COMPONENTS NEEDED TO ENSURE WATER IS SUPPLIED TO PRESSURIZER. THESE COMPONENTS ARE WITHIN SCOPE (SER SECTION 2.3.1.2.2)

SCOPING AND SCREENING REVIEW RESULTS

CONCLUSION

THE FCS STRUCTURES, SYSTEMS, AND COMPONENTS WITHIN THE SCOPE OF LICENSE RENEWAL HAVE BEEN IDENTIFIED, AS REQUIRED BY 10 CFR 54.4(a)

THE FCS STRUCTURES AND COMPONENTS WITHIN THE SCOPE OF LICENSE RENEWAL AND SUBJECT TO AN AGING MANAGEMENT REVIEW HAVE BEEN IDENTIFIED, AS REQUIRED BY 10 CFR 54.21(a)(1)

AGING MANAGEMENT PROGRAMS

STAFF REVIEW SUPPLEMENTED BY AMR INSPECTION AND AUDIT

24 AMPs CREDITED FOR LICENSE RENEWAL

14 COMMON AMPS

CONSISTENT WILL GALL: 5
CONSISTENT WITH GALL, BUT WITH SOME DEVIATION: 7
NON - GALL: 2

10 SYSTEM-SPECIFIC AMPS

CONSISTENT WILL GALL: 4
CONSISTENT WITH GALL, BUT WITH SOME DEVIATION: 6
NOT CONSISTENT WITH GALL: 0

NUMBER OF AMPs THAT ARE CONSISTENT WITH GALL - 22

1 AMP (NON-EQ CABLES) WAS REVISED TO BE CONSISTENT WITH GALL

NUMBER OF AMPs THAT ARE CONSISTENT, BUT WITH A DEVIATION FROM GALL - 13

AGING MANAGEMENT PROGRAMS

DEVIATIONS FROM GALL:

CLARIFICATIONS - 4
EXCEPTIONS - 6
ENHANCEMENTS - 10

NUMBER OF GALL AMPs THAT ARE REFERENCED IN THE LRA - 33

38 RAIs

NO OPEN ITEMS

1 CONFIRMATORY ITEM (RESOLVED)

STAFF ALSO REVIEWED USAR SUPPLEMENTS

ONE-TIME INSPECTIONS

ONE-TIME INSPECTION (OTI) PROGRAM NOT YET DEVELOPED

STAFF CONFIRMED ITEMS TO BE ADDRESSED IN OTI AMP. ITEMS IDENTIFIED IN APPENDIX A OF SER (COMMITMENT TABLE)

AMR INSPECTION TEAM CONFIRMED THAT DEVELOPMENT OF OTI AMP, AND ITEMS TO BE INCLUDED IN THE OTI AMP, ARE CAPTURED IN APPLICANT'S COMMITMENT TRACKING SYSTEM

STAFF WILL REVIEW FULFILLMENT OF COMMITMENTS IN IP 71003 (CURRENTLY UNDER DEVELOPMENT)

AGING MANAGEMENT PROGRAMS

CONCLUSION

APPLICANT HAS DEMONSTRATED THAT AGING MANAGEMENT PROGRAMS WILL EFFECTIVELY MANAGE AGING IN STRUCTURES AND COMPONENTS SO THAT THEIR INTENDED FUNCTIONS WILL BE MAINTAINED CONSISTENT WITH THE CURRENT LICENSING BASIS FOR THE PERIOD OF EXTENDED OPERATION, AS REQUIRED BY 10 CFR 54.21(a)(3)

THE USAR SUPPLEMENTS PROVIDE AN ACCEPTABLE SUMMARY DESCRIPTION OF THE PROGRAMS AND ACTIVITIES FOR MANAGING THE EFFECTS OF AGING FOR THE PERIOD OF EXTENDED OPERATION, AS REQUIRED BY 10 CFR 54.21(d)

AGING MANAGEMENT REVIEW

STAFF REVIEW SUPPLEMENTED BY AMR INSPECTION AND AUDIT

90 RAIs ISSUED

6 OPEN ITEMS (ALL ARE RESOLVED)

NO CONFIRMATORY ITEMS

OPEN ITEM 3.0-1

CONCLUSION

APPLICANT HAS DEMONSTRATED THAT EFFECTS OF AGING WILL BE ADEQUATELY MANAGED SO THAT THE INTENDED FUNCTION(S) WILL BE MAINTAINED CONSISTENT WITH THE CURRENT LICENSING BASIS FOR THE PERIOD OF EXTENDED OPERATION, AS REQUIRED BY 10 CFR 54.21(a)(3)

TIME-LIMITED AGING ANALYSES (TLAAs)

8 TLAAs IDENTIFIED IN LRA

13 RAIs ISSUED

2 CONFIRMATORY ITEMS (BOTH ARE RESOLVED)

2 OPEN ITEMS (BOTH ARE RESOLVED)

1 OPEN ITEM WAS AN ADDITIONAL TLAA THAT WAS IDENTIFIED FOLLOWING ISSUANCE OF THE SER WITH OPEN ITEMS

> ALLOY 600 WELD REPAIR IN PRESSURIZER LOWER SHELL TEMPERATURE NOZZLE
>
> APPLICANT CHOSE TO DEFER THE TLAA EVALUATION. IN ACCORDANCE WITH NEI 95-10, THE APPLICANT PROVIDED INFORMATION TO ALLOW STAFF TO CONCLUDE THAT 10 CFR 54.21(C)(1)(iii) HAS BEEN MET

TLAAs

REACTOR VESSEL NEUTRON EMBRITTLEMENT

UPPER SHELF ENERGY (USE)

STAFF PERFORMED INDEPENDENT CALCULATIONS

APPLICANT'S ANALYSIS OF USE PROJECTED TO END OF EXTENDED OPERATING PERIOD

- MINIMUM LIMIT OF 50 FT-LBs

- LOWEST PROJECTED VALUE USING METHODOLOGY IN REG. GUIDE 1.99, REVISION 2, IS 54.6 FT-LBs AT 48 EFPY

TLAAs

REACTOR VESSEL NEUTRON EMBRITTLEMENT

PRESSURIZED THERMAL SHOCK (PTS)

STAFF PERFORMED INDEPENDENT CALCULATIONS

APPLICANT'S ANALYSIS OF PTS PROJECTED TO END OF EXTENDED OPERATING PERIOD

	PTS SCREENING CRITERIA (Degrees Fahrenheit)	FCS (Degrees Fahrenheit)	STAFF (Degrees Fahrenheit)
PLATES/FORGINGS/AXIAL WELDS	270	268	269
CIRCUMFERENTIAL WELDS	300	243	260

TLAAs

CONCLUSION

THE APPLICANT HAS IDENTIFIED THE TLAAs AND HAS DEMONSTRATED OR WILL DEMONSTRATE THAT THE TLAAs:

1. **WILL REMAIN VALID FOR THE PERIOD OF EXTENDED OPERATION**

2. **HAVE BEEN PROJECTED TO THE END OF THE PERIOD OF EXTENDED OPERATION, OR**

3. **THE AGING EFFECTS WILL BE ADEQUATELY MANAGED FOR THE PERIOD OF EXTENDED OPERATION**

INSPECTIONS AND AUDITS

SCOPING AND SCREENING METHODOLOGY AUDIT JULY 8 - 12, 2002

RESULTS DOCUMENTED IN SER SECTION 3.0.4

SCOPING AND SCREENING INSPECTION NOVEMBER 4 - 8, 2002

4 INSPECTION OPEN ITEMS WERE IDENTIFIED

RESULTS DOCUMENTED IN INSPECTION REPORT 50-285/02-07, ISSUED ON DECEMBER 20, 2002

AGING MANAGEMENT REVIEW INSPECTION AND CONCURRENT AUDIT JANUARY 6 - 10 AND JANUARY 20 - 23, 2003

INSPECTION REPORT DISCUSSES RESOLUTION OF THE 4 INSPECTION OPEN ITEMS IDENTIFIED DURING THE SCOPING AND SCREENING INSPECTION

INSPECTION RESULTS DOCUMENTED IN INSPECTION REPORT 50-285/03-07

AUDIT RESULTS DOCUMENTED IN LETTER DATED APRIL 9, 2003

REGION CONCLUDED THAT OPTIONAL FINAL INSPECTION WAS NOT NEEDED

COMMITMENT TRACKING SYSTEM

SER APPENDIX A LISTS APPLICANT'S LICENSE RENEWAL COMMITTMENTS

FULFILLMENT OF COMMITMENTS WILL BE CONFIRMED BY STAFF IN INSPECTION PROCEDURE 71003 (BEING DEVELOPED)

TWO ON-SITE PROCEDURES RELATED TO COMMITMENT TRACKING

- ONGOING COMMITMENT PROGRAM
- COMMITMENT TRACKING SYSTEM

COMMITMENTS ARE TRACKED USING ACTION REQUESTS (A/Rs)

OPEN AND CONFIRMATORY ITEMS

11 OPEN ITEMS

3 RELATED TO SCOPING AND SCREENING

6 RELATED TO AGING MANAGEMENT

2 RELATED TO TLAAs (1 WAS IDENTIFIED AFTER THE SER WITH OPEN ITEMS WAS ISSUED. ACRS SUBCOMMITTEE WAS BRIEFED ON THIS OPEN ITEM ON JUNE 11, 2003)

ALL ARE RESOLVED

4 CONFIRMATORY ITEMS

1 RELATED TO SCOPING AND SCREENING

1 RELATED TO AGING MANAGEMENT

2 RELATED TO TLAAs

ALL ARE RESOLVED

OPEN ITEM SUMMARY

OPEN ITEM	SUBJECT	STATUS
2.2-1	SEVERAL SYSTEMS THAT MET 54.4(a)(2) SCOPING CRITERION WERE NOT IDENTIFIED AS BEING WITHIN SCOPE	CLOSED: SYSTEMS AND ASSOCIATED AGING MANAGEMENT INFORMATION WERE BROUGHT INTO SCOPE. STAFF REVIEWED AGING MANAGEMENT INFORMATION AND FOUND IT TO BE SATISFACTORY. ALL SYSTEMS MEETING 54.4(a)(2) HAVE BEEN IDENTIFIED DISCUSSED DURING ACRS SUBCOMMITTEE MEETING
2.2-2	DISCREPANCY BETWEEN SCOPING TABLE AND SYSTEM DESCRIPTION FOR BLOWPIPE SYSTEM	CLOSED: DISCREPANCY RESOLVED. BLOWPIPE COMPONENTS WERE ALREADY IDENTIFIED IN LRA DISCUSSED DURING ACRS SUBCOMMITTEE MEETING
2.3.3.15-1	CIRCULATING WATER DISCHARGE TUNNEL COULD BLOCK RAW WATER DISCHARGE	CLOSED: TUNNEL BROUGHT INTO SCOPE AS PART OF INTAKE STRUCTURE. NO ADDITIONAL AGING MANAGEMENT INFORMATION NEEDED DISCUSSED DURING ACRS SUBCOMMITTEE MEETING

3.0-1	APPLICANT MADE REVISIONS TO LRA TABLES. STAFF HAD TO REVIEW THE REVISIONS	CLOSED: STAFF FINISHED ITS REVIEW AND FOUND REVISIONS SATISFACTORY THIS WAS OPEN AT THE ACRS SUBCOMMITTEE MEETING
3.3.2.4.1.2-1	IMPACT ON CVCS PERFORMANCE OF DEGRADATION OF REGENERATIVE HEAT EXCHANGER TUBES	CLOSED: LOSS OF TUBE INTEGRITY WOULD NOT IMPACT ABILITY TO INJECT, WOULD NOT RESULT IN CONTAINMENT BYPASS, NOR WOULD RESULT IN BORON DILUTION DISCUSSED DURING ACRS SUBCOMMITTEE MEETING
3.6.2.3.1.2-1	REVISE USAR SUPPLEMENT TO REFLECT CHANGE TO NON-EQ CABLE AMP	CLOSED: USAR SUPPLEMENT WAS REVISED DISCUSSED DURING ACRS SUBCOMMITTEE MEETING
3.6.2.4.3.2-1	STAFF REQUESTED APPLICANT TO PROVIDE AMP TO MANAGE BUS BAR AGING	CLOSED: AGING MANAGEMENT WILL BE PERFORMED WITH EXISTING AMP (PERIODIC SURVEILLANCE AND PREVENTIVE MAINTENANCE). NO NEW AMP NEEDED DISCUSSED DURING ACRS SUBCOMMITTEE MEETING
3.6.2.4.4.2-1	STAFF REQUESTED APPLICANT TO PROVIDE AMP TO MANAGE AGING IN HIGH-VOLTAGE CONDUCTORS OR JUSTIFY WHY AMP NOT NEEDED	CLOSED: APPLICANT PROVIDED JUSTIFICATION (AMPLE STRENGTH MARGIN TO ENSURE CORROSION WILL NOT PREVENT TRANSMISSION CONDUCTORS FROM PERFORMING THEIR INTENDED FUNCTION DURING EXTENDED OPERATING PERIOD) DISCUSSED DURING ACRS SUBCOMMITTEE MEETING

3.6.2.4.5.2-1	AGING MANAGEMENT OF FUSE BLOCKS	CLOSED: APPLICANT WILL MANAGE FUSE BLOCKS IN ACCORDANCE WITH ISG-05 DISCUSSED DURING ACRS SUBCOMMITTEE MEETING
4.7.2.2-1	LEAK-BEFORE-BREAK ANALYSIS SHOULD BE SUBMITTED FOR STAFF REVIEW	CLOSED: APPLICANT WILL COMPLETE AND SUBMIT ANALYSIS PRIOR TO EXTENDED OPERATING PERIOD. APPLICANT PROVIDED SUPPORTING INFORMATION PER NEI 95-10 GUIDANCE DISCUSSED DURING ACRS SUBCOMMITTEE MEETING
4.7.4-1	FLAW LEFT IN PLACE DURING ALLOY 600 WELD REPAIR ON PRESSURIZER LIQUID SPACE TEMPERATURE ELEMENT	CLOSED: APPLICANT WILL COMPLETE AND SUBMIT EVALUATION PRIOR TO THE EXTENDED OPERATING PERIOD TO DEMONSTRATE THAT CRACK AND ANY POTENTIAL FUTURE GROWTH OF THE CRACK DOES NOT IMPACT STRUCTURAL INTEGRITY OF THE VESSEL FOR THE EXTENDED PERIOD. APPLICANT PROVIDED SUPPORTING INFORMATION PER NEI 95-10 GUIDANCE DISCUSSED DURING ACRS SUBCOMMITTEE MEETING

CONFIRMATORY ITEM SUMMARY

CONFIRMATORY ITEM	SUBJECT	STATUS
2.1.3.1.2-1	SAFETY INJECTION TANK LEVEL AND PRESSURE INDICATORS SHOULD BE IN SCOPE	CLOSED: INDICATORS BROUGHT INTO SCOPE AND SCREENED OUT AS ACTIVE COMPONENTS DISCUSSED DURING ACRS SUBCOMMITTEE MEETING
3.0.3.12.1-1	SPENT FUEL POOL COOLING SYSTEM SHOULD BE BROUGHT INTO SCOPE OF THE "GENERAL CORROSION OF EXTERNAL SURFACES" AMP	CLOSED: SYSTEM ADDED TO THE SCOPE OF THE AMP DISCUSS DURING ACRS SUBCOMMITTEE MEETING
4.3.2-1	APPLICANT SHOULD SUBMIT AMP DETAILS BY LICENSE AMENDMENT IF ENVIRONMENTALLY-ASSISTED FATIGUE IN THE LIMITING PRESSURIZER SURGE LINE WELDS WILL BE MANAGED FOR AGING	CLOSED: APPLICANT WILL PROVIDE THE REQUESTED INFORMATION BY LICENSE AMENDMENT IF THIS OPTION IS CHOSEN DISCUSSED DURING ACRS SUBCOMMITTEE MEETING
4.3.2-2	SAMPLING PIPING MAY EXCEED USAS B31.1 LIMIT OF 7000 EQUIVALENT FULL-RANGE THERMAL CYCLES DURING EXTENDED PERIOD. CYCLES WILL BE TRACKED BY FATIGUE MONITORING PROGRAM (FMP). FMP WILL ALSO ANALYZE PIPING AND PERFORM STRESS CALCULATION TO DETERMINE THERMAL STRESS RANGE. APPLICANT SHOULD CONFIRM THAT RESULTS WILL MEET USAS B31.1	CLOSED: APPLICANT CONFIRMED THAT RESULTS WILL MEET USAS B31.1 DISCUSSED DURING ACRS SUBCOMMITTEE MEETING

LICENSE CONDITIONS

TWO STANDARD LICENSE CONDITIONS:

1. FOLLOWING ISSUANCE OF THE RENEWED LICENSE, THE APPLICANT WILL INCLUDE THE USAR SUPPLEMENT IN THE NEXT USAR UPDATE, AS REQUIRED BY 10 CFR 50.71(e)

2. FUTURE INSPECTION ACTIVITIES IDENTIFIED IN THE USAR SUPPLEMENT WILL BE COMPLETED PRIOR TO THE PERIOD OF EXTENDED OPERATION

NO PLANT-SPECIFIC LICENSE CONDITIONS

LESSONS LEARNED

LINKAGE BETWEEN SECTION 2 AND SECTION 3 OF LRA

- INITIAL SUBMITTAL (JANUARY 9, 2002) DID NOT LINK LRA SECTIONS 2 AND 3 (STAFF AND APPLICANT HAD AGREED TO THIS LACK OF LINKAGE DURING THE GALL DEMONSTRATION PROJECT)

- WITHOUT THE LINKS BETWEEN LRA SECTIONS 2 AND 3, STAFF COULD NOT DETERMINE WHETHER APPLICANT HAD IDENTIFIED ALL THE AGING EFFECTS OR WAS PROPERLY CREDITING GALL FOR AGING MANAGEMENT OF PLANT STRUCTURES AND COMPONENTS

- STAFF REQUESTED APPLICANT TO LINK LRA SECTIONS 2 AND 3

- APPLICANT PROVIDED LINKAGE IN APRIL 5, 2002 SUBMITTAL

- SUBSEQUENT LICENSE RENEWAL APPLICATIONS CONTAIN LINKAGE

LESSONS LEARNED

IDENTIFICATION OF STRUCTURES AND COMPONENTS NOT ADDRESSED IN GALL FOR WHICH APPLICANT TAKES CREDIT FOR GALL

THE APPLICANT CREDITED GALL WITH MANAGING AGING FOR SOME STRUCTURES AND COMPONENTS THAT WERE NOT EVALUATED IN GALL

STAFF FOUND THAT LRA DID NOT CLEARLY IDENTIFY THIS GROUP OF STRUCTURES AND COMPONENTS.

STAFF REQUESTED THAT LRA BE REVISED TO CLEARLY IDENTIFY THESE STRUCTURES AND COMPONENTS

APPLICANT PROVIDED REQUESTED REVISIONS IN ITS APRIL 5, 2002 SUBMITTAL (LRA TABLES 3.X-3 FOR FCS)

SUBSEQUENT LICENSE RENEWAL APPLICATIONS HAVE THESE STRUCTURES AND COMPONENTS CLEARLY IDENTIFIED (THOUGH NOT IDENTIFIED IN SEPARATE TABLE)

LESSONS LEARNED

DEFINITION OF "CONSISTENT WITH GALL"

APPLICANTS AND STAFF NOT IN AGREEMENT ON WHAT "CONSISTENT WITH GALL" MEANS

REACHED AGREEMENT ON DEFINITION

FARLEY WILL BE FIRST APPLICATION TO USE THE AGREED-UPON DEFINITION

LESSONS LEARNED

ENVIRONMENTS WERE NOT ALWAYS CLEARLY DEFINED

STAFF ISSUED RAI REQUESTING IDENTIFICATION OF ALL RELEVANT ENVIRONMENTS AT FCS

APPLICANT PROVIDED INFORMATION

AS A RESULT OF THESE LESSONS LEARNED, STAFF AND INDUSTRY REVISED OVERALL LRA FORMAT. NEW FORMAT BEGINS WITH THE FARLEY LRA

LESSONS LEARNED

VERIFICATION OF CONSISTENCY OF APPLICANT'S AGING MANAGEMENT PROGRAMS WITH GALL AGING MANAGEMENT PROGRAMS

AMR INSPECTION WAS EXPANDED TO INCLUDE CONFIRMATION OF APPLICANT'S CLAIM OF AMP CONSISTENCY WITH GALL

PROVED TO BE EXCESSIVE BURDEN ON THE INSPECTION TEAM

PROCESS HAS BEEN REVISED TO HAVE CONFIRMATION OF CONSISTENCY PERFORMED BY HEADQUARTERS STAFF

NEW PROCESS BEGAN WITH ROBINSON LRA

LESSONS LEARNED

USEFULNESS OF GALL

STAFF FOUND THAT USE OF GALL PROVIDED FOR A MORE EFFECTIVE AND EFFICIENT REVIEW

HOWEVER, FURTHER PROCESS IMPROVEMENTS WERE IDENTIFIED

IMPLEMENTATION OF THE IMPROVEMENTS BEGAN WITH ROBINSON

FULL IMPLEMENTATION OF THE IMPROVEMENTS WILL BEGIN WITH FARLEY

STAFF EXPECTS TO SEE FURTHER EFFICIENCY AND EFFECTIVENESS GAINS WITH THE FARLEY REVIEW

ENVIRONMENTAL REVIEW

STAFF'S EVALUATION DOCUMENTED IN NUREG-1437, SUPPLEMENT 12, "GENERIC ENVIRONMENTAL IMPACT STATEMENT FOR LICENSE RENEWAL OF NUCLEAR POWER PLANTS, SUPPLEMENT 12, REGARDING FT. CALHOUN STATION, UNIT 1," PUBLISHED ON AUGUST 15, 2003

CONCLUSION

THE ADVERSE ENVIRONMENTAL IMPACTS OF LICENSE RENEWAL FOR FORT CALHOUN STATION, UNIT 1, ARE NOT SO GREAT THAT PRESERVING THE OPTION OF LICENSE RENEWAL FOR ENERGY-PLANNING DECISION MAKERS WOULD BE UNREASONABLE.

CONSIDERATION OF COMMISSION RULES AND REGULATIONS IN ADJUDICATORY PROCEEDINGS

NO REQUEST FOR HEARING OR PETITION TO INTERVENE WAS FILED FOR THE FCS LRA REVIEW

CONCLUSION

REQUIREMENTS OF 10 CFR 2.758 HAVE BEEN MET

STAFF CONCLUSION

THE APPLICANT HAS MET THE REQUIREMENTS FOR LICENSE RENEWAL, AS REQUIRED BY 10 CFR 54.29:

- ACTIONS HAVE BEEN IDENTIFIED AND HAVE BEEN OR WILL BE TAKEN SUCH THAT THERE IS REASONABLE ASSURANCE THAT ACTIVITIES WILL CONTINUE TO BE CONDUCTED IN THE RENEWAL TERM IN ACCORDANCE WITH THE CURRENT LICENSING BASIS

- THE APPLICABLE REQUIREMENTS OF 10 CFR PART 51 HAVE BEEN SATISFIED

- MATTERS RAISED UNDER 10 CFR 2.758 HAVE BEEN ADDRESSED

Omaha Public Power District

Fort Calhoun Station Presentation to ACRS

October 1, 2003

Presenters

Sudesh Gambhir – Division Manager, Nuclear Projects

Bernie Van Sant – License Renewal Project Manager

Plant Operating Status

Sudesh Gambhir

Plant Operating Status

- Currently in refueling outage after breaker to breaker run (~468 days)
- All NRC Performance Indicators are Green
- NRC Problem Identification & Resolution Inspection completed May 8: no Green or higher findings
- Recognized for Industry Operating Excellence by INPO

Strategy

Vision: Keeping the Nuclear Energy Option Alive to 2033 and Beyond

C - Critical self-assessments and broad and lasting corrective actions
H - Human performance is exemplary
O - Operations are event-free throughout the organization
I - Initiatives in high visibility areas have strong performance
C - Cost-effective producer of electricity
E - Excellence in materiel condition

Status of RCS Inspections and License Renewal Implementation

Bernie Van Sant

Status of RCS Inspections

- Control Element Drive Mechanisms
  - No indications found in 2002 inspection
  - No indications found in 2003 inspection
- Reactor Vessel Head
  - No indications found in 2002 inspection
  - No indications found in 2003 inspection
  - More inspections planned for 2005
  - Replacement in 2006

License Renewal Implementation

- 10 CFR 54.4 criteria met for in-scope safety related and non-safety related SSCs →Appendix B criteria applied
- Configuration control procedures being revised to meet 10 CFR 54.37 requirements for existing and new SSCs

License Renewal Implementation

- LR Commitments
  - Listed in SER and to be in USAR
    - New Programs
    - Program Enhancements
    - TLAA Evaluations
  - Identified and tracked using existing FCS regulatory commitment system
  - Implementing procedures annotated to flag commitments

License Renewal Implementation

- Training will be provided as part of procedure and other document revisions
- LR requirements will be ongoing and incorporated into documents, databases, and training for future plant staff

Summary/Questions

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

NRC Research Addressing Materials Degradation

October 1, 2003
Rockville, MD

US NRC Office of Nuclear Regulatory Research
Division of Engineering Technology (DET)

M. E. Mayfield, Director, DET, (301) 415-5678
J. Muscara, Senior Technical Advisor, (301) 415-5844
W. H. Cullen, Jr., Senior Materials Engineer, (301) 415-7510

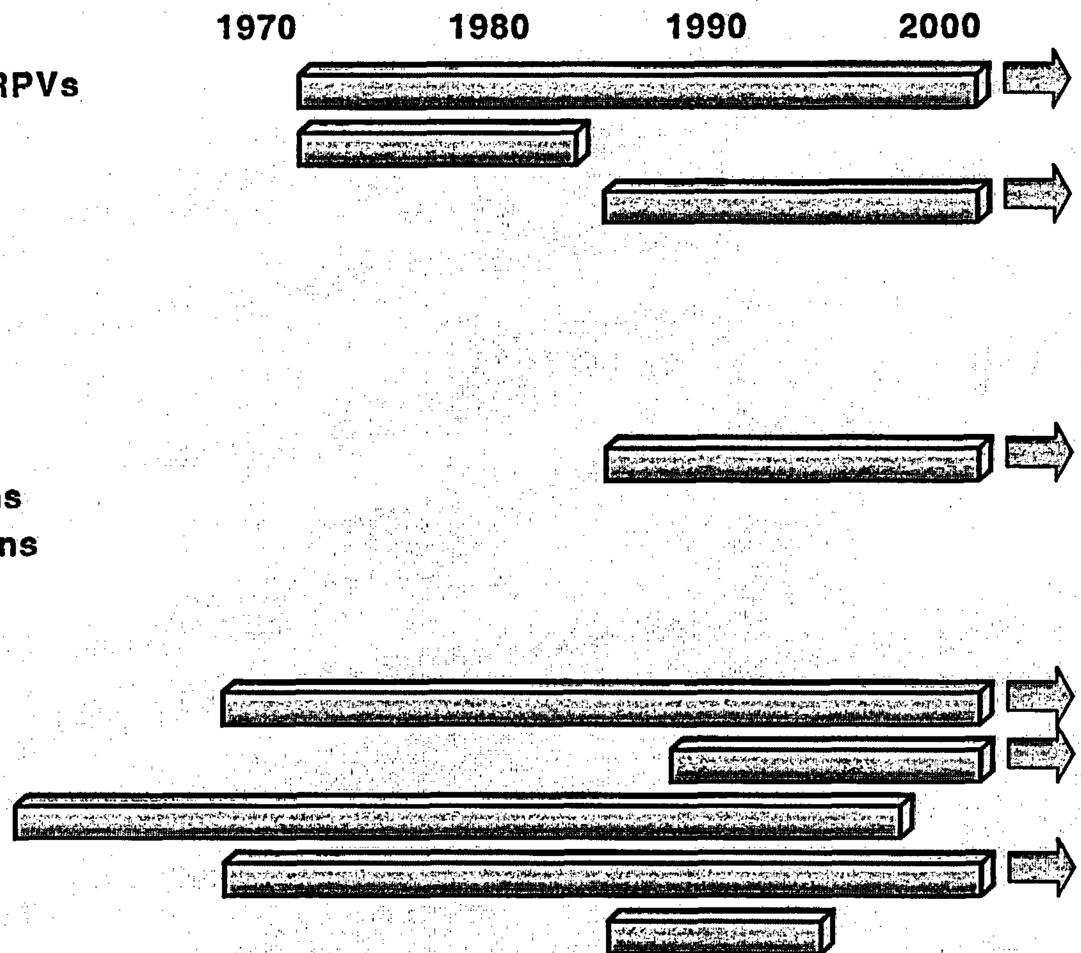
RES' Materials Degradation Research Programs

- EAC research an important element of RES program since 1977
- Program has been adjusted over time to respond to current degradation issues
  - IGSCC
  - IASCC
  - Fatigue Life for Piping
  - Fatigue Crack Growth in RPV and Piping
  - Steam Generator Tube Degradation
  - PWSCC
  - Boric Acid Corrosion
- Recent emphasis on proactive research

Sample of Significant Materials Degradation Issues in U.S. Nuclear Power Plants (Excluding Steam Generators)

Degradation/Issue

- Radition Embrittlement of RPVs
- IGSCC in BWR Piping
- BWR Internals Cracking
  - Core Spray Piping
  - Jet Pumps
  - Top Guide
  - Core Shrouds
- PWSCC in PWRs
  - Pressurizer Penetrations
  - Vessel Head Penetrations
  - Primary System Piping
  - "Other" Penetrations
- Boric Acid Corrosion
- IASCC in PWRs
- Vibratory Fatigue
- Thermal Fatigue
- Erosion/Corrosion



RES' Materials Degradation Research Programs

- Major Activities
  - Environmentally-assisted Cracking in Light-Water Reactors
  - Corrosion of Pressure Boundary Materials in Concentrated Boric Acid Solutions
  - Examination of North Anna 2 Nozzles & J-Welds

- Other Tasks
  - Vessel Penetration Conference – Sept. 29 – Oct. 2, 2003
  - Alloy 600 Issues Task Group
  - Formation of Int'l Coop Group on PWSCC and NDE
  - Proactive Materials Degradation Initiative

Reliability of NDE for In-Service Inspection

- **Research on NDE Reliability was Initiated in 1977**
- **ISI Reliability and Code Requirements**
  - Evaluation of surface roughness effects
  - SCC in reactor internals
  - Evaluation of performance demonstration programs and results
  - Evaluation of parallel international research
- **Inspection of Cast SS, DMWs and Assessment of Advanced NDE Methods**
  - Determine the effectiveness and reliability of improved UT for coarse-grained material structures (cast & welded structures)
- **Continued Development of ISI Programs**
  - Assess improvements to ISI requirements and programs
  - Support ASME Code and industry activities
  - Development and assessment of NDE techniques for complex and tight cracks in stainless steels, nickel-base alloys, and dissimilar metal welds

International Cooperative Project on PWSCC & NDE

- Cooperative project being developed
  - Significant international activities in this area
  - Opportunity to benefit from collaboration
  - Leverage a small budget

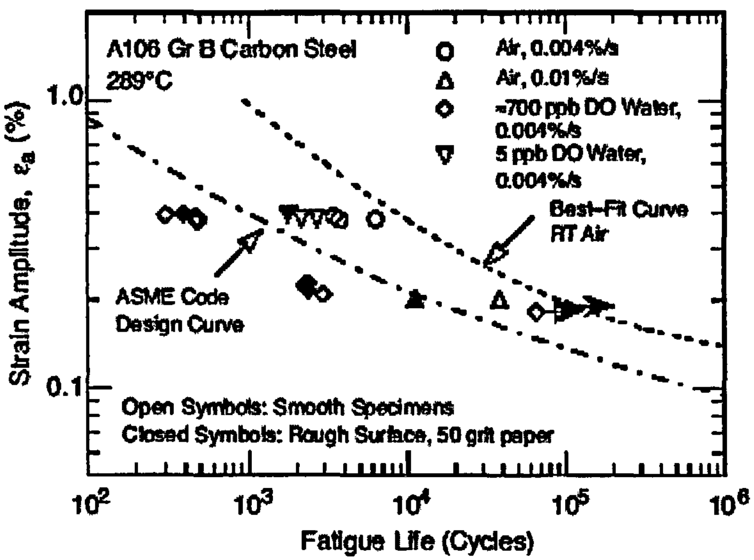
- Informal meetings held with potential participants from US, France, Sweden, Netherlands, etc.

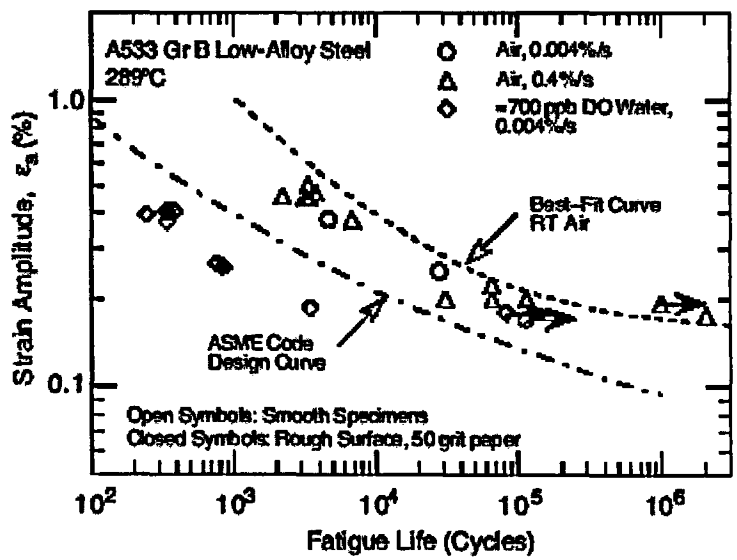
- Information and kick-off meeting to be held at Vessel Head Penetration Conference, Oct. 1, 2003

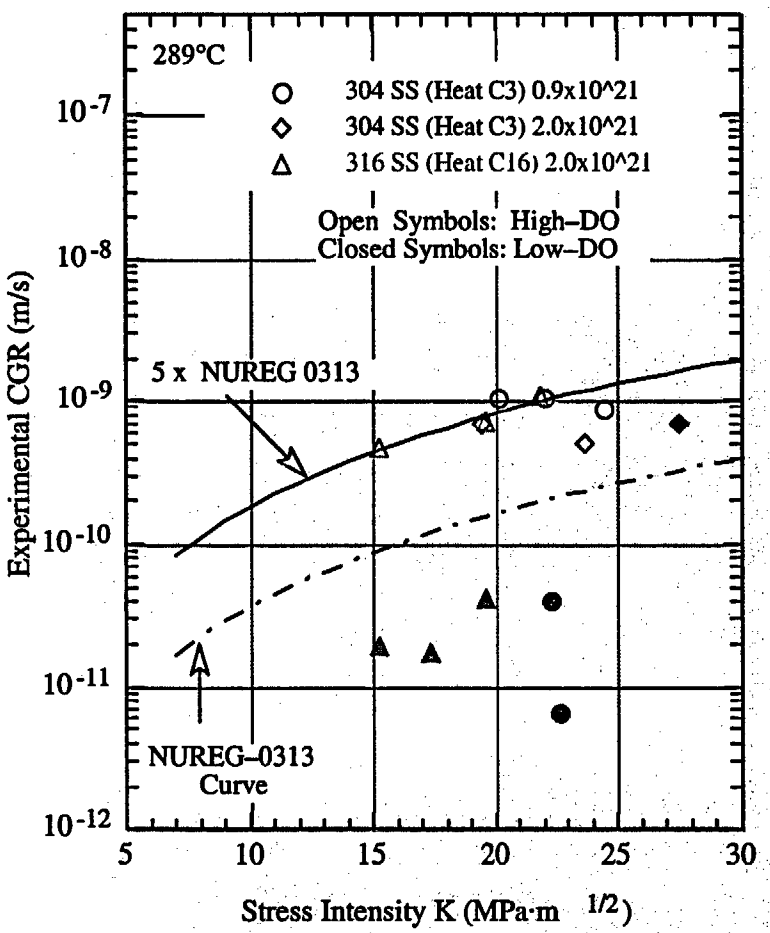
Elements of EAC in LWR Program at Argonne

- Fatigue Life Evaluation – PWR & BWR Environments
  - Carbon and Low-Alloy Steels (NUREG/CR-6583)
  - Stainless Steels (NUREG/CR-5704, CR-6787)
- IASCC for Stainless Steels in BWR & PWR Coolant Environments
- CGRs in Nickel-Base Materials
  - Alloys 600, 182, 690, 152
    - Samples taken from former Davis-Besse Head
- Code Committee/Rule Making Involvement

Degradation of Fatigue Life Due to Surface Roughness and Coolant Environment





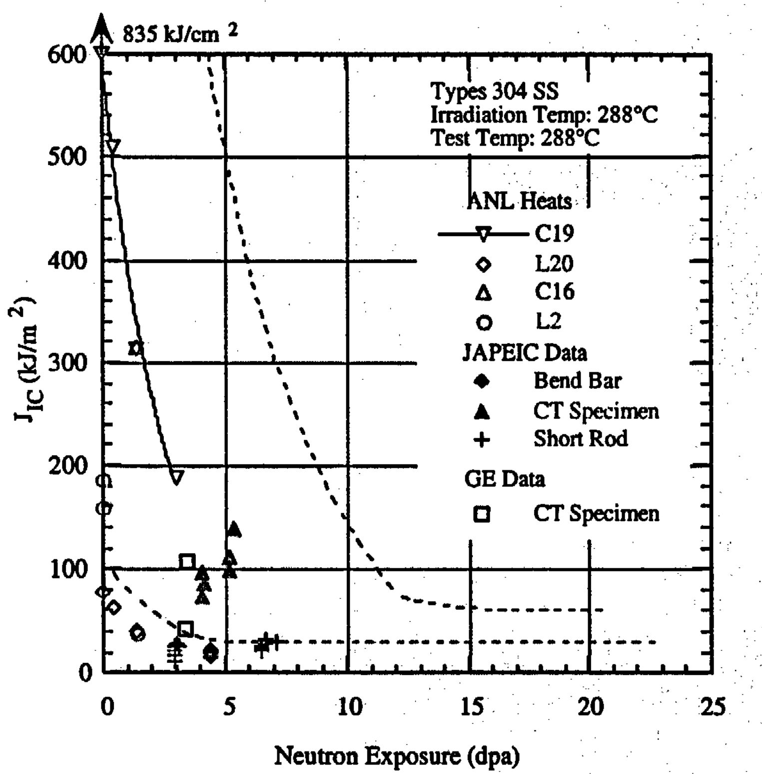


- In NWC BWR environment, CGRs from present study are a factor of ≈5 higher than NUREG 0313 curve for austenitic SSs
- CGRs decreased by more than an order of magnitude in low–DO water
- Decrease in DO appears to have no effect on CGRs of Heat C3 Irradiated to 2.0 x 10^{21} n/cm^2

Summary of IASCC Effects for Stainless Steels (BWR Coolants)

- CGR data have been obtained under gentle cycling and constant load in simulated BWR environments for Type 304 & 316 SS irradiated up to 2.0 x 10^{21} n/cm^2 (3.0 dpa) at 288°C
- In NWC BWR environment, CGRs of irradiated steels are a factor of ≈5 higher than NUREG 0313 curve for non-irradiated austenitic SSs
- In low–DO BWR environments, CGRs of irradiated steels are decreased by more than an order of magnitude; beneficial effect of decreased DO level not observed for Type 304 SS Heat C3 irradiated to 2.0 x 10^{21} n/cm^2

Degradation of Fracture Toughness of Stainless Steels Due to Irradiation Damage



- *Fracture toughness J–R curve data obtained on several heats of austenitic SSs irradiated to ≈0.3, 0.9, and 2.0 x 1021 n/cm2 (0.45, 1.35, & 3.0 dpa) at 288°C*
- *Neutron irradiation at 288°C decreased the toughness of all steels*
  - *commercial steels exhibit superior fracture toughness*
  - *poor toughness of laboratory heats reflected in their fracture behavior*
- *The results for commercial heats falls within the scatter band for data obtained from higher temp irradiations*

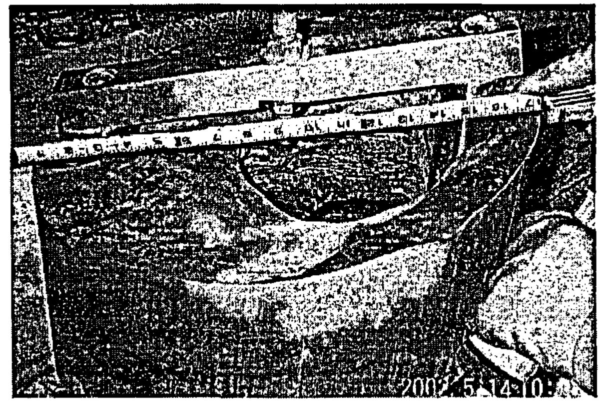
Planned Research on IASCC Effects for Stainless Steels (PWR Coolants)

- Irradiations to 4 dose levels: 5, 10, 20 & 40 dpa
  - In BOR-60 reactor, at ~300°C (5 & 10 dpa doses completed)
- Examination of C, S & O effects in commercial and model 304, 316, 347, 348 & cast stainless steel
- SCC, tensile, shear-punch tests
- Microstructural characterization (precipitates, RIS, grain boundary chemistry)
  - Characterization of crack tip chemistry
- Development of quantitative modeling and IASCC projections for PWR coolant environments

Sept. '03 Conference on CRDM and related Issues

- Five main session topics
  - Structural Analysis and Fracture Mechanics Issues
  - Inspection technologies, disposition & sizing of flaws, new developments
  - Crack growth rates for relevant nickel-base alloys & welds
  - Mitigation & Foreign Experience
  - Continued Plant Operation
- Sept. 29 – Oct. 2 At Gaithersburg-Marriott
- 220 attendees (11 countries) & participants
- Proceedings issued as CD and NUREG/CP

Harvesting of Head for Additional Research



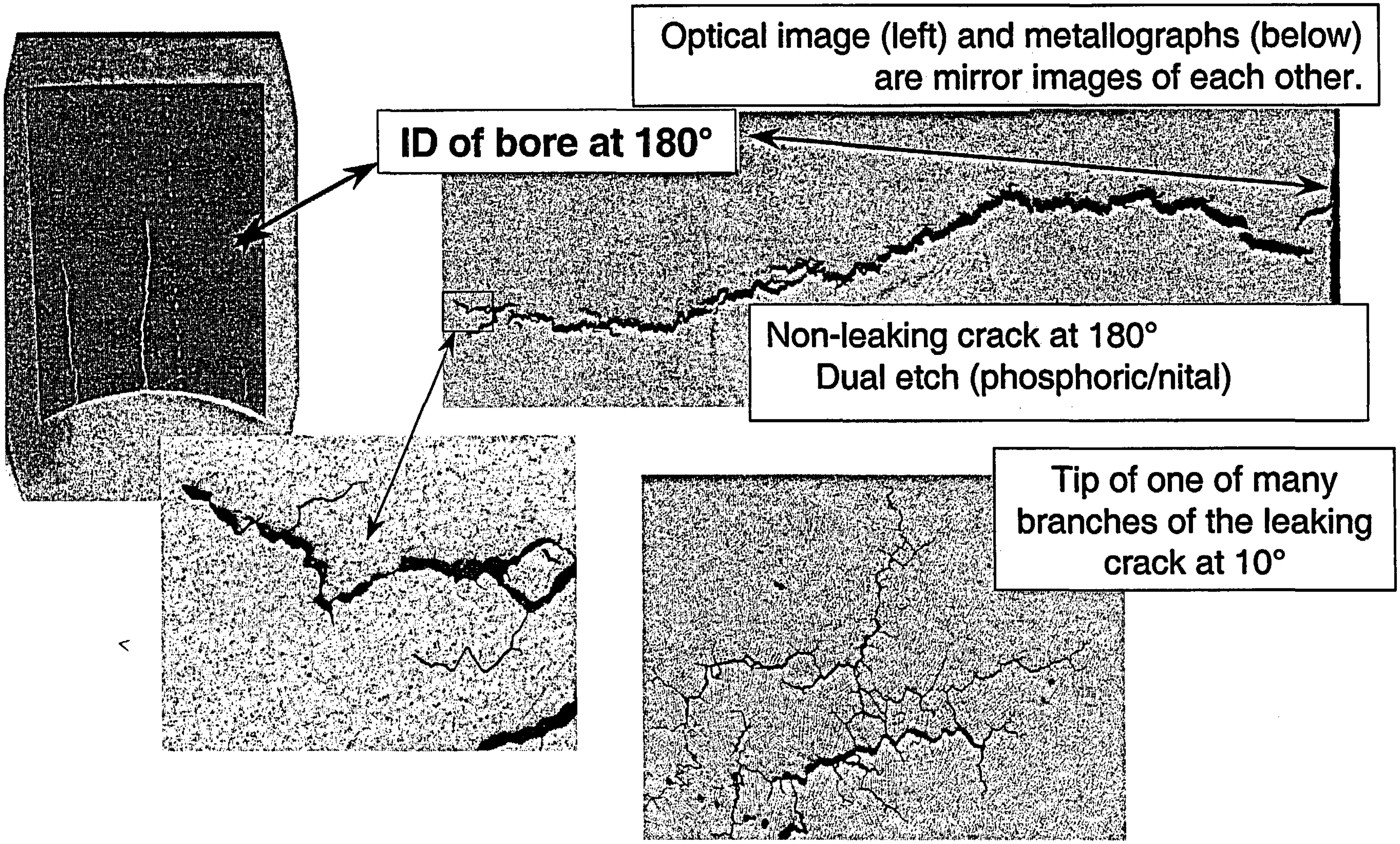
- **Nozzle #3 and surrounding low-alloy steel at BWXT-Lynchburg**
  - Optical & SEM Microscopy of Cavity Surface
  - Cladding Properties, Microstructure, etc.

- **Nozzles #2 and #46 - removed in June**
  - Sent to PNNL for exam of cavity and research on "anomalous" UT indications
  - Additional nozzles for crack growth rate testing

- **Crack Growth Rate Testing of Alloy 600 (Nozzle #3) and Alloy 182 (J-weld, from Nozzle #11) soon underway**

- **North Anna Unit 2 Head Being Harvested by Industry**
  - NRC/Industry Coordination of NA2 Research
  - Program combines NDE, stress analysis and SCC studies

Character of PWSCC cracks in J-weld of Nozzle #3



Content of New Boric Acid Corrosion Research Program

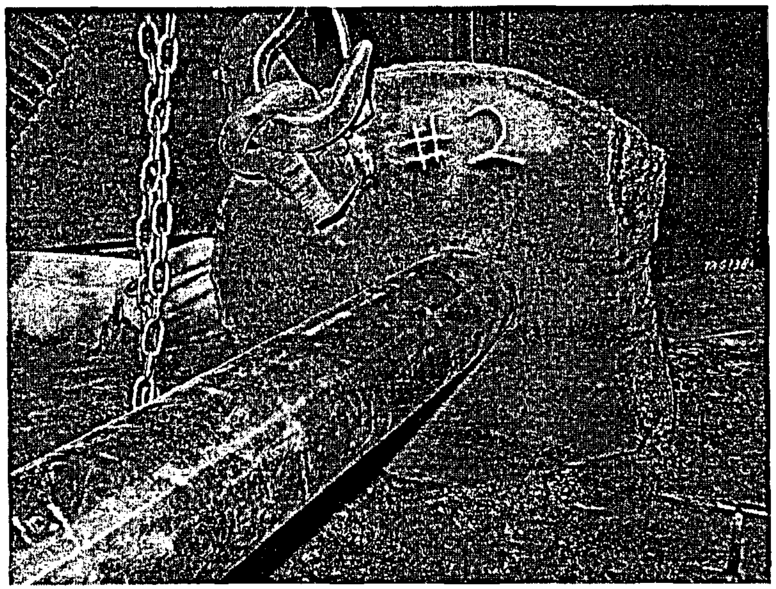
- 1. Crack Growth Rates of Alloys 600 & 182 from Davis-Besse Head
  - Specimens Fabricated, Supporting Tests underway, complete by 12/03
- 2. Computational Model, Probabilistic Assessment of:
  - Statistics of Initiation, Probability of Detection & Accuracy of Sizing
  - Crack Growth Rate Variations, Stress Intensity Factor Gradients
  - Electrochemical Potential and Polarization Measurements of Low-Alloy Steel, Alloys 600 & 182 in Concentrated Boric Acid Solutions
- Measure E_{cp} and wastage rates for range of solution compositions, temperatures & pressure boundary materials
  - Tests at boiling point temps. nearly complete

Status of North Anna 2 Discarded Head Exams

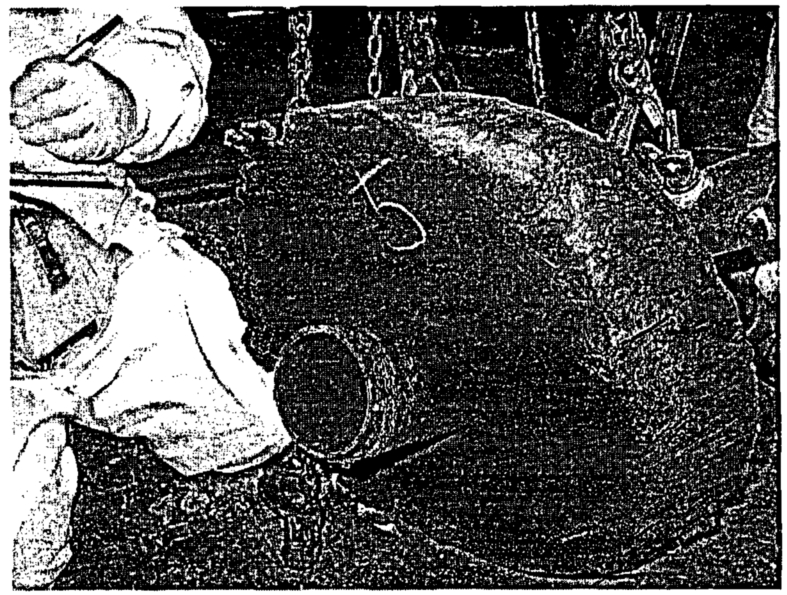
- Part of NRC/Industry Collaboration on Alloy 600 Issues
- Seven nozzles removed in late June, shipped to PNL
- Several NDE teams will re-examine nozzles for:
  - Confirmation of flaw indications
  - Laboratory-based level of exam – compare to field results
  - Independent exam by NRC contractor
- Destructive exams to follow
  - Confirmation of defects, types of cracking
    - PWSCC, TGSCC, fatigue (?), how initiated
    - Leak paths (or absence thereof !)
    - Materials for crack growth studies, residual stress analysis

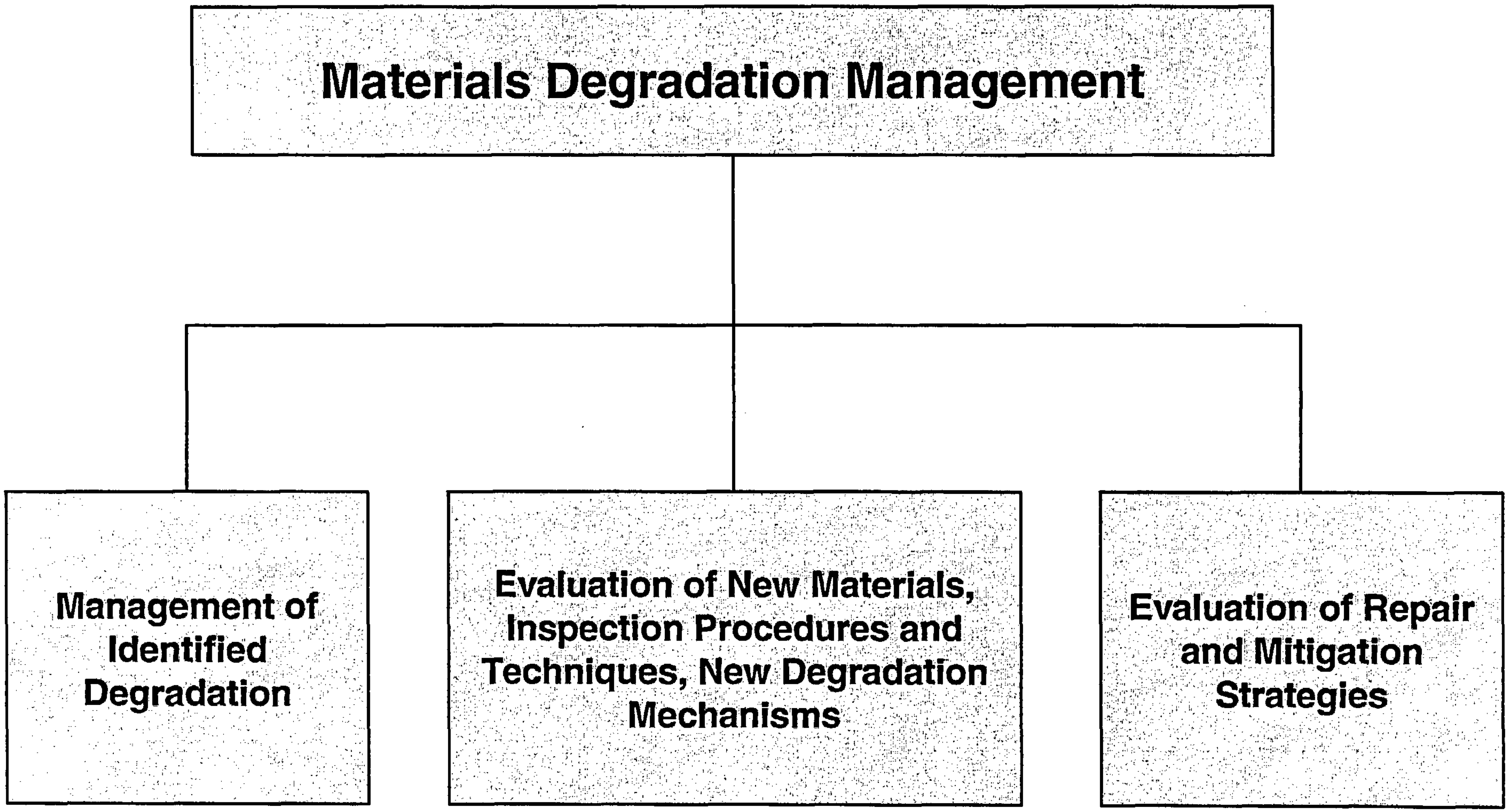
Salvaging of nozzles from North Anna 2's Discarded Reactor Head

Nozzle #31



Nozzle #59




Materials Degradation Management
Management of Identified Degradation
Evaluation of New Materials, Inspection Procedures and Techniques, New Degradation Mechanisms
Evaluation of Repair and Mitigation Strategies

Proactive Materials Degradation Initiative

- Identify materials and locations where degradation can reasonably be expected in the future
  - PIRT-like process
- Review and evaluate inservice inspection and continuous monitoring techniques for the detection, characterization, and evaluation of degradation
- Review and evaluate techniques that could ameliorate the stressors to mitigate or prevent the expected degradation
  - Identify where developments are needed
- Review and evaluate existing or new materials for replacement in components where degradation is expected
- Review and evaluate repair and replacement techniques for the materials and components of interest, and identify where developments are needed
- Review and study potentially new degradation mechanisms
- Industry and international interaction

AP1000 Design Certification Status

October 1, 2003

ACRS Briefing

Joseph Colaccino, Senior Project Manager

Office of Nuclear Reactor Regulation

NRC Current Review Status

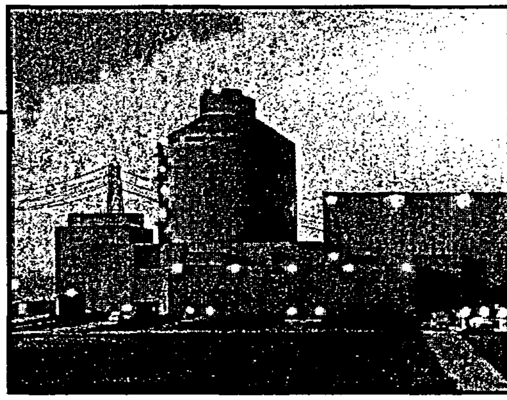
- Issued DSER on June 16, 2003, with 174 Open Items
  - 24 Open Items Considered Resolved
  - 36 Open Items Require Verification of Westinghouse DCD and/or Open Item Response Changes to Consider Resolved
  - Additional Questions Provided to Westinghouse (Materials, Boron Concentration)

- Progress of Supplemental DSER Reviews
  - Wind and Tornado Loadings (3.3): Open Item Resolution in Progress
  - Leak-Before-Break (3.6.3.4): Public Meeting Scheduled 10/02/03
  - Security (13.3): Review in Progress
  - Initial Test Program (14.2): Questions Provided to Westinghouse
  - Testing and Computer Code Evaluation (21): Documentation In Progress

- Significant Technical Issues
  - Reactor Systems (Liquid Entrainment, LTC, Core Swell, and Boron Precipitation)
  - Structural/Seismic (Containment Design and Basemat Uplift)

- Schedule for Final Safety Analysis Report: September 2004
  - Reassess Schedule after completion of October 2, 2003, Reactor Systems Meeting and October 6-10, 2003, Structural/Seismic Audit

AP1000



AP1000 Design Certification Status Review

Westinghouse Electric Company

Presentation to

Advisory Committee on Reactor Safeguards

October 1, 2003

AP1000

Today's Agenda

- **AP1000 Overview**
- **Design Certification Status**
- **Technical Presentations Requested by ACRS**
  - ADS-4 Squib Valve Reliability
  - AP1000 Post-LOCA Aerosol Deposition Calculation

AP1000 Design Features - Same as AP600

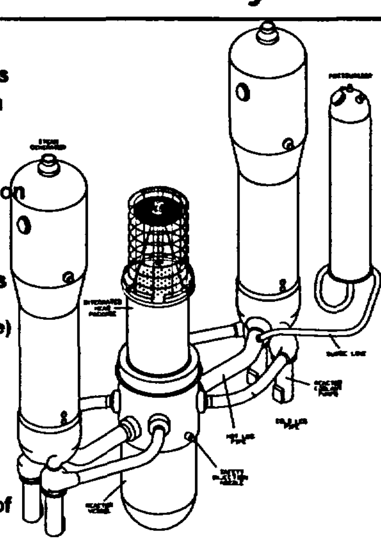
AP1000

- Retain AP600 Design Detail and Design Maturity
- Retain AP600 Basis for Cost Estimate, Construction Schedule and Modularization Scheme
- Integrated Power Plant Design
- Simplified RCS Loops with Canned Motor Pumps
- Simplified Passive Safety Systems
- Microprocessor, Digital Technology Based I&C
- No Requirement for Safety Related AC Power
- Compact Control Room, Electronic Operator Interface
- Optimized Plant Arrangement
  - Construction, Operation, Maintenance, Safety, Cost
- Extensive Use of Modular Construction
- No Plant Prototype Required

AP1000

Proven AP1000 Reactor Coolant System

- Proven Reactor Design/Fuel
  - Similar to Doel 4, Tihange 3, S. Texas
  - No bottom-mounted instrumentation
  - Improved materials - 60 yr. life
- Steam Generators - Δ125
  - Similar to large W/CE SGs in operation
  - System 80; ANO RSG
- Reactor Coolant Pump
  - Canned motor pumps, no shaft seals
    - Naval reactors, early commercial reactors (Shippingport; Yankee Rowe)
- Simplified Main Loop
  - Reduces welds 50%
- CRDM, Reactor Vessel and Internal
  - Typical Westinghouse design
- Pressurizer
  - 50% larger than operating reactors of similar power rating



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AP1000 Approach to Safety

- **Passive Safety-Related Systems**
  - Use "passive" process only, no active pumps, diesels, ...
    - *One time alignment of valves*
    - No support systems required after actuation
  - Reduced dependency on operator actions
  - Mitigate design basis accidents without nonsafety systems
  - Meet NRC safety goals without use of nonsafety systems
- **Active Nonsafety-Related Systems**
  - Reliably support normal operation
    - Redundant equipment powered by onsite diesels
  - Minimize challenges to passive safety systems
  - Not required to mitigate design basis accidents

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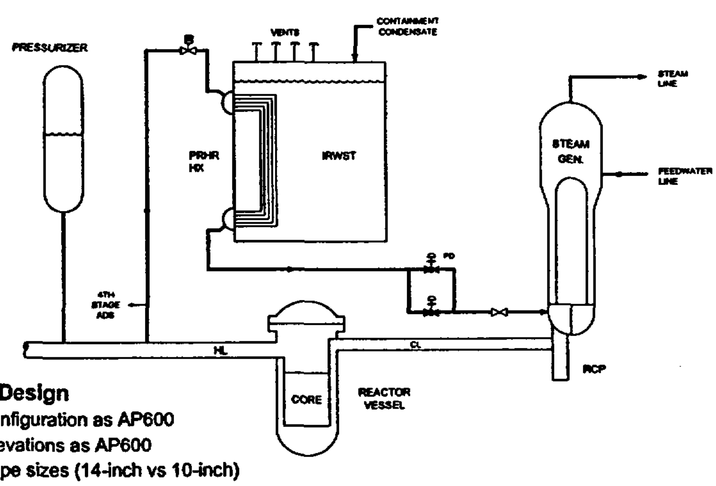
AP1000 Retains AP600 Passive Decay Heat Removal System



- **PRHR HX Design**
  - Same configuration as AP600
  - Same elevations as AP600
  - Larger pipe sizes (14-inch vs 10-inch)
  - Increased HX surface (more / longer horizontal tubes)

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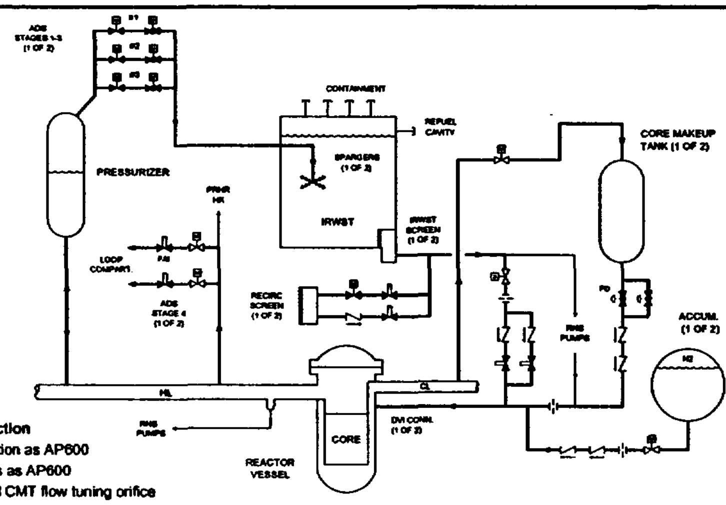
AP1000 Passive Safety Injection



- Passive Safety Injection
  - Same configuration as AP600
  - Same elevations as AP600
  - Larger CMT and CMT flow tuning orifice
  - Larger IRWST, Recirc, ADS 4 pipe sizes

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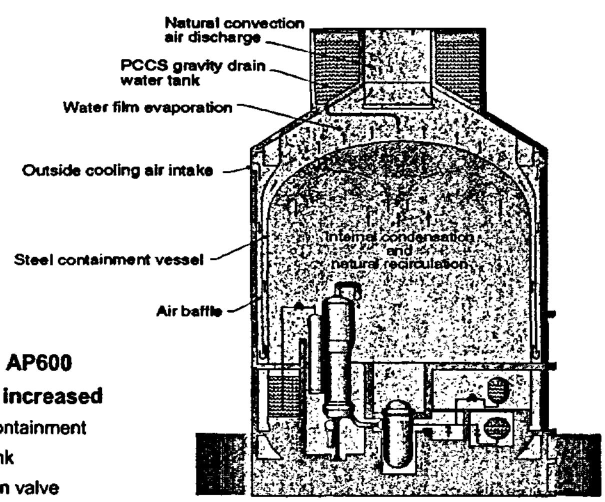
Passive Containment Cooling System



- **Same configuration as AP600**
- **Heat removal capacity increased**
  - Larger, high pressure containment
  - Larger water storage tank
  - Added 3rd, diverse, drain valve

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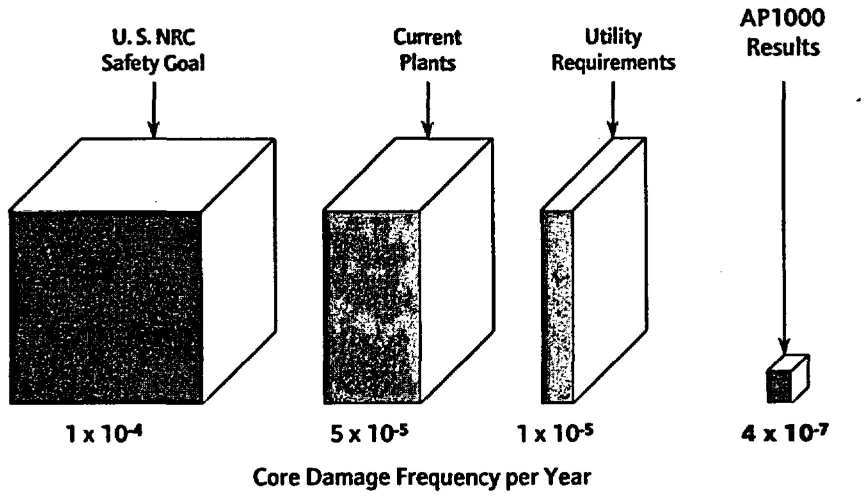
AP1000 Provides Safety and Investment Protection



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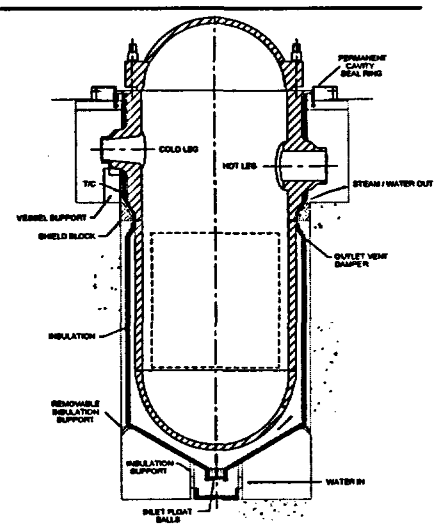
Severe Accidents Addressed

- **Invessel Retention**
  - Ex-vessel cooling
  - Provides reliable means of cooling damaged core
  - AP600 tests and analysis of IVR reviewed by U.S. NRC - additional tests for AP1000 completed
  - Prevents core-concrete interaction
- **High Pressure Core Melt**
  - Eliminated with ADS
- **Hydrogen Detonation**
  - Prevented by igniters and passive autocatalytic recombiners
- **Steam Explosions**
  - ADS eliminates high pressure
  - IVR eliminates low pressure



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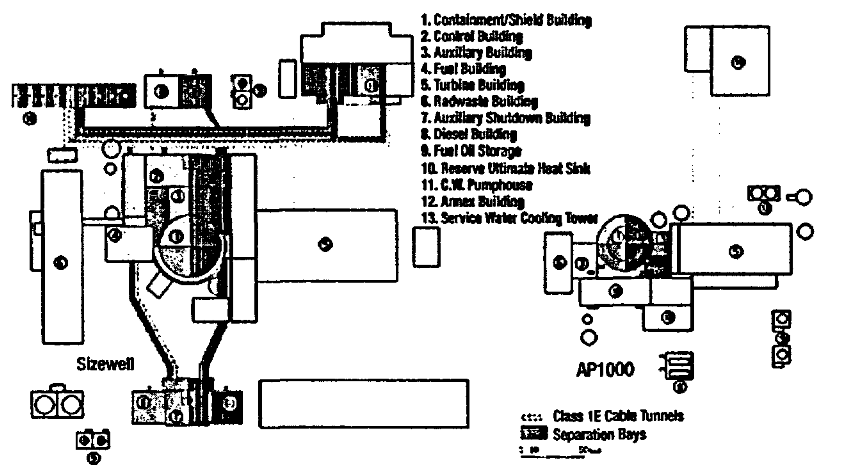
AP1000

Physical Comparison Sizewell/AP1000



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AP1000

Design Certification Schedule

Past Milestones	Target Schedule	Status
1. AP1000 Pre-Certification Review	12/01 - 3/02	☑
2. W Submits DCD Application (DCD / PRA)	3/28/02	☑
2. Staff Issues All RAI	9/30/02	☑
3. W Provide Responses to All RAI	12/2/02	☑
4. NRC Identify Potential DSER Open Items	2/28/03	☑
4. W Addresses Potential DSER Open Items	4/15/03	☑
5. NRC Issues DSER	6/16/03	☑
DSER Contains 174 Open Items - AP600 had over 1300 at DSER Stage		
6. ACRS Future Plant / T&H Subcommittee Meetings	7/03	☑

Westinghouse / NRC have been working to resolve DSER Open Items
Approximately 60 Technically Resolved

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Draft Safety Evaluation Report

- **Key Issues Identified in DSER**
  - Thermal-hydraulic issues associated with SB LOCA
  - Structural design of nuclear island critical structures
  - Acceptance of LBB for AP1000
  - Miscellaneous PRA items
    - RTNSS uncertainty sensitivity study, squib valve reliability
  - Sump performance
  - Security
  - Dose analysis
    - Control room X/Q, Post-LOCA aerosol deposition
  - 10 CFR 50.44
  - Miscellaneous ITAAC items

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SBLOCA and LTC Open Items

- **Upper Plenum and Hot Leg Entrainment during SBLOCA**
- **WCOBRA/TRAC Modeling for Long Term Cooling**
- **Boron Precipitation during Long Term Cooling**

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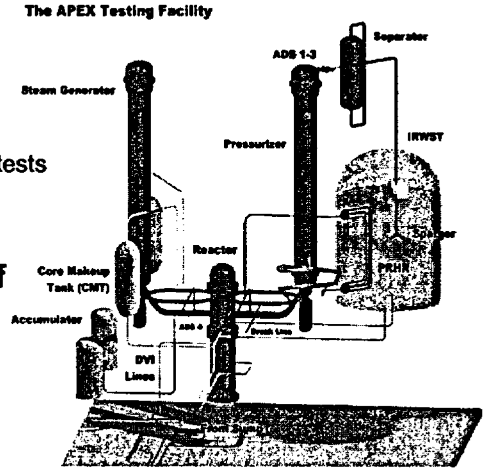
OSU Testing Performed to Address Entrainment Issues

AP1000

- **APEX-1000 Testing at Oregon State University**
  - Facility Description Report
  - Scaling Report
  - Test Reports/Data for five tests
  - Tests behavior same as APEX-600
- **NOTRUMP Simulation of APEX-1000 Tests**
  - Simulations show good agreement
  - No core uncovery for DBA tests

The APEX Testing Facility



AP1000

Entrainment Open Item

- **Bounding AP1000 sensitivity studies performed**
  - NOTRUMP analysis to assess the effect of using a homogeneous flow assumption for the flow from core exit through the ADS4 lines
  - No core heatup
- **Validation of level-swell model**
  - Validation of core void fraction correlation used in NOTRUMP relative to full scale bundle test data
- **First principles analysis (Simple Model) completed**
  - Assess integrated system equilibrium condition during ADS4/IRWST transition period
    - sensitivity to distribution parameter C_0 for core void equation
    - sensitivity to slip ratio for flow from core exit through ADS4

AP1000

Entrainment Open Item Resolution

- NRC Requested Additional Test Data to Support Resolution of Entrainment Issue
- APEX-1000 Tests Completed
- NOTRUMP Validated Against APEX-1000 Tests
- Sensitivity Analysis and Simplified Model Supports Predicted Safety Performance
- NOTRUMP AP1000 DCD Analysis Confirmed

AP1000

WCOBRA/TRAC LTC Model Open item

- Additional Information provided to address this item:
  - Validation of WCOBRA/TRAC level swell prediction relative to full scale bundle tests
  - More detailed WCOBRA/TRAC model for AP1000 Long Term Cooling analyses
    - Model description
    - Results with more detailed model incorporated in Chapter 15

AP1000

Boron Open Item

- **Additional Information provided to address this item:**
  - WCOBRA/TRAC LTC analysis for decay heat level at 14 days after LOCA
  - First principles analysis to assess amount of liquid flow through ADS4 in long term
    - Comparison to WCOBRA/TRAC result
  - Calculation of core boron concentration and core inlet temperature as a function of time during long term cooling

AP1000

Status of T/H Open Items

- **NRC provided 30 follow-on questions on 9/16/03 and these were discussed with Westinghouse in a telecon to reach an understanding of how each will be addressed**
- **Responses to 27 of the 30 questions have been submitted**
- **Staff/Westinghouse Meeting tomorrow to further develop basis for addressing these questions and reaching resolution**

AP1000

AP1000 Final Safety Evaluation Report

- **Westinghouse & NRC Must Resolve Remaining DSER Open Items**
  - Upcoming meetings scheduled
    - T&H meeting at NRC 10/2/03
    - LBB meeting at NRC 10/2/03
    - Structural audit at Westinghouse 10/6/03 - 10/10/03
- **NRC Completes Supplemental DSER**
- **ACRS Letter Required for FSER**

Original NRC Schedule for FSER - September 2004
NRC to issue schedule with key milestones after upcoming meetings

AP1000

Background

- **ACRS Requested Additional Justification of ADS 4 Squib Valve Reliability Assumed in AP1000 PRA**
- **Today's Discussion**
  - Squib valve design [valve vendor, CONAX]
  - Squib valve reliability [West. PRA]
    - Independent reliability evaluation [Sandia]

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ADS 4 Valve Type Selection

- **Squib Valves Were Selected for ADS Stage 4**
  - Very reliable to open on demand (better than AOVs, MOVs)
  - Ability to add independent actuation circuits (use 2 PMS, 1 DAS)
  - Diverse from ADS stage 1/2/3 MOVs
  - Very low chance of inadvertent opening
  - Zero leakage during normal operation
  - Simplified IST, ISI, maintenance
  - Reduced capital cost
  - Reduced development costs / uncertainties
  - Compact size, weight
  - Supported by U.S. utilities

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AP1000 Squib Valve Actuation Circuits

- SUMMARY
  - ADS 4 actuation circuits are highly-reliable to actuate
    - 3-way redundant (2 PMS divisions and DAS for each ADS 4 valve)
    - 2-way diverse (PMS/DAS)
  - ADS 4 actuation circuits have low probability of spurious actuation
    - 2-out-of-4 voting for automatic actuation
    - Squib valve controller circuit minimizes likelihood of hot short causing spurious actuation
      - Energize-to-actuate
      - Two-pole, ungrounded
      - Controller has no power during normal operation
      - In containment, no adjacent cables have sufficient energy for actuation

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SQUIB VALVE

Dan Frederick
Vice-President Engineering

CONAX florida
A Cobham plc company

BACKGROUND

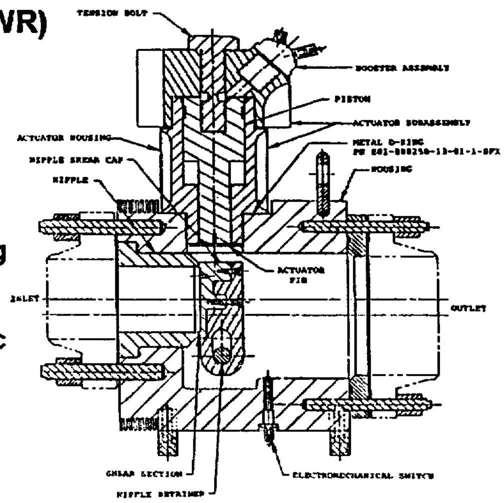
- General Electric large squib valve design for SBWR
  - Requested bids from 7 established valve vendors
  - Squib valve (Pyronetics) judged best design
    - Scale up from 2" to 7"
    - GE surveyed Pyronetics customers
    - General Electric concluded OEA Pyronetics was capable of designing, manufacturing and testing squib valves (7" ID)
  - Valves were built and successfully tested
- Westinghouse application of Pyronetics for Squib Valves
  - AP600 ADS 4 is same ID as GE valve
  - AP1000 ADS 4 requires larger ID (9" vs 7")

CONAX florida
A Cobham plc company

ADS SQUIB VALVE DESIGN

Testing Performed (SBWR)

- Acceptance Tests
- Closed Bomb Tests
- Lab Sample Tests
- Radiation Testing
- Accelerated Thermal Aging
- Reliability Testing
- Seismic and other dynamic loads evaluated
  - Vibration testing
  - Actuation / Flow



CONAX florida
A Cobham plc company

HIGH RELIABILITY REQUIRED

- Our customers require high reliability
  - Life Support programs
  - Aerospace programs
  - Consequences of failures are high
- Conax procedures control high reliability
- Custom Valve Designs / Up-Scaling is Standard Process
  - Simple valve design reduces problems
  - Development process delivers highly reliable valves

- UPCO reliability of:
  - .999568 at 90% confidence
  - .999437 at 95% confidence

  Valves manufactured: 64,690
  Total quantity fired: 5,324

- Conax reliability of:
  - .9998169 at 90% confidence

  Based upon:
  Total Initiators > 25,000
  Valves manufactured: >25,000

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HIGH RELIABILITY BUILT IN

Design / Analysis

- Past experience with similar products (lessons learned)
- Design analysis of new design
- Examination and analysis of drawings
- FMEA
- Reliability analysis

Testing

- Development and prototypes units
- Margin testing (over and under loaded boosters)
- Acceptance and qualification
- On propellants (powder form and in initiators and booster)

Quality Assurance: ISO 9001 Certification

CONAX florida
A Cobham plc company

ADS SQUIB VALVE DESIGN SUMMARY

- Squib valves have high inherent reliability
  - Reliability for smaller valves applicable for larger valves
    - Same design standards established
      > Engineering Analysis
      > Proof and Leak Testing
      > Over and under loaded boosters used during testing
      > Design concept similar (shearing material) in all cases.
      > No failures associated with shear section cracking under constant high pressure and temperature

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AP1000

Reliability of Squib Valves in AP1000 Design

Selim Sancaktar
Fellow Engineer
Reliability and Risk Assessment

BNFL

Westinghouse

Squib Valve Reliability Evaluation

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Sandia National Laboratories

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Sandia National Laboratories

Sandia Evaluation

- Why Sandia National Laboratories?
  - Sandia has successfully developed & tested thousands of squib valves
  - Sandia has produced numerous high reliability squib valves for use in nuclear weapons
  - Sandia has extensive experience and expertise in the design and reliability of pyrotechnically actuated valves

- AP1000 Evaluation
  - AP1000 Functional Requirements
  - CONAX proposed ADS-4 Squib Valve Design
  - Available Valve Reliability Data

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Valve Test Data (2002)

			Product D-Tests		Stockpile Evaluation	
MC No.	System	Development Tests	Lot No.	No.	NMLT/SLT	NMFT/SFT
3006	W76	143	110	554	192	126
3205	W79	354	45	318	311	83
3206	W79	194	33	210	164	88
3294	B83	97	72	162	47	85
3784			37	79	1	
3295	B83	41	45	113	47	101
3297	B83	70	14	227	47	101
3785			40	422		
3298	B83	65	38	176	48	60
All †	W84	60		604	311	80
3570	W87	59	40	87	119	54
4232			13	46		
4241	W87	0	33	59	37	14
	TOTALS:	1083		3057	1324	792
GRAND TOTAL WITHOUT DEVELOPMENT TESTS =						5173

No Observed Failures
Current Failure Rate Assessment : 0.00013
† Includes 4 valves: MC3425/A, MC3427/A, MC3428/A, MC3604/A

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Conclusions

- The AP1000 valve design is a basic design that has been used extensively for many smaller squib valves.
- Existing fleets of smaller valves have been successfully utilized in similar and harsher environments than that proposed for use in the AP1000.
- Evaluations by subject matter experts indicate that reliability information from smaller valves has applicability to larger valves when scaling the design.
- Given that standard mechanical engineering design practices are followed, the reliability performance of the larger valve will be consistent with that of smaller valves.

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Summary of Reliability Data

- The following data is used either for AP1000 failure to open calculations or is obtained recently:

Source	Failure to Open on demand	
EPRI	3.0E-03 *	
Sandia 1	2.0E-04	
Sandia 2	3.2E-04	
AP600 & AP1000 PRA	5.8E-04	(calculated from above)
UPCO	4.32E-04	
Conax	1.83E-04	
Sandia(2002)	1.30E-04	

* - EPRI data is based on MOV failure probability from NUREG/CR-4550

AP1000

PRA Sensitivity to Squib Valve Reliability

- **If the Squib valve failure probability (FTO) is doubled, then the plant CDF for internal events at power goes from 2.41E-07/yr to 2.77E-07/yr - a 15% increase**
- **The contribution of spurious ADS opening initiating event to plant CDF is 12.3%. If the spurious opening of ADS failure probability is doubled, the plant CDF will increase by 12.3%**
- **The importance of ADS Squib valves in AP1000 plant risk is recognized and design and operational precautions are already built in to assure their reliability**

AP1000

Conclusions

- **Recent information obtained from different sources support the AP1000 PRA treatment of the ADS 4 squib valves**
  - Failure probabilities used for squib valves in AP1000 PRA are reasonable
    - Are consistent with operating experience
    - Are expected to be achievable for the AP1000 squib valves
  - Up-scaling of squib valves would not negatively affect their historical high reliability
  - Operational environment is not seen as an important contributor to valve failure probability
  - The conclusions of the AP1000 PRA with respect to spurious failure of ADS 4 squib valves are valid

AP1000

AP1000 Post-LOCA Aerosol Deposition

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AP1000

AP1000 and AP600 Comparison

- **AP1000 has, compared to AP600:**
  - 75% higher thermal power.
  - 20% larger containment by volume.
  - 75% more aerosol mass.
- **Expected results, compared to AP600:**
  - Higher diffusio- and thermophoresis due to higher heat transfer to containment shell.
  - Similar sedimentation due to similar concentration and well-mixed assumption (conservative).
  - As a result, higher containment lambda.

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Calculation Procedure

- **Select the AP1000 sequence**
  - high frequency in PRA
  - timing that is similar to the NRC specified RG 1.183 timing for PWR fission product release.
- **Containment thermal hydraulic conditions: MAAP4 code.**
- **Containment aerosol removal rates: Polestar QA code STARNAUA.**
- **STARNAUA**
  - documented and benchmarked against experiment,
  - applied as part of AP600 design certification,
  - recently been applied to numerous operating plant DBA alternate source term aerosol calculations

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Accident Sequence Definition

- **Dominant core damage sequence from PRA**
  - Break in a direct vessel injection line (fails 1 train of passive injection)
  - Full RCS depressurization
  - failure of gravity injection
  - successful cavity flooding and in-vessel retention of core debris
  - vessel reflooding through break
  - hydrogen igniters
- **Severe accident environment generated with MAAP4**
  - conservative conditions for lambda calculation
  - methodology used for AP600 Environment for Lambda calculation

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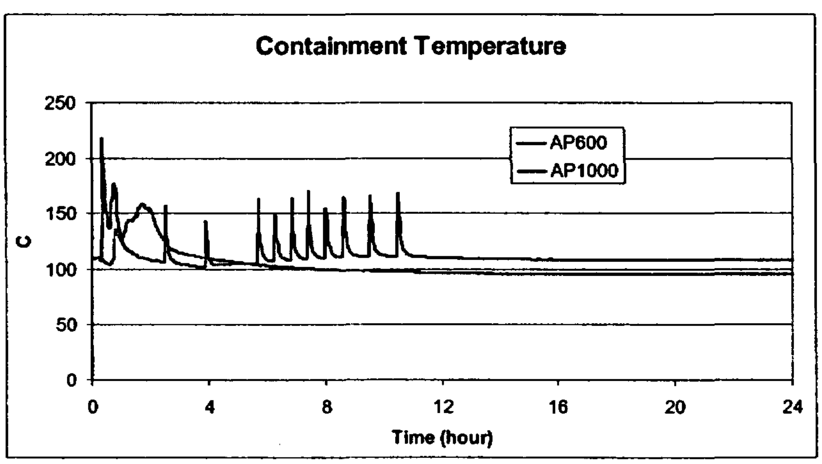
T&H Parameters for Lambda Calculation

- **NAUA code T&H input parameters**
  - containment pressure
  - containment gas temperature
  - containment steam mole fraction
  - condensation rate on heat sinks
  - total heat transfer to heat sinks

AP1000

T&H Parameters for Lambda Calculation



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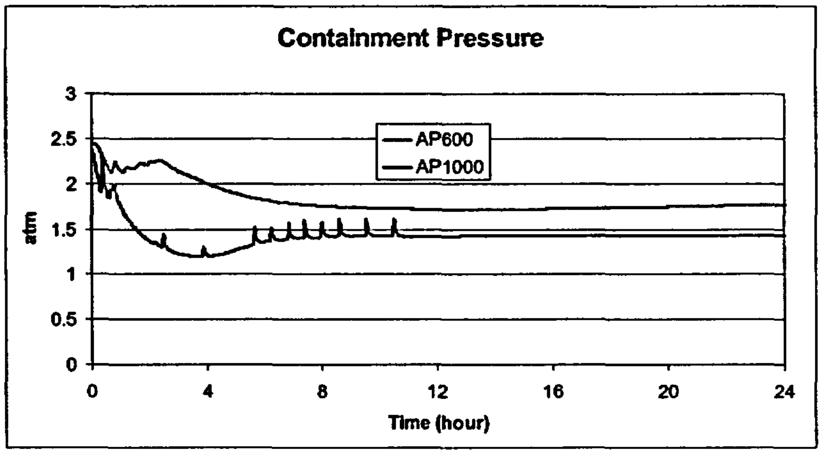
AP1000

T&H Parameters for Lambda Calculation



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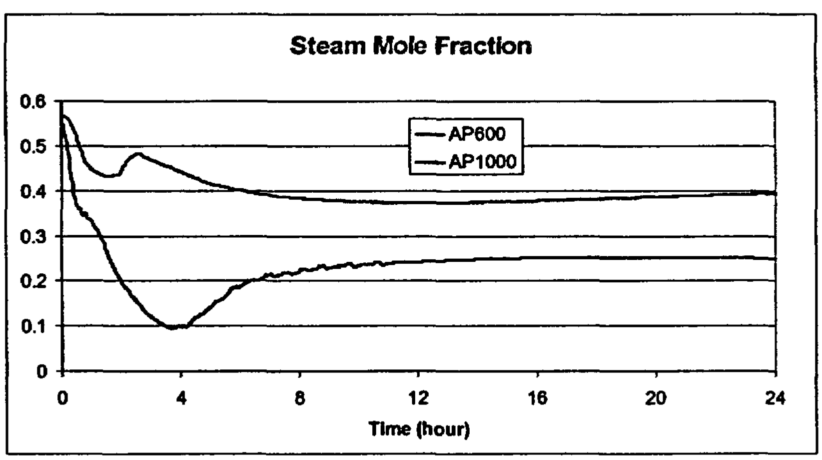
T&H Parameters for Lambda Calculation



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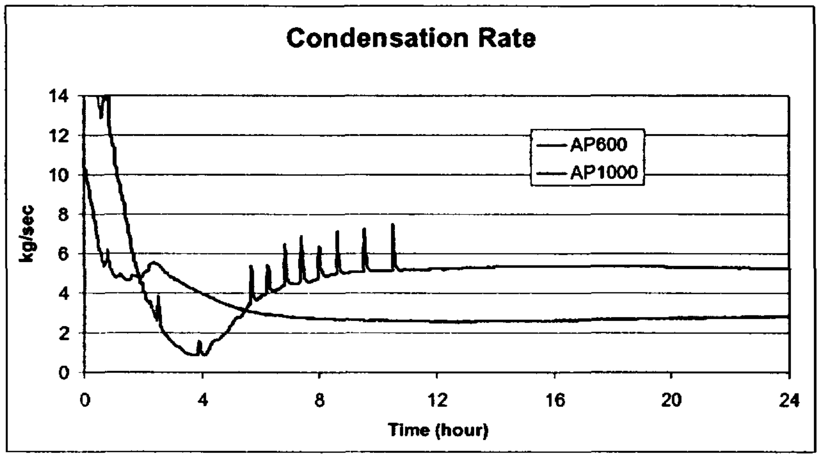
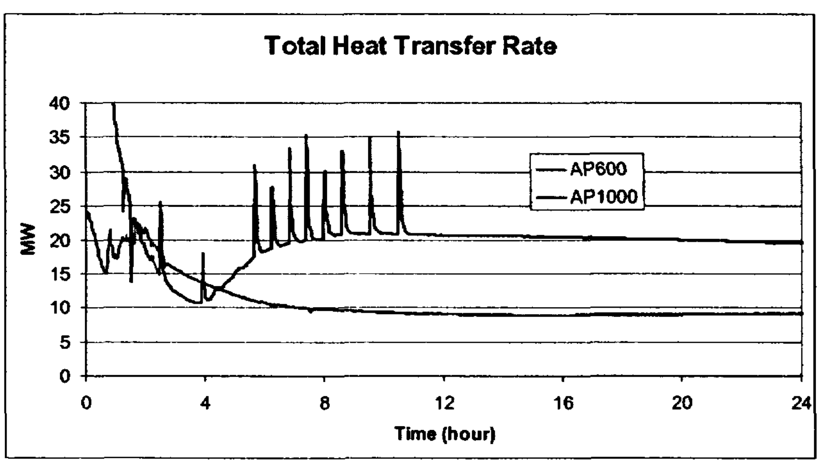
AP1000

T&H Parameters for Lambda Calculation



AP1000

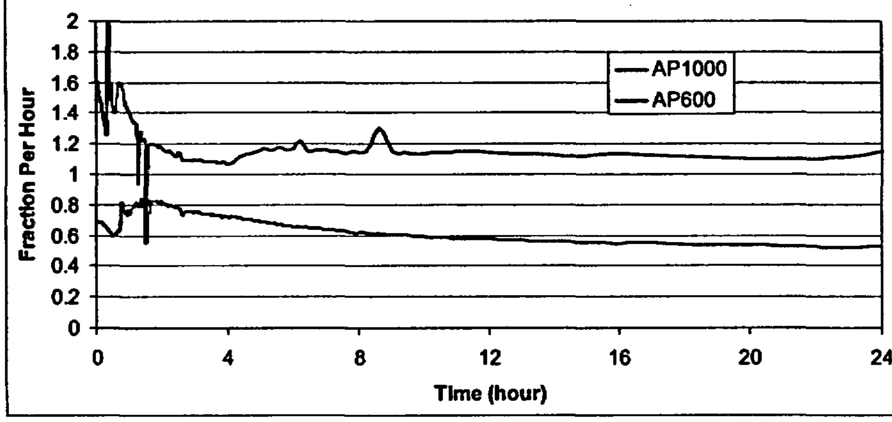
T&H Parameters for Lambda Calculation



AP1000

STARNAUA Calculation Results

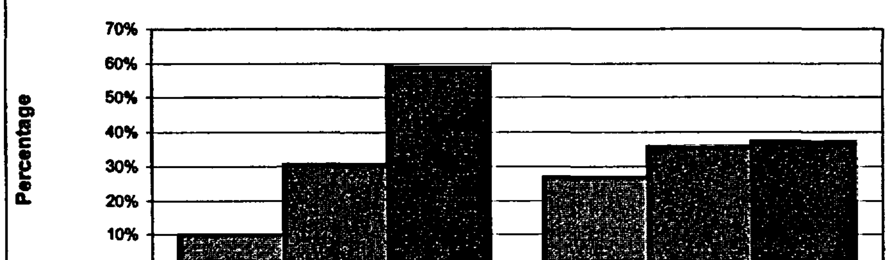
Containment Lambda



AP1000

Calculation Results (cont.)

Aerosol Removal by Different Mechanisms



	AP1000	AP600
Sedimentation	10%	27%
Diffusiophoresis	31%	36%
Thermophoresis	59%	37%

AP1000

Discussion (cont.)

- **Conservatisms**
  - Hygroscopicity neglected.
    - Hygroscopic particles grow bigger and settle faster.
  - Inertial impaction on wet surface neglected.
  - Retention of aerosols in leak paths neglected.
    - Experiment (e.g., LACE) shows that aerosols tend to form sticky material that either be retained in narrow path or fall quickly to the ground, if they resuspened, after leaving the path.
  - Smaller than usual particle size (mmd=1.3μm) used.
    - Mass mean diameters used in NUREG/CR-5966 for the analysis of natural aerosol removal rates range from 1.5 to 5.5 μm.

AP1000

Conclusions

- **Average lambda is 1.1 per hour.**
- **Result is quite robust due to combination of removal mechanisms (<±25% variation on "exaggerated" sensitivities).**
- **The results are conservative.**

United States Nuclear Regulatory Commission

NRC Assessment of Thermal-Hydraulics Issues of the AP1000 Design

Presented to

The Advisory Committee on Reactor Safeguards

October 1, 2003

By

Jennifer L. Uhle, Chief

PWR Systems

Reactor Systems Branch

Division of Systems Safety and Analysis

Office of Nuclear Reactor Regulation

Summary of NRC Review

- NRC Review Team
  - Steve Bajorek (RES)
  - Gene Hsii
  - Walt Jensen
  - Lambros Lois
  - Summer Sun
  - Len Ward

- Independent Analysis
  - NRC Code Calculations
  - Data Comparison
  - Analytical Modeling

- Draft Safety Evaluation Report Open Items
  - Identification of Limiting SBLOCA Transient
    - → Containment Backpressure
  - NOTRUMP/RELAP5 Comparison
  - Core Level During ADS4/IRWST Transition Phase
  - APEX-1000 Test Series
    - → Scaling
    - → NOTRUMP Validation
  - Core Level During Long Term Cooling Phase
    - → WCOBRA/TRAC Validation
  - Boron Precipitation
    - → RELAP5 or WCOBRA/TRAC sensitivity study