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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

July 11, 2007

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS (ACRS)

544th MEETING

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THURSDAY,

JULY 11, 2007

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The meeting was convened in Room T-2B3 of Two White Flint North, 11545 Rockville Pike, Rockville, Maryland, at 8:30 a.m., Dr. William J. Shack, Chairman, presiding.

MEMBERS PRESENT:

WILLIAM J. SHACK, Chairman

MARIO V. BONACA, Vice Chairman

SAID ABDEL-KHALIK, ACRS Member-At-Large

GEORGE E. APOSTOLAKIS, ACRS Member

J. SAM ARMIJO, ACRS Member

MICHAEL CORRADINI, ACRS Member

THOMAS S. KRESS, ACRS Member

OTTO L. MAYNARD, ACRS Member

DANA A. POWERS, ACRS Member

GRAHAM B. WALLIS, ACRS Member

NRC STAFF PRESENT:
SANJOY BANERJEE
RICHARD RASMUSSEN
RICHARD LAURA
MICHAEL JUNGE
TONY CERNE
RON GARDENER
SCOTT NEWBERRY
DAVID FISCHER
MARK LESSER
TED SULLIVAN
AL CSONTOS
DAVID RUDLAND
SCOTT MORRIS
BONNIE SCHNITZLER
ERASMIA LOIS
ALEX KLEIN
JOSE IBARRA
PHIL QUALLS

ALSO PRESENT:
AMIR SHAHKARAMI
GLENN WHITE
PAUL GUNTER

I-N-D-E-X

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

8:30 a.m.

CHAIRMAN SHACK: On the record. The meeting will now come to order. This is first day of the 544th Meeting of the Advisory Committee on Reactor Safeguards. During today's meeting, the Committee will consider the following: Sampling Methodology and Statistical Thresholds for Selecting ITAACs for Inspection; Dissimilar Metal Weld Issues; Activities in the Safeguards and Security Areas; Revisions to Draft Final NUREG-1852, "Demonstrating the Feasibility and Reliability of Operator Manual Actions in Response to Fire;" and "Preparation of the ACRS Reports. A portion of this meeting may be closed to discuss safeguards and security information.

This meeting is being conducted in accordance in with provisions of Federal Advisory Committee Act. Mr. Sam Duraiswamy is the Designated Federal Official for the initial portion of the meeting.

We have received no written comments from members of the public regarding today's session. We have received a request from Mr. Paul Gunter, Nuclear Information Resource Services, for time to make oral statements regarding NUREG-1852.

A transcript of portions of the meeting is being kept and 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.

I will begin with some items of current interest. Mr. Dave Bissett has joined the ACRS staff as a Senior Staff Engineer on July 9, 2007.

(Applause.)

CHAIRMAN SHACK: Dave received his BA in Physics and an MS in Mechanical Engineering from the University of Connecticut. He began his career with combustion engineering in 1976 working in fuel development.

In 1979, he joined the ACRS as one of the original fellows. In addition to working directly with Dr. Paul Schumann, he worked with the subcommittees on PRA, Reactor Fuel, Waterford 3, LaSalle 1 and 2 and St. Onofri 2 and 3. Dave left the ACRS in 1981 to work for the OECD Nuclear Energy Agency for three years. Upon returning in 1984, he joined the Office of Nuclear Regulatory Research where for the past 23 years he has worked on a wide variety of thermal hydraulic matters. Welcome aboard.

On July 25, 2007, Mrs. Vicky Murphy joined the ACRS ACNW staff as the Office's Executive Secretary. Vicky comes from the Office of Nuclear Regulatory Research where she served as the Division Secretary for the Division of Fuel, Engineering and Radiological Research. Prior to working at the NRC, Vicky worked as an Administrative Assistant and Technology Coordinator for the Calvert County Public Schools.

Vicky performed her undergraduate studies at Villanova University. Her husband, Martin Murphy, is Chief of the Generic Communications and Power Uprate Branch in NRR DPR. Welcome aboard.

(Applause.)

CHAIRMAN SHACK: Mr. Mike Junge who has been with the ACRS staff for about 18 months is leaving to join the Office of New Reactors as Chief of the Operator Licensing and Human Performance Branch on July 16, 2007. As a Senior Staff Engineer, he provided outstanding technical support to the Committee in reviewing numerous technical and regulatory matters including several license renewals applications, fire protection issues, operating plant issues, digital I&C matters and human reliability methods. He also made arrangements and provided technical support to the Committee's annual visit to a nuclear plant and meeting with the NRC regional administrator.

Mike's dedication, hard work, attention to details, professionalism, sense of humor, thorough knowledge of regulatory and operating plant issues, willingness to carry heavy workloads, including those not in his area of responsibility, and his outstanding technical support to the Committee are much appreciated. We're just glad he's becoming a branch chief and not a travel agent because everybody remembers the famous trip to TMI.

(Laughter.)

CHAIRMAN SHACK: Thank you and good luck in your new job.

(Applause.)

DR. APOSTOLAKIS: Which branch is that, Mike?

MR. JUNGE: The bridge? The one the bus ran into?

(Laughter.)

MR. JUNGE: We know a way now that the bus can make. So I'll be glad to give advice.

DR. APOSTOLAKIS: Which branch?

MR. JUNGE: Oh, branch.

(Off the record comments.)

MR. JUNGE: I was really expecting a comment about the bus running into the bridge. Operator Licensing and Human Performance in New Reactors.

DR. APOSTOLAKIS: Human Performance.

MR. JUNGE: Why do you think I've been so nice to you the past few days?

DR. APOSTOLAKIS: Make sure you use FAR H.

CHAIRMAN SHACK: And another note, Dr. Steven Hannauer who served on the ACRS between 1965 and 1970, he was the ACRS Chairman in 1969 died on May 21, 2007. Sort of one of the grand old man of nuclear energy.

DR. APOSTOLAKIS: Very smart guy. Very smart.

CHAIRMAN SHACK: Our topic today will be the Sampling Methodology and Statistical Thresholds for Selecting ITAAC and George will be leading us through that.

DR. APOSTOLAKIS: No.

CHAIRMAN SHACK: No? Mike.

DR. CORRADINI: He didn't want to do it. So he gave it to me. I just wanted to give some us some background on this. The purpose of this session is to respond to the May 16, 2007 staff requirements memo which is associated with the SECY paper entitled "Staff Approach To Verifying the Closure of Inspections, Testing, Analysis and Acceptance Criteria Through A Sample Based Inspection Program."

In the SRM, the Commission directed the staff and let me quote this one, "The staff from ACRS should discuss whether it would be feasible for the committee to review the sampling methodology and statistical thresholds and, if so, the scope and timing of the review. An ACRS review should not divert the committee from performing high priority reviews of safety issues pertaining to existing and future nuclear power plants."

So prior to a June 2006 full committee presentation on new reactor licensing and construction, the staff provided the ACRS with a technical report on prioritizations of ITAACs. The technical report was prepared by Information Systems Laboratory, ISL, and formed the basis for the SECY paper. They used an analytic hierarchy process, an IHP, to prioritize the ITAAC for inspection.

A little more background. Some of the members may recall that on December '03 the ACRS letter on the draft construction and inspection program framework document. In that letter, the committee made four recommendations, two of which are relevant here today. First, we agree with the staff the use of the statistical sampling to limit the number of required inspections, testing, analysis and acceptance, ITAAC, inspections will valid in only a few areas and, two, we recommend that the number of ITAACs that are subject to minimal inspection be small.

So what we propose is to have the staff explain how the ITAAC inspection program fits into this overall construction inspection program. We've asked the staff to get into some details of the sampling selection process, discuss how they group the ITAACs, how they prioritize them, what are the thresholds they are using to decide what to inspect and what to potentially leave go. To remind everybody to date, the staff has prioritized ITAACs for the AP 1000, the ABWR and we'll also probably here about results from the staff proposed approach for the future.

So finally, I'll turn the meeting over to the staff and Mr. Rasmussen will lead us through this.

MR. RASMUSSEN: Thank you very much. My name is Rick Rasmussen. I'm with the Division of Construction Inspection and Operational Programs. I'm the Branch Chief of the Construction Inspection and Allegations Branch. With me to make this presentation, I have Rich Laura. He's a Team Leader for the Construction Oversight Team. Rich has a long background as a resident inspector and very familiar with various plant operations through his years in the Operations Center.

Also supporting us through the development of these products and in this presentation, if necessary, I have Mr. Tony Cerne, Ron Gardener, ex-resident inspectors, who actually lived through the inspection phase. They bring a ton of experience with them and they were also members of the expert panels that did a lot of this work. Also over on the side table is Mr. Scott Newberry from ISL and ISL was instrumental in the paper that supports our methodology. So they're here if we need them.

I already presented why we're here, to describe our plans to use a formal decision making process to inform the selection of ITAAC for a sample base inspection. The objectives of the briefing is to describe the staff's approach to inspection and the verification of closure of ITAAC, to describe why prioritization was chosen and to describe how the formal decision method was used.

A quick overview. We're just going to discuss the background, the inspection of ITAAC, the regulatory basis, how the ITAAC were grouped, the inspection prioritization process, our results that came out of that and our conclusions.

This is a slide we use to overall describe our program. I could probably talk for an hour on this slide alone, so I won't. The points that I would like to make with regard to this is that ITAAC are just one element of inspection program. As you can see, the blue line in the center that Rich is highlighting, ITAAC inspections are an ongoing process and it begins when the first elements of construction start. The inspection of ITAAC is a series of samples of those activities and we're also talking about being thorough in our sampling of ITAAC on an overall basis, but even within the ITAAC, it's a series of samples.

Many of the ITAAC are not at all single-point, inspection-type processes. They're very complex things. The system was installed, tested. The design, any deficiencies were reconciled through their engineering processes and then the ITAAC is closed. So in order for us to inspect those, it's a series of snapshots. Those results are documented in our CIPMs inspection program and at the end when we go to do these closeouts, we validate the inspection record to make sure we've done the inspection we expected to do and then we can verify closure.

DR. BANERJEE: Can you give us an example of some sort of an item which would be subjected to this?

MR. RASMUSSEN: Actually, that's coming in about two slides.

DR. BANERJEE: Okay.

DR. APOSTOLAKIS: What's the difference between assessment?

MR. RASMUSSEN: Okay. Assessment, the 2505 process is a regional process. We're thinking currently perhaps on a quarterly basis the regions will look at the inspection record, see what kind of findings we're having and decide if we need to expand our samples in any areas either of ITAAC on a global basis. Are we seeing some kind of problems that are generic across all ITAACs like a QA kind of problem?

DR. APOSTOLAKIS: So you kind of sit back and look at the information you have.

MR. RASMUSSEN: That's right.

DR. APOSTOLAKIS: And what kind of conclusions.

MR. RASMUSSEN: Correct. It's analogous

to the annual assessments that are currently done in the ROP in terms of the region managing the resources and we're building it into this process so that if we're seeing these trends we can respond in a predictable manner across all the plants that are being built and allocate more researches where they are necessary.

DR. CORRADINI: So, an example would be as if you're looking at some weld and you're sampling and something pops up as a generic concern, you might change how you're doing the inspection, etc.

MR. RASMUSSEN: That' correct. And then as you'll see the way the sampling prioritization was done, using the information that we already have, we would have an informed way to think about expanding that inspection, which ones to go up next, which are the next most significant. So we're set up to do that.

DR. APOSTOLAKIS: Now OMC 2507 is interesting, the vendor activities.

MR. RASMUSSEN: Correct. 2507 --

DR. APOSTOLAKIS: Right.

MR. RASMUSSEN: -- is a new manual chapter that is currently being developed and this is used by our vendor inspection groups when they go out and look at the activities that are offsite at the various vendors. They can have tied to ITAAC both direct and indirect. At the lefthand of that bar before the licensee has even come in with the application, currently in Japan watching the construction of major components, they can look at the quality assurance program, document those results in our database and then later on when we truly determine where those components are going, we'll be able to track that through our inspection record for the ultimate closeout.

DR. APOSTOLAKIS: Did you say you have inspectors in Japan right now?

MR. RASMUSSEN: They've made a trip to Japan. They're traveling different places.

DR. APOSTOLAKIS: I see. Already.

MR. RASMUSSEN: We have two branches devoted to vendor inspection in our division.

DR. APOSTOLAKIS: Interesting.

CHAIRMAN SHACK: Now some of the ITAAC are not so much construction as they are completion of design. Right?

MR. RASMUSSEN: Correct.

CHAIRMAN SHACK: Now presumably once you do those once, those will be sort of done.

MR. RASMUSSEN: They will be done in as much as they're applicable. Yes, sir. There will be site specific elements to those.

CHAIRMAN SHACK: Site specific. But many of them should be generic once they're completed I would think.

MR. RASMUSSEN: And we are hoping so and that's part of our design center approach to completing these. So hopefully we will be able to inspect them thorough once and then on the subsequent units just verify that they didn't deviate and take credit for that.

With that, I'll turn it over to Rich to continue.

MR. LAURA: Can you go back to that slide? Hi. My name is Rich Laura and I work for Rick. One point on this slide that shows the whole oversight process for construction is that ITAAC is a big element, but there's a number of different activities that go in parallel that make up our oversight. So there are other inspections of non ITAAC activities like QA programs, design translation inspections and it's important to understand that as you go forward and we focus solely on ITAAC that there are other inspection activities all around them, too. Next slide.

DR. MAYNARD: Will you cover kind of how those are integrated? I take it some of these will be performed by the same people. It may be a construction inspection or it may be an ITAAC.

MR. LAURA: It's going to take a lot of coordination and scheduling and the region will be heavily involved and, in Headquarters, we're developing a scheduling process of how we're going to get the licensee's schedule and we're going to break it down into fine pieces and then to schedule everything through CIPMs. We have a construction inspection program management system. So it's going to fairly involved and a lot of those activities are in process. We're working on developing them. So it's a good question.

Okay. Starting on ITAACs, this slide generally shows what we already know that ITAACs are created by Part 52 rulemaking. It's a list of items that are developed by the applicants and submitted to the NRC for review and approval. We have to-date reviewed and approved the AP 1000 and also the ABWT designs. There are several other designs that may come in at the end of the year and we'll have to evaluate how we're going to approach those. And really, all that an ITAAC is it just means an important part of construction process has been completed and the licensee has reviewed it and then they're going to send a letter to us saying they're done and they're real important slices of the overall construction that are highlighted and, typically, there are about 500 to 1,000 per design. We'll get into some specific numbers later.\

And because of the large number of them, that's where the prioritization becomes an important piece. The NRC has decided that we're going to use a sampling approach generally consistent with how we do other inspections where we go in and try to find the high value, safety-significant issues and inspect those on a sampling basis and then if we find problems, we'll have the ability, as Rick said, through the assessment process to expand that sample. And then in addition to the ITAAC, you still have those other inspections that all go in parallel. Next slide.

DR. APOSTOLAKIS: So what will be inspected will be known in advance both to you and the licensee. Right?

MR. LAURA: That's something that we're looking at as far as whether or not we would make that publicly available. But as we --

DR. APOSTOLAKIS: But they would have your methodology.

MR. LAURA: Yes.

DR. APOSTOLAKIS: Presumably, they can figure it out.

MR. RASMUSSEN: Presumably, although wioll not necessarily have the exact results of the expert panels.

DR. CORRADINI: Nor will they know when you plan to do it. I mean, they will know when the inspectors are coming on site for their variety of activities as Otto was saying, but it's not clear what they might be doing at any one time.

MR. RASMUSSEN: That's correct.

DR. APOSTOLAKIS: But are there any plans to have maybe also a few randomly selected items to inspect in addition to the results of the methodology?

MR. LAURA: One element that we have is the region has some flexibility to do independent inspection if they see fit when they look as family and we're going to get into this in a little bit. But as we look at a family of ITAAC, one of the principles of the process we use is that all ITAAC in that family share a common activity and becomes a basis for sampling.

Now if the region as they look in detail at those, getting ready to inspect, they find here's one that really doesn't fit that, they'd have flexibility to go ahead and include that, inspect it, and that's an independent, random type decision.

DR. APOSTOLAKIS: Well, I mean, that brings up another issue. The recommendation, so to speak, of the prioritization that the methodology provides, is that binding? I mean, they have to do it that way or is that a recommendation? Does the region have the flexibility of saying "Yes, you guys are recommending A, B, C, D. I will do A, B, E, F, G because I don't want to do that and I'll do something else"?

MR. LAURA: It's a good -- There is some flexibility and really where the flexibility is is within a specific ITAAC it may say "Look at all pressure boundary welds." There may be 500 welds that are in that sample. The region has the flexibility to pick which ones they want to look at. So there's really no way for a licensee to anticipate exactly which welds we're going to inspect.

DR. APOSTOLAKIS: I understand that, but also from the perspective of the region.

MR. LAURA: Right.

DR. APOSTOLAKIS: They must follow the recommendations or the results of these methodology or they have some flexibility to work around it?

MR. LAURA: Well, this is the program and the expectation is that we're going to use it and there's some flexibility and, obviously, they have some economy in the region that they're going to use judgment and as it gets closer to doing it, that would be something they would have evaluate at that time.

DR. MAYNARD: I would think that if they were going to not do something that came out of this there would probably have to be some discussion and justification. But both NRR and the region have flexibility to add things at a short notice or no notice.

(Off the record comments.)

MR. LAURA: Absolutely. That's a good point. This listing of ITAAC that we're going to get to that are targeted is the minimum baseline inspection. So it's the minimum and we have flexibility to do more if we choose to. So thank you.

Okay. This slide shows some real examples of ITAAC. I'm not going to run through the details, but essentially, the purpose of the slide is to show the top one that deals with reactor coolant pump coastdown. That's a pretty focused, straightforward ITAAC. It's easy to understand and under the acceptance criteria, it has even a specific value.

Now the next one down on pressure boundary welds referring to the ASME Code Section III, that's a little more complex and takes more effort to interpret what that means and actually develop how we're going to go out and inspect that. So that's a good contrast that all ITAACs aren't created equal. They vary quite a bit.

DR. CORRADINI: So just to nail this, the second one as a box is where your sampling may occur because there would be so many welds.

MR. LAURA: Right.

DR. CORRADINI: The first one be a go check it out and make the vendor's performance data on the reactor coolant pump is what they say it is and it at least meets this level.

MR. LAURA: Right. Exactly.

DR. CORRADINI: Thank you.

MR. LAURA: Next slide. Okay. We felt it was important to have this time line because this is something that the staff has been working for several years and a lot of the work was done back in about mid

2005. That's when Tony and Ron were working with these lists of ITAACs trying to figure out what to do with them and they had some ideas and then decisions were made to bring in a consultant team to help us out to look at how do we prioritize these, what's the best way, and the result of that effort is this green book. And this became -- This book was issued 9/30/05 and then after that, there was a launch of several expert panels and NRC implemented this methodology and the NRC had to decide which aspects we could reasonably and there are some parts of this that we chose that it wouldn't be practical to implement. And the book allows flexibility. There's even a particular note in here that recognizes that just so long as you have, in a sampling process, a set of rules and you stick to those, that it's okay to do it in slightly different ways. That was necessary as we get to the part of showing you want we built.

Following the green book, the 2503 is our program document. That tells you in fairly good detail how we plan to inspect ITAACs. We had a briefing next to the ACRS basically just referring that this process was done and giving an update to the ACRS.

Earlier this year, we held a public

meeting with NEI and the topic of that was ITAACs, exactly what ITAACs mean and how we plan to review closure of them. Also earlier this year as Rick mentioned, we sent a SECY paper up to the Commission and explained our plan on how we plan to verify closure of ITAAC and also an SRM that's related was sent back down giving us guidance and that's why we're here today. But in essence, the Commission, in that SRM, approved a sampling approach which was good.

And we have also recently created a team called "The ITAAC Closure Verification Working Group" and that's where we have representatives from each division in NRO getting together to really get down to the policy issues that we need to iron out as we go forward because what we learned early on is that ITAAC affect everybody. All of the branches have involved in ITAAC and we have to build consensus as we go forward. It does not no good if we develop something and then we find out later the region doesn't agree or the technical groups don't agree. So we're focusing heavily on building consensus so as we go forward we can nail this down and just move forward and not have to come back to it.

Okay. This slide is a little bit busy and it talks about implementation of ITAAC and it's not necessarily in sequence. It's just a listing of different activities.

As far as the NRC portion of this slide, NRC will verify closure of 100 percent of ITAAC and we'll do that in two ways. One way is we're going to do direct inspect of a sample and that's what we're going to talk a lot about on later. And for those ITAAC that we don't do direct inspection on, we're going to review the licensee's incoming technical basis in their letter and we're going to make sure that it sounds reasonable and it makes sense. But that will also be an opportunity that if concerns are raised that the staff will have the ability to keep that ITAAC open and follow up on it. So that's the two-prong approach to the 100 percent verification for the NRC aspects.

DR. MAYNARD: On your second bullet there, is it expected that they submit closure for each item or wait until they'll all done and submit one overall letter?

MR. LAURA: It's expected to be on a routine basis and the exact process was still -- That's one of the tasks for our working group. But, obviously, we're going to try to do -- keep them well scheduled and timely so that we don't end up -- We can minimize that at the end. We don't end up with 80 percent of them.

DR. MAYNARD: And I would think that would be the way they would be done as they were completed or in groups, at least. That does create kind of an accounting issue.

MR. LAURA: Right.

DR. MAYNARD: You have to make sure that at the end of it you got letters or you got confirmation, whatever you want.

MR. LAURA: Right. And in one of the other bullets there, the second one from the bottom, once we've reviewed an ITAAC and verified its closure, we're going to post it in the *Federal Register*. So it's going to be a very formal process. It's going to take a lot of thought exactly how we do it all and keep it moving efficiently. That's a real challenge.

MR. RASMUSSEN: But I think it's important to note that through the nature of ITAAC because they are so encompassing the welds were done per the drawings and then the design reconciliation phase is all tied into this single ITAAC. So it's estimated right now that about 80 percent of the ITAACs will close in the last 20 percent of the construction process which puts the emphasis on our need to do our inspection sampling of these ITAAC activities in process throughout the construction phase and then use our inspection record to validate that we've done the inspection that we need to at the end or else it will be just a huge bottleneck.

MR. LAURA: Okay. This next slide --

DR. ARMIJO: Just a quick question on the closure report. The information that you receive on these closure reports, for example on welds, would the licensee submit information on problems that they had including, let's say, rework or weld repairs, other things like that which gives you an indication that ought to augment or increase your inspection? Are you going to have that level of detail?

MR. RASMUSSEN: The Part 52 rulemaking was not specific as to the level of detail of those closure letters and the Commission actually directed the staff to work that out with industry through a guidance document type thing and that work is still ongoing.

DR. ARMIJO: Okay. So we don't have a firm vision of that yet.

DR. MAYNARD: As part of the construction process outside of the ITAAC, the region and other inspectors are going to be inspecting these.

MR. RASMUSSEN: Right.

DR. MAYNARD: And there are also reporting requirements that a utility has when they have issues or problems outside the ITAAC process.

MR. RASMUSSEN: Right.

MR. LAURA: Right, and there's a good example. One of the other non ITAAC activities, we're going to do some pretty major design translation inspections early on to gain confidence in what the applicant, you know, the quality of their work. Those will be a fairly intense inspection of looking at how they took the design and how they translated it down into to the different documents and drawings and that sort of backs up what we do with ITAAC. So we have a multi-pronged approach and that's what we were trying to get at with that busy slide.

This slide here on grouping ITAAC, essentially what it's saying is we developed a matrix approach and this matrix is fundamental to everything as we go forward. What the matrix does is it tries to group ITAAC in what we're going to call families and in those families, those ITAACs will have common activities and it turns out that the common activities are the inspection procedures of the processes and programs that will show and we have a diagram of this that we'll get to. But this is really the basis of the prioritization process. It starts here. And we've developed a matrix for AP 1000, ABWR and each one has its own unique set of ITAAC.

I'm going to cover all these points talking on the picture. I just want to mention the last bullet which is really key saying "Observing performance of ITAAC activity within a family provides insights that are applicable to the remainder of the ITAAC in that family." So that's the fundamental premise of our sampling.

Okay. This is a picture of the AP 1000 ITAAC matrix and --

DR. APOSTOLAKIS: Excuse me. Is their methodology prioritized in families or individual ITAAC?

MR. LAURA: Individual ITAAC.

DR. APOSTOLAKIS: Individual?

MR. LAURA: Yes.

DR. APOSTOLAKIS: Considered within the family or in the global?

MR. LAURA: Global.

DR. APOSTOLAKIS: I see. So what's the value of having the family then?

MR. LAURA: The value of the family is

let's say you have 20 ITAAC in that family and we have a slide on this coming up and we go through and we calculate that there are five or 20 that exceed our threshold that we're going to talk about and our threshold is 0.4 that we plan on using.

DR. APOSTOLAKIS: That means you're going to do something about it.

MR. LAURA: Right. That means we're going to inspect those five and those are going to be representative of the 15 that we don't inspect.

DR. APOSTOLAKIS: I see. So you're drawing conclusions about the other 15.

MR. LAURA: Right. Exactly.

CHAIRMAN SHACK: But you are going to do one from each family at least. Right? The minimum.

MR. LAURA: Yes, that's true.

DR. APOSTOLAKIS: You are what?

CHAIRMAN SHACK: They are going to do at least one from each family.

(Several speaking at once.)

MR. LAURA: Right. And that's the second part of the methodology, the coverage check, our portfolio check. The first step is are there any families that aren't covered because they don't have any ITAAC greater than the threshold and, in fact, you'll find that there are 17 families like that and we added in 17 ITAAC.

DR. APOSTOLAKIS: (Off microphone.) So that's like ***9:04:36

DR. KRESS: If you have a family that has 63 ITAACs in it and all of them are below your 0.4, are you just going to sample one?

MR. LAURA: Well, that --

DR. KRESS: Doesn't it depend on how many is in there?

MR. LAURA: That's where Region 2 will some flexibility and that would probably be a case where they would probably exercise that and maybe pick a few a more.

DR. KRESS: Do you have criteria on how many to pick based on how many are in there and based on the overall value of the ITAAC?

MR. LAURA: No, I guess that would be judgment at the time and at the end, I guess, some of what would be important is the amount of resource available to do the inspections especially --

DR. KRESS: It seems to me like for consistency at the various regions you would need some guidance on that.

MR. LAURA: Yes, we could look at that and that's a good point. That's --

CHAIRMAN SHACK: That's ***9:05:35 of AHP.

DR. KRESS: Yes.

MR. LAURA: One point regarding --

DR. CORRADINI: Can I just interject?

MR. LAURA: Sure.

DR. CORRADINI: Maybe I assumed this and maybe I'm wrong. So there will be X orders and the X construction projects. So all regions of the NRC will be looking at this.

MR. RASMUSSEN: No. That ties into what he was talking about consistency. All of our construction inspection is going to be led out of the Region 2.

DR. CORRADINI: Okay. Fine.

MR. RASMUSSEN: So that will provide a single point, continuity and consistency, for this process.

DR. CORRADINI: Doesn't that partly answer your question, Tom, in terms of consistency? Okay. Thanks.

MR. LAURA: If you -- The way the matrix is constructed is if you look at the top row A, B, C, D, E, it talks about as-built inspection, welding, construction testing, operational testing, qualification criteria, design and fab requirements. Those are all construction programs. So the top columns here are rows. These are actually programs.

Now down the rows, the 19 rows, these are construction processes used to build the structures, systems and components and where these intersect, where a row intersects a column, let's say this block here, that's a family and that number there indicates that there are six ITAAC in that family. So that generally how the matrix is constructed. And within that family, they share some common connection that we'll tap into for the prioritization later.

DR. KRESS: I think -- Is that matrix, you think, general rather than just specific to AP 1000? Would it apply to the other type of reactors?

MR. LAURA: Well, the shell of it would but not the specific ITAACs.

DR. KRESS: That's cool. But the categories are. Right?

MR. LAURA: Yes, that's true.

DR. CORRADINI: So this matrix, I mean, I was reading this in the, I guess it's the ISO document, is by activity. So the reason they fall into your Box 6 and by construction testing is that the activity requires that somebody has to go onsite and see what's happened during the construction. In difference to one, they're going to look at some as-built -- They are going to inspect some as-built or in difference to F where they're going to look at some design report or fab report.

MR. LAURA: Right.

DR. CORRADINI: So it's an activity sampling with area sampling.

MR. LAURA: Right, and actually the ITAAC, they're very focused in a sense, but yet when the inspector goes out to inspect that, he's going to be looking using two different procedures. He's going to be looking at that program procedure and then the process procedure and he's going to be looking more broadly. So really each ITAAC that's inspected will give you more confidence as you're looking at other things when the inspector is out there.

DR. APOSTOLAKIS: So if we look at Rows 6 and 7.

MR. LAURA: Okay.

DR. APOSTOLAKIS: Why are valves separate? Aren't they mechanical components?

MR. LAURA: I guess the way it was done is you could only count when you sorted through all the ITAAC you could only put them one block. So there are some instances where judgment was needed to put it in the most appropriate place.

DR. APOSTOLAKIS: And pumps are not separate? Or I don't see any.

MR. LAURA: No.

DR. APOSTOLAKIS: Yes. But why --

MR. LAURA: Tony, do you want to add something on this?

MR. CERNE: Yes. The way this was structured was to get a maximum spread so we didn't have matrix blocks with 100 items in them. So when we were looking at this, we saw there were a lot of actual valve inspection activities, valve installation activities. So we broke them out from the mechanical components. So all your other mechanical components like heat exchangers and pumps, steam generators, whatever are in the mechanical components process block, but the valves were broken out separately because there were sufficient number of ITAAC to justify them as a separate category. Otherwise, you could just take the valves and move them into mechanical components and that would just add the two numbers together which doesn't give you the spread you want when you're going your sampling.

DR. APOSTOLAKIS: So again, just for my

own benefit, let's look at valves. It says, "Operational test..." Well, I understand. "Construction testing six ITAACs" and then "design fabrication requirements 20." What -- And "as-built inspection eight." Can you give me an example of these?

MR. CERNE: For example, the valve construction test may be an ITAAC that are basically inserts a signal and you're doing a continuity check that upon the insertion of an electrical signal, the valve operates, either opens or closes to the right position. A fabrication erection or fabrication design kind of requirement for a valve might have something to do with some specific fabrication detail in the pressure boundary requirements for the ASME Code or other things that go into the vendor inspection of the valve. It's not a single test after the valve has been installed and you're looking at it. You're looking more at the actual installation and design requirements and that's the way these different definitions were divided up in a way to get some kind of spread of the entire population of ITAAC but also get discrete samples that were common and the same is true for the other requirements. The ASME requirement of the valve may be just something simple. There are tests that say "Go out and check that these kind of check valves are different than the other kind of check valves." Well, that's a simple, as-built ITAAC inspection requirement. Thank you.

Moving to the next --

DR. ABDEL-KHALIK: Not all intersections will obviously logically have a family in them.

MR. LAURA: True.

DR. ABDEL-KHALIK: Some of those boxes will be empty always.

MR. LAURA: True.

DR. ABDEL-KHALIK: So what is the minimum number -- What is the maximum number of families in this diagram?

MR. LAURA: Do you know the total number offhand?

MR. CERNE: Well, it's obviously 6 X 19 which is -- But you're question is more focused on that. What we've found is -- Again, the question earlier was the matrix is going to be used for all designs. So some of the blocks that don't have anything in it for the ABWR and AP 1000 may have ITAAC for the future designs.

DR. ABDEL-KHALIK: There are some boxes that will always be empty.

MR. CERNE: And there will be some boxes that may always be empty and for the designs we have, we're roughly getting in the 70 to 80 range for the blocks that are filled.

DR. ABDEL-KHALIK: I'm just trying to block out the ones that will always be empty to find out what is the maximum number of boxes that one can possibly -- You talk about welding of electrical cable. I don't know if that will ever have an item in it.

DR. ARMIJO: Or welding of security.

MR. LAURA: Right.

DR. ABDEL-KHALIK: Or whatever. Based on that I want to find out what is the maximum size of the sample if you have a certain, if you have a minimum of one item per family. That's why I'm asking the question.

MR. RASMUSSEN: If you have a minimum of one item per family, we would sample that one item.

DR. ABDEL-KHALIK: Right. I understand. But how many of these will always be empty?

MR. LAURA: We'd have to tally that up. We don't know that right offhand, but the construction of the matrix is the best fit. It's not absolute perfect in every way and you're pointing that there might be some blocks that remain empty and that's true. But it's our best effort and our judgment that wanted to sort them this way and this is what we built our processes on because it seemed to follow that. If you look at the ITAAC within the families, they share that common activity. So that seemed to be the logical way to build the matrix.

PARTICIPANT: One more thing. I think what we were looking for at the end was there enough diversity, was there enough diverse numbers of blocks that we could feel that any design could be accommodated by this matrix and that's the way we ended up. Every time we look at it, we say what representation do we have across the 114 potential families that is it sufficient that we feel like we have a sufficient spread that our sampling will be sufficient and the process will be aptly applied. And in this case, while you can point out some cases where cable with welding, those are points that obviously could happen. It doesn't affect the fact that our sampling is robust and the fact that our sampling methodology is --

MR. CERNE: And one additional point just to explain why the matrix was created, it wasn't created only for the purpose of sampling. It also gives you the universe of actual construction activities that we want to inspect. So, for example, if you look at your electric cable, we want to inspect that. That's why there will be procedure 09 that inspect electrical cable and there will be B procedure which inspects welding. If there is not electrical cable welding, we're not inspecting that intersection, but we're still inspecting that process and that program.

DR. ARMIJO: I noticed you didn't have anything under emergency planning for this particular one. Are there ITAACs for other systems that have emergency planning?

MR. RASMUSSEN: Yes.

DR. ARMIJO: There's nothing in this.

DR. CORRADINI: I seem to remember there was.

MR. RASMUSSEN: And those come under as-built. The facilities would be inspected for as-built although they support emergency planning and an important point of this is this table provided focus for this prioritization process. It allows the regions to come up with a methodology for inspecting at the family level that's going to be very useful going forward. But it's not intended to restrict the inspectors to only looking at the topics of the intersection. As they go out and get into those items, part of the program is the inspectors using every tool in the toolbox that is relevant to whatever situation because the real life situations don't fall directly in those boxes.

PARTICIPANT: One more point, too, and that is that this represents -- what you see on that table represented the design certified ITAAC. There will be we're estimating 50, 60. It's just an estimate of site-specific ITAAC that will deal with such things as EP or ultimate heat sink, things like that which are not generic in nature but are site-specific and they will be coming in with the COL.

DR. BANERJEE: I suppose the important point is in each box there must be items with rather similar attributes. Right?

DR. CORRADINI: Activities.

MR. LAURA: True.

DR. BANERJEE: That's the basis of this sampling procedure.

MR. LAURA: Exactly.

DR. APOSTOLAKIS: So one can extrapolate these sides --

DR. BANERJEE: Or interpolate, yes.

DR. APOSTOLAKIS: -- a limited number of inspections to the rest of the family.

MR. RASMUSSEN: Right.

MR. LAURA: Okay. Moving on --

DR. APOSTOLAKIS: This all was done randomly before. Right?

MR. LAURA: Yes. Well, before they didn't have specific ITAAC and talking to Tony and Ron, what they indicated was inspections were done more in a random way, more of a scheduling. Inspectors would show up onsite on a certain week and they would go out and inspect at random whatever was in process at that time. So that was a different approach and they would try to make it performance-based and select the best you could during that week. But it wasn't as sharply focused as what we were trying to accomplish here and actually this will be much more challenging because we would have to schedule to have inspectors out there to see exact, specific points, where before that might not have been the case.

DR. APOSTOLAKIS: Does this save resources?

MR. LAURA: We're looking at resources and trying to determine how much resource the baseline will take. But I think the rough talk that we're hearing is that it's roughly in the same ball park.

MR. RASMUSSEN: But this process isn't necessitated by the premise of the Part 52 rulemaking and the fact that the Commission ultimately has to find that these ITAAC have been completed in order to allow these units to operate.

DR. MAYNARD: A big different is that in the past you didn't get a license to operate until you were done. This process really gives you a license up front as long as you do these things. There's a major difference there.

MR. RASMUSSEN: That's the difference and that's why a more -- The groundwork has to be laid through this process.

DR. APOSTOLAKIS: There's a major difference --

DR. CORRADINI: This is the QA --

DR. APOSTOLAKIS: What is the consequences of that difference?

DR. CORRADINI: If they don't satisfy.

DR. APOSTOLAKIS: Does anybody save any money or --

DR. CORRADINI: But they don't satisfy.

DR. APOSTOLAKIS: No, the fact that they have the license in advance.

DR. MAYNARD: Well, from the licensee's standpoint, in the past you could put a lot of money in and do everything you said you were going to do and you still may not get a license. This way you know up front whether you're going to be able to operate it as long as you do --

DR. CORRADINI: Do what you say you're going to do.

DR. BANERJEE: If you're an investor, George, you would want to be sure this thing has a license before you --

DR. APOSTOLAKIS: But I mean still at the end, the Commission has to accept the ITAAC results.

(Off the record comments.)

DR. APOSTOLAKIS: They can stop at the end.

MR. RASMUSSEN: The subjectivity though is done up front.

DR. APOSTOLAKIS: I agree.

MR. RASMUSSEN: The criteria are already laid out.

DR. APOSTOLAKIS: It's a more structured approach. No question about that.

DR. ABDEL-KHALIK: Presumably, this would give the Commission a higher level of confidence in the fidelity of the inspections.

DR. APOSTOLAKIS: And I agree with that.

DR. ABDEL-KHALIK: Versus the random process that was used in the past.

DR. APOSTOLAKIS: I think this is better that way. Fine.

MR. LAURA: That's a good point and I think that the folks that have done actual construction inspection feel that way that this is a much more focused, better way of doing it looking at more important activities.

DR. BANERJEE: But is there a way that the licensee can actually work out what is going to be inspected and things?

DR. APOSTOLAKIS: Sure.

DR. BANERJEE: So in a way, the things that you're not going to inspect in order to be done quite so well --

MR. LAURA: Well, you have to go back --

DR. BANERJEE: The randomized thing would take care of that.

MR. LAURA: Within each ITAAC though, again, you get back to there may be hundreds of components that one ITAAC touches. They don't know which sample we're going to look at and also if you go back to that first slide with all the manual chapters in parallel, there's a number of other activities as part of our oversight that cuts across this as well, just not as sharply as the ITAAC, and that's a real critical point and that's why that slide is really critical that they're supporting process inspections and program inspections that are done separate from ITAAC.

DR. BANERJEE: So you feel comfortable that there isn't a way to game this process.

MR. LAURA: We feel very confident that there are enough variables and enough activities going on as they're trying to build the plant and with the little element of independence that we have in the region level that they can't game the system.

DR. MAYNARD: It's very difficult in a large project to use different standards in different areas based on what you think is going to be inspected. It becomes unmanageable.

MR. LAURA: Right.

DR. MAYNARD: And it still is going to be a little bit of a moving target. It's not going to be something that you know for sure this is all you're going to be looked at. And I think in the past even in unannounced inspections, we used to try to do more of those, you find that you really can't change things that much to influence it. I think you'll still be able to get a good look at what's going on.

MR. RASMUSSEN: I would also contend that the inspectors onsite were planning a crew of about five resident inspectors onsite through the construction process. When they're out there day in and day out, the ITAAC numbers are not stamped on these components as they're working them. So they will walk up and engage on things and then realize that it was a low priority thing and move on. But they will still see those activities.

DR. MAYNARD: And the workers get pretty vocal. I mean, the workers, if they see some gaming going on, it's going to come forward. It's not going to be something you can hide.

MR. LAURA: Okay. Thanks. Moving on to the prioritization process, the first step is really rank ordering of ITAAC and this is an overview slide and I'm going to talk about each step in more detail in later slides. The vision is the first bullet. Rank ordering of ITAAC inspection was based on attributes and associated ITAAC impact that make one ITAAC more or less important to inspect based on optimizing resources to minimize the possibility of a significant flaw going undetected.

DR. KRESS: Let me ask you about that point.

MR. LAURA: Okay.

DR. KRESS: Just plot in your mind the possibility of a significant fault going undetected versus resources which I'll make that number of inspections. I can't see that that has a minimum in it. It seems like it's just sort of continuously going down. I don't see how you -- When you optimize them, I'm looking for minimum in that curve.

MR. LAURA: Well, as we get into the attributes in the following slides, those are really critical what attributes of an ITAAC is important to look at and we get into such things of propensity of error. Also we get into how the flaw or error could get revealed. How easy is it to identify that problem? So as we move on, I think there might be some attributes that address that.

And again, this is just an overview before we delve a little lower into theory and utility factors. Step 1 was to deliver the attributes of the ITAAC that were important for construction and they came up with five attributes: safety significance, there's no surprise there; propensity for making errors; construction and testing experience; opportunity to verify by other means; and licensee oversight. So those are the five attributes that were developed by the ISL team and the expert panels that were important.

DR. APOSTOLAKIS: Now, in some other applications of this approach, what the methodology does is it comes up with a ranking of things based on tradeoffs among these attributes.

MR. LAURA: True.

DR. APOSTOLAKIS: But one might say that there are certain ITAACs that are safety significant that I really don't want to do any tradeoffs. I want to do them anyway.

MR. LAURA: Right. But --

DR. APOSTOLAKIS: And I was wondering whether that would be appropriate. I gave you the example yesterday.

MR. LAURA: Right.

DR. APOSTOLAKIS: We have our Department of Facilities at MIT is using this to prioritize infrastructure renewal projects and when they were developing it, they said "Look. If one of these projects, if the president of MIT wants to do it, we'll do it. We're not going to optimize anything."

Okay. So in this case, safety plays that role.

MR. LAURA: True.

DR. APOSTOLAKIS: But are there any ITAACs that because of their safety significance, if they have to be done anyway and forget about propensity of errors and so on -- Now yesterday, you said that the methodology will catch them anyway. But maybe for the --

MR. LAURA: Right. I think in the next few slides we're going to touch right on that and I think where we're leading to safety significance dominates and that we're confident that using that waiting factor that we have identified all of the ITAAC, the most important ones, to inspect.

DR. APOSTOLAKIS: So even if one does this tradeoff analysis, still the important ones from the safety perspective will be --

MR. LAURA: Right.

DR. APOSTOLAKIS: That's --

PARTICIPANT: That's one of the things we did when we ended up with a prioritization was to go back and see if it encompasses issues like that. Did we have a really high safety significant issue that for some other reason because of the other attributes ended up not being recognized as being important for us to inspect and the answer was no, there's none like that.

DR. APOSTOLAKIS: That's good to know.

DR. CORRADINI: I'm sorry. I was just going to ask it a different way just to get to your response. So in other words, if you went through your summation of waiting times, whatever it was, and you set the waiting to zero of the other three and then look back at how you sample, you're saying you'd come up with essentially the same list to inspect.

PARTICIPANT: No, because your variations in safety cover a scale and so I thought what he was talking about was the ultimate safety one.

DR. CORRADINI: Okay.

PARTICIPANT: And that's what we were talking about an extreme safety issue.

DR. APOSTOLAKIS: You don't want to have a situation where one ITAAC is very, very important to safety but because of the other attributes it was --

PARTICIPANT: Right.

DR. APOSTOLAKIS: They are saying yes. Even if that happens, it will be just a little bit. It will still be --

PARTICIPANT: Right.

MR. LAURA: What might help --

DR. APOSTOLAKIS: The threshold is low.

DR. BANERJEE: I think if you go through the details of the procedure it becomes clear.

MR. LAURA: Right.

DR. APOSTOLAKIS: By the way, this is how we rate --

MR. KAUFMAN: This is how we judge the research quality. Right?

DR. APOSTOLAKIS: The ACRS does this to evaluate the quality of research progress more or less. The expert panel --

MR. LAURA: Okay. Step 2, once we've identified the attributes that are important, Step 2 is the NRC formed expert panels staffed with knowledgeable people and they assigned relative weights for each attribute using the AHP process. Then once that was --

DR. BANERJEE: What is the AHP process?

MR. LAURA: Well, we're going to get into that. So it's some process.

MR. LAURA: Right. We're going to get further into it. Then the next step -- It's important to have an overview before we delve right into it because once you get into the theory, it gets a little --

DR. BANERJEE: We can hold on for that.

MR. LAURA: Okay.

DR. KRESS: Now when it says it assigns relative weights for the attributes, that's unique for each ITAAC.

MR. LAURA: No, each -- Well, if you could hold that, we're going to get to that.

DR. KRESS: Okay.

MR. LAURA: Yes. We keep -- Again, this is an overview and --

DR. CORRADINI: Keep on going.

MR. LAURA: Okay.

DR. APOSTOLAKIS: This is just documentation versus technical content. But then you have to rate it within technical content. That's what you said comes in.

MR. LAURA: Okay. Then once the relative weights are assigned, the same expert panel then determined utility values for each attribute.

Step 3, a separate expert panel determined utility factors for each attribute for each ITAAC and we have a slide that shows that very clearly. Step 4, the results of all of that --

DR. ARMIJO: What do you mean "utility factors"? I don't --

DR. CORRADINI: We're coming to that.

MR. LAURA: Yes, it's coming.

DR. ARMIJO: That's going to be defined.

DR. APOSTOLAKIS: This overview uses too many terms that aren't defined.

DR. BANERJEE: But there are two items as I see it which have to be assigned. One is the relative weight and one is something called a utility value.

MR. LAURA: True.

(Several speaking at once.)

DR. APOSTOLAKIS: Let's think in terms of the evaluation of projects. The two attributes that we're using are technical for meeting the objectives and documentation. There is a relative weight and then within each one you say it meets satisfactorily or -- That's a utility.

DR. ABDEL-KHALIK: Is there a bigger loop around this process where the results of a prior inspection are fed back to these expert panels so that they may revise the relative weights?

MR. LAURA: The members of the expert panels were selected based on having significant construction experience, knowledge of what inspection procedures were used during construction activities and, you know, would be the right mix of people to determine these weights and they were guided. So guidance was given to the expert panels. They were sort of fostered. In fact, Tony and Ron did some of that.

But what I'd like to do now is just move forward because --

MR. RASMUSSEN: Let me answer this. On the original drawings that you probably saw in the previous presentations that loop was in there. However, we don't have any data to support that loop and in practice, we've knolled that out so it won't be a player in this process. However, that 2505 assessment process that's part of our overall program is going to be our tool for feeding back and informing our inspection resources.

DR. CORRADINI: Yes, if something pops up, you're going to use the 2505 procedure to essentially bore down into something that looks fishy essentially.

MR. RASMUSSEN: That's correct.

DR. CORRADINI: I think you need to move.

MR. LAURA: Okay. The last step which is an important step, the results of these previous steps get fed into an algorithm that produces a listing of ITAAC value of inspection results and that's the actual rank is the value of inspection and we'll show that as well.

Here is a little more detail on each of the five attributes. Propensity for making errors is simply how complex, how difficult, is this activity. What's the likelihood that someone would make a mistake or an error.

Construction and testing experience generally means is this the first time this has ever been done or is this something that's routine and done all the time or it could mean does the company have little nuclear experience.

Opportunity to verify by other means, this means do we have just one shot to find this error or are there multiple opportunities down the road either through testing or other activities that it would come to light.

Licensee oversight attention. That related to how effective is the licensee's oversight.

And the last one, safety significance, as far as that one, the safety significance was defined by PRA waiting factors which was assigned by a separate expert panel and essentially what was done is all systems were ranked with PRA and then that panel went back and ranked every ITAAC and came up with a number for each individual ITAAC. So quite a lot of work was done on that particular one. That attribute is a little unique as compared to the others and you'll see how that factors in on the next slide.

DR. APOSTOLAKIS: But, now -- wait. Let's go back.

DR. BANERJEE: Let's back because of the last point.

MR. LAURA: Okay.

DR. APOSTOLAKIS: Go back to that slide. When we were reviewing the risk-informed version of 5069, they did exactly the same thing there and you can copy that process, although those guys were doing it for an existing reactor and this is for something that is being built.

Why PR -- I mean, are you looking only at the structure, systems and components that appear in the PRA? Because if they are not, then the expert panel has to do it using other methods.

MR. LAURA: the focus of the expert panel was on the ITAACs. The ITAAC is our focus.

DR. APOSTOLAKIS: And ITAACs are only for PRA components?

MR. LAURA: No. ITAACs cross boundaries.

DR. APOSTOLAKIS: Okay. And the expert

panel, they had real risk experts on it and they looked at the risk information that was submitted to the agency, used our own judgments and they ranked all the systems of the new design and came out with a value for each system.

DR. APOSTOLAKIS: I understand that. For the components that appear in the PRA, there's no problem. But the ones that are not and the majority are not, the panel would have to make a judgment without the PRA insight.

MR. LAURA: True and that's where safety significance is a little bit different than risk significance.

DR. APOSTOLAKIS: Yes.

MR. LAURA: That's where there's some engineering judgment.

DR. APOSTOLAKIS: Right. Now what are the relative weights that came out of all of this? Do you show them anywhere?

MR. LAURA: We have those. It's coming.

DR. APOSTOLAKIS: I'm not sure. Yes.

MR. LAURA: You're right. It's not there, but I can tell you what they are.

DR. APOSTOLAKIS: Can you tell us now?

MR. LAURA: If you want to skip the

utility theory.

DR. CORRADINI: No, I think we need to do utility theory.

MR. LAURA: Okay.

DR. APOSTOLAKIS: It's important to understand what we're doing.

MR. LAURA: Okay.

DR. APOSTOLAKIS: I mean, we have the --

MR. LAURA: Okay. If you look at the attributes which starts here and goes across the safety significance. Here are the five attributes and the dominant one is safety significance at 0.33.

DR. APOSTOLAKIS: What?

MR. LAURA: 0.33. That would be weight of safety significance.

DR. APOSTOLAKIS: So you see. It's not there. Right?

MR. LAURA: True.

DR. APOSTOLAKIS: Okay. So let's back and put it there, 0.33.

MR. LAURA: Right. The next one, licensee oversight, that's 0.3. Verified by other means is 0.19.

DR. APOSTOLAKIS: Okay.

MR. LAURA: C&T experience is 0.09 and

error propensity is 0.5. So what you see there is some of these pretty much --

DR. APOSTOLAKIS: Do these add up to one?

MR. LAURA: More or less.

DR. ABDEL-KHALIK: 0.96.

DR. APOSTOLAKIS: What?

DR. ABDEL-KHALIK: 0.96.

DR. BANERJEE: Do they have to add up to one?

DR. APOSTOLAKIS: Yes.

MR. LAURA: Yes. Licensee --

DR. APOSTOLAKIS: Relative weights over exhaustive space. So safety significance and licensee oversight attention were judged to be almost of equal importance.

MR. LAURA: True.

DR. APOSTOLAKIS: Interesting.

MR. LAURA: And there is going to be some follow-up discussion on that that we're going to get to because the item on licensee oversight when we start the project we don't have real experience with that licensee. So initially, that gets nulled with the medium value number.

DR. CORRADINI: Okay.

MR. LAURA: Okay. If we go back to

utility theory, the approach is to prioritize ITAACs by inspection value and then the next bullet gives a definition of what the utility is. But essentially in my own words, it's the relative importance of each attribute as it's compared to each other. So what it does is it bounces the attributes against each other and how does the expert panel rate them. So at a very high level, that's what it's doing.

And also there's a second utility application. When we get to the specific ITAAC and we rate each ITAAC for each attribute, there's a utility figure there as well. So it's easy to get a little confused.

DR. BANERJEE: I'm still a little confused. Now you have a weight which is more or less fixed to each attribute.

MR. LAURA: True.

DR. BANERJEE: Now for each ITAAC now within this, there are these attributes or whatever.

MR. LAURA: True.

DR. BANERJEE: So clarify again what this utility is.

MR. LAURA: What the utility is it's relative importance which means you compare one item against another item.

DR. BANERJEE: Give me a concrete example.

MR. RASMUSSEN: Next slide.

DR. BANERJEE: The next slide. Let's do it then.

MR. LAURA: Okay. This slide shows really some of the details of it and in this column here, these are both AP 1000 ITAACs and one of them, the first one, deals with flow through a drain line from a refueling water storage tank and the second ITAAC deals with seismic qualifications of important buildings which is a big heavy hitter and here are the five attributes and the output of all of this is going to be this number which the algorithm determines which is a value of inspection ranking --

DR. BANERJEE: Those twos and threes and so on, are they utility values or what?

MR. LAURA: I'm going to get to those.

DR. BANERJEE: Okay.

MR. LAURA: Actually, yes, they are. But there's not the same utility that we talked about for the attributes. Those have their own utility value and then when we get to this point, you also have a -- This B and V are utility values and one is called "baseline" where baseline means the likelihood that an error or problem actually exists. That's baseline and then the value of inspection or what the green book calls "no flag" that means what confidence does NRC have that if we did not inspect it that it would be okay, that there would be no problem. And then what you do is you subtract the value of inspection from the baseline and that gives you a delta, a delta U, and that delta is the actual value of inspection and that's what we're --

DR. APOSTOLAKIS: I think the question was different. If you go back to Slide 13, see, the relative weights that were just given to us tell us how more important is safety significance with respect to opportunity verify by other means. Now given an ITAAC though, you look now at each one of these. Safety significance, how important is that ITAAC to safety? That is not covered by these weights. These are just relative among the applicant.

DR. BANERJEE: Yes.

DR. APOSTOLAKIS: And they have scale that says one or two or three or four. I don't know. How many steps? How many?

DR. CORRADINI: Nine.

DR. APOSTOLAKIS: Nine levels. So that's really what the utility does.

DR. BANERJEE: That's right.

DR. APOSTOLAKIS: Within each one of the --

DR. BANERJEE: It's attached to each ITAAC.

DR. APOSTOLAKIS: Exactly. Within each attribute.

DR. CORRADINI: So the expert panel basically works through this.

DR. BANERJEE: The weights are attached to the attributes and the utilities are attached to the --

DR. APOSTOLAKIS: Exactly.

DR. CORRADINI: But the second point that I think he makes with the example as important is that they're looking at the delta so that if something has a propensity there's no -- You said it better than I understood it when I read the green book. But basically, it's the delta that determines the final ITAAC rank. For example then, safety significance, although we would worry that at 0.33 it's only one-third of the total thing, it essentially dominates because it's the delta U that essentially determines the final ranking. So --

(Several speaking at once.)

DR. BANERJEE: V is zero there. Right?

MR. LAURA: I'm going to get to that. But --

DR. APOSTOLAKIS: I'm not sure I understand.

DR. BANERJEE: What is the V there? What is V for --

MR. LAURA: V is -- If you look in the green book, it's called "Utility No Flag" and in English what that means to me or as I've learned it is the value of inspecting. In other words, if we didn't inspect that item, what's the likelihood that there are error or major problems that will exist and not get detected.

DR. BANERJEE: So when 2 and 2 is there, what does that mean?

MR. LAURA: Okay. I'm going to go through that.

DR. BANERJEE: Okay.

MR. LAURA: The first three attributes, if you look at error propensity, C&T and verified by other means, they have 2 and those three were treated -- We had both values, the baseline and the value of inspection and that created this delta that drives the value of inspection for those attributes.

Licensee oversight, when this was looked at, the expert panels decided that at the beginning there was not enough information available as you start a project. So they essentially nulled that attribute giving it a 3 score. The scale is 1 to 5.

And then the last one safety significance, the safety significance doesn't change between the baseline or value of inspection. So safety significance is treated in a little bit different way and if you look at these numbers, they were scored in these examples very high. Like this one is a 5. A 5 out of 5 dominated this computation and gave it 0.65 rating which will -- And our threshold is 0.4 and we're going to get to that. So it clearly drove that one that we're going to directly inspect it.

DR. APOSTOLAKIS: How does the rank get computed? This is the fundamental question. This 0.432, what is it?

MR. LAURA: That's an output from an algorithm.

DR. APOSTOLAKIS: Yes, given these numbers there, how would I get that?

DR. BANERJEE: Are you going to show us the algorithm?

MR. LAURA: No. The algorithm, it's a software.

DR. APOSTOLAKIS: I know that.

MR. LAURA: Okay.

DR. APOSTOLAKIS: But if I have the values you are showing on the row, I should be able to calculate the 0.432 by hand.

MR. NEWBERRY: Let me try. Scott Newberry, ISL. It's just the summing of the individual products of the weight, the individual attribute weight, times the utility value for that ITAAC for that attribute. I think you said it yourself. You should be able to do the arithmetic of each of those terms.

DR. APOSTOLAKIS: But you -- The thing that's confusing me is that I have a B and a V value.

(Several speaking at once.)

MR. NEWBERRY: Thank you. You do two computations and then take the difference.

DR. APOSTOLAKIS: So I do two computations, one with the B values and one with the V for the first three and the B for the second, for the last two?

MR. NEWBERRY: Yes sir. And a comment on that is --

DR. ARMIJO: It's B minus V times the weighting factor for each of those.

DR. APOSTOLAKIS: But I don't understand why B-V. Why isn't it just B X W?

MR. NEWBERRY: The challenge -- One of the major challenges on the project was to think about and come up with a method for determining the priority of the value of inspecting the ITAAC not the importance of the ITAAC itself. So the B more closely represents the priority of the ITAAC. This V term and the whole concept was invented working with the inspectors to have them think about the information you would get that from that inspection or what you would lose if you don't inspect. So the difference you see there between -- Well, no difference, in fact, on the first one, 2 to 2. That would imply that there's not much value in the inspection at all.

As you move to the right, you'll see that the inspectors, the expert panels judged as the difference grows that there is a higher value to looking or inspecting that ITAAC.

DR. APOSTOLAKIS: So if we look at verified by other means, a value of 4 for B means that there is a pretty good chance that they will be verified by other means.

PARTICIPANT: No, it means that there is a higher likelihood that an error could go undetected because of the fact there isn't a way to verify. For example, rebar and concrete being placed over it, if you don't take advantage of your chance for inspection, the concrete covers it. There's not another way to inspect it unless you do something highly esoteric. So there is a high likelihood that without another way that there could be an error.

So now you look at it and say though is there any confidence that if the NRC doesn't inspect, what's our confidence level without NRC inspection that the licensing or the applicant would do it seamlessly with no issue and the 1 indicates there's low confidence that the issue could be assumed to be okay without NRC inspection. So you have high likelihood or relatively high likelihood 4 and relatively low or actually the lowest confidence that it would be done seamlessly without NRC overview. So you get a 3 delta which is a fairly significant delta which makes that value then applied with the attribute number somewhat higher than by itself. So the deltas actually can control how much weight, with the weight, how much that attribute is valued.

DR. CORRADINI: So that's why he said -- George, the way I understand, that's why he said that at least in these examples even though we were worried about the ranking or the equating of safety as being not as high as we'd like, the very fact that as you explained to the inspection, you're essentially weighting everything even more with safety significance and license and oversight. So if you had a licensee that you knew built 17 plants in the last 17 years, that might -- But we have very little knowledge. So we would rank both of those quite high which may dominate the total weighting of everything.

DR. APOSTOLAKIS: So in the error propensity, a value of 2 under B means that there isn't any much likelihood that they would --

PARTICIPANT: That's right.

DR. APOSTOLAKIS: And then the value of 2 means what?

MR. CERNE: The value of inspection gives you a confidence that without NRC interaction or inspection of this issue, it will be done properly. So you could have a value, an error propensity value of 5. In other words, there's high propensity for errors. However, the NRC inspection, there's still high confidence it will be done right and that you could have a 5 there also. So you would still get a delta of 0.

A good example of that, the verified by

other means, the concrete was a good example of if you put concrete over the rebar, you're not going to be able to see it. So if you have a high value for concrete for verified by other means and the NRC wants to look at it, our inspection of that rebar adds value.

On the other end of the scale, you could take a test which in itself maybe a highly complex test and there might be a high error propensity to it, but what if that test is also going to be a tech spec test which is repeated every quarter and therefore, even though we think it's high error propensity, we also believe that our value of inspecting it at that time isn't quite as great because we know during the life of this plant it's going to be checked every quarter. So it's always the delta that gives you the value of inspection, not the innate value of the ITAAC, but the value of NRC inspection of that ITAAC.

MR. LAURA: Okay. Thanks, Tony. The next slide.

DR. BANERJEE: Now for safety significance and licensee oversight would effectively be zero there.

MR. CERNE: Right. Because licensee oversight was no doubt because we have no doubt at this point.

DR. BANERJEE: So the way your algorithm works is 0.33 multiplied by B plus +3 multiplied by B for the second column, then whatever it is multiplied B-V and so on and you sum it. Is that it?

MR. CERNE: That's what we did.

DR. CORRADINI: You normalize it.

DR. BANERJEE: It's a summation or --

DR. APOSTOLAKIS: They take the differences and the weight that sum -- Using the weights they show the --

DR. CORRADINI: And normalize. Yes?

DR. APOSTOLAKIS: No, it's normalized already.

PARTICIPANT: Normalized based on weighting factors.

MR. LAURA: Okay.

DR. APOSTOLAKIS: The scale is given. It's from 1 to 5.

MR. LAURA: This slide shows --

DR. APOSTOLAKIS: It will be normalized from 1 to 5.

DR. KRESS: Okay. Here's where you do the sanity check. Look at the end --

DR. CORRADINI: Or insanity.

(Off the record comments.)

MR. LAURA: This slide shows six different families now, specific families with the ITAAC numbers listed in the left column and then their rank of inspection and value. And so to pick an example, if you look at family 6B, welding mechanical components, you have five ITAAC. And then over here you have five different -- or five ranks, one of each ITAAC.

Now the threshold that we chose based on judgment and having the proper coverage was 0.4. And we're going to talk about that some more next. But what we would essentially do is draw a line right here on the 0.52 and we would inspect the top three ITAAC in that family and we would not inspect the bottom two. Now if problems were found in the top three, then that changes the ballgame. But if we -- Initially going in, we're going to target for direct inspection the ITAAC greater than 0.4.

DR. KRESS: Now why did you arrive at 0.4?

MR. LAURA: It was judgment and it was a matter of do we have the right coverage looking at all the systems and we did some sensitivity studies as well. What would happen if we used 0.3? How many more ITAAC would get added in? But when you look at those ITAAC that got added in, did they really add significant value of inspection and the judgment was no. So we felt comfortably that 0.4 was the right threshold.

DR. ABDEL-KHALIK: Does that threshold depend on which machine we're talking about or is it universal?

MR. LAURA: You mean between designs?

DR. ABDEL-KHALIK: Right.

MR. LAURA: That's a good question and it turned out for the ABWR, and you're going to see this when we get to that, that the slightly different results, and there's good reasons for those, but we ended up sticking with the same 0.4 for both designs that we've looked at so far.

DR. APOSTOLAKIS: Now that's one number you could have kept secret.

MR. LAURA: Right. 0.4.

MR. RASMUSSEN: But that's a question we're going to have to ask as we do the other designs.

DR. ARMIJO: Just your highest value -- Can you go backwards?

DR. APOSTOLAKIS: Yes, 0.4 is something that you may rethink. Right?

MR. LAURA: Right.

DR. ARMIJO: Now you have three

significant figures here on something and our highest number on that chart is 0.569 around on mechanical components.

DR. APOSTOLAKIS: Where are you looking at, Sam?

DR. ARMIJO: I'm just trying to get a scale.

DR. APOSTOLAKIS: Yes, but where?

DR. ARMIJO: Family 6D.

DR. APOSTOLAKIS: Okay.

DR. ARMIJO: At the very bottom, 0.569.

DR. APOSTOLAKIS: The second column. Bottom of the second column.

DR. ARMIJO: There's 0.596 right above it. Is that your highest one? Just tell me what that is compared to -- just so we'll have a feeling that that is the right --

MR. LAURA: I don't have -- We'd have to go back and --

CHAIRMAN SHACK: You don't memorize them all.

MR. LAURA: No. Remember, there's 1,000.

(Laughter.)

DR. KRESS: Tell us which ITAAC that is.

DR. APOSTOLAKIS: Why don't you do that on slide 15 where you have the description and explain the difference? Slide 15 you actually have the description.

MR. LAURA: Right. Slide --

DR. APOSTOLAKIS: But why did 3.3.2.a.i come out ahead and the other one barely makes it?

MR. LAURA: And that was the point of these examples. The 3.3.2.a.i is the seismic qualification of the buildings, you know, the ones that have been seismic. So that's like central. So that got a very high number. The other one is dealing with the flow rate through a drain line off of a tank and it has some importance, but it doesn't come out as high as all the buildings being seismically qualified.

DR. BANERJEE: Why does the safety significance of that drain line go to four? That's pretty high, isn't it?

DR. APOSTOLAKIS: That's pretty high.

DR. CORRADINI: Wait a minute. Is it drain drying drain line or is this the drain line to the vessel?

PARTICIPANT: It's drain line to containment and it's part of the passive core cooling system's ability to cool the outside surface of the reactor vessel under severe accident conditions.

DR. CORRADINI: It's important. It's not your normal drain line.

DR. ARMIJO: It's a good, very important drain line.

MR. LAURA: The last step of this is to call the portfolio perspective or coverage check and we've already touched on this essentially saying that any families that have ITAAC and none of those are greater than the 0.4 threshold, in order to stay honest and true to the principles of sampling, we're going to add in one ITAAC for that family and, in fact, for the AP 1000, 17 more were added in for the coverage check.

And then the last part of it is what we've mentioned a few times already that there is some flexibility as they're actually implementing inspection for the region to make some changes to add additional ITAAC if they feel that they come across a family and there's one in that family that may be a little different or is important enough to inspect. So there is an element of some independent selection.

DR. APOSTOLAKIS: I think the two most important, not most important but very important, pieces of information you should have slides. One is the weights. We had to ask you to give that to us and the scale of the utility, you said it's 1 to 5, 1, 2, 3, 4, 5?

MR. LAURA: That's the rating.

DR. APOSTOLAKIS: What does that mean? What does 1 mean? What does 4 mean? Can you explain those?

MR. LAURA: Yes. Five would be most significant and 1 would be least.

DR. APOSTOLAKIS: And then -- So it's just a --

MR. LAURA: It would probably take a more --

DR. APOSTOLAKIS: -- graphic kind of rating.

DR. KRESS: Question. This is a prioritization and sampling process. You want to be sure you don't miss too many things. Is there going to be a test to see it actually works? For example, are you going to take the AP 1000 and inspect all of them and compare the results of all of them with your sampling method to see if it really didn't miss very much?

MR. LAURA: Yes. In an ideal world, that might be possible. But the whole point of this is to use our resources in the best way we can.

DR. KRESS: But you know you have a lot of these and if you just do it one time, that's maybe not a lot of resource.

MR. LAURA: We're going to have -- If you think about it, we're going to have multiple applications and construction in parallel and we're one agency and the decision generally has been made that we cannot look at 100 percent of every ITAAC at every plant being built.

DR. KRESS: Get 100 percent of one of them.

DR. BANERJEE: But suppose this is very optimistic and that we really don't get these multiple applications. You could do what Tom says.

CHAIRMAN SHACK: But I think you have an internal check if you're finding things and expanding.

DR. KRESS: Right.

DR. APOSTOLAKIS: Yes.

DR. KRESS: That's the --

DR. APOSTOLAKIS: What it takes is a couple of times to shake their confidence and then I don't think they're going to forget about this. If they look and find certain things are not done the way --

DR. CORRADINI: That's what the 2505 --

DR. APOSTOLAKIS: I don't want to put words in your mouth now.

DR. CORRADINI: That's the 2505 process that is mentioned in the green book. The other thing I guess is for historical, I asked you guys this privately, but I guess I want to ask it so it's on the record. Go back to all the 104 plants that are operating. What was your construction inspection percentage? It was about the same, maybe a little bit lower.

MR. RASMUSSEN: Our viewpoint in terms of inspection hours we believe were coming out similar to what some of the later plants were and we're still in the process of laying out procedures and validating that.

PARTICIPANT: And don't forget this is a baseline. This is to start and we have the ability and we as an agency have proven that we will expand our inspection universe for cause and we're ready to do that if necessary. Also if you look at, for example, the AP 1000, if you look at the ITAAC within our baseline, the ones that are 0.4 or greater, you will see one such as all the critical aisle instructors, that the containment, the aux building and the shield building are seismically, not only seismically, but can handle all design loads including the critical aisle instructors which are the most heavily loaded structures within the nuclear island. So you have chunks of those huge ones, ASME. All of those things we'll find a seismic qualification for your passive core cooling system that are within the baseline.

So you say what's outside the baseline. You're going to find a lot of HVAC. You're going to find a lot of testing. We're doing testing in 2504 in parallel. So the testing ones we don't do we'll probably pick up under the 2504 process. So you'll find that we're doing a lot.

DR. CORRADINI: Just for the sake of background, the thing that's important to realize, their pre-operational testing is 2504, not the 2503. So you're going to have a whole set of pre-op testing once construction releases the systems to the plant staff to go through those.

MR. RASMUSSEN: That's absolutely right and I wanted to put this slide back up. As you see the 2504 program encompasses a lot of things that really can't be independently extracted from the ITAAC. The quality assurance applies to both ITAAC and non ITAAC. However, we're going to focus on the program more than the individual products during those inspections.

Problem identification and resolution is going to be key for the licensees as they go through these projects. The work planning controls, the engineering aspects of translating the design elements into the details, the design change process will be ongoing throughout the process and those will have impacts on ITAACs although our inspection focus is on an ongoing and periodic through the 2504 program and again, those both get rolled together into the 2505 for our ultimate allocation of resources.

DR. APOSTOLAKIS: Has the industry complained about this being too burdensome?

MR. RASMUSSEN: They haven't quite figured it out yet.

(Laughter.)

DR. APOSTOLAKIS: I really think you should keep that point for a floating number. Don't say that you have a cutoff.

DR. BANERJEE: Do they have access to the B & V values that you assign to each of these?

MR. LAURA: No, not at this time.

MR. NEWBERRY: It is not intended to publish any of the data going into it or those rankings afterwards. Those 0.4/0.3 numbers are not going to be released.

(Several speaking at once.)

DR. CORRADINI: I can't imagine why not.

DR. MAYNARD: But in terms of --

PARTICIPANT: I really think we're being overly --

DR. APOSTOLAKIS: -- this information.

DR. MAYNARD: This is not something that -- I think we're worried too much about that. I don't think that's an issue.

MR. RASMUSSEN: And we are going through our program with industry in a series of public meetings and keeping them informed as we develop this and soliciting their input.

DR. MAYNARD: Actually from the industry standpoint, they would be better off if you did 100 percent of these because the NRC does not have the resources to do a good job on 100 percent. So you're not going to get as thorough --

(Laughter.)

DR. MAYNARD: And then at the end of the process, you would have a written document saying that the NRC accepted all these things, whereas, right now you're still on your own on those things that aren't inspected.

DR. CORRADINI: I was just going to say their investment butt is on the line.

DR. ABDEL-KHALIK: Yes. Was there a target percentage when you set that 0.4?

MR. LAURA: No. This is the result slide and this is the real high level. If you look at the AP 1000, out of the 672 population, 233 were selected for direct inspection. That equates to 35 percent. For the ABWR using the same 0.4 threshold, out of a total of 881 population, 383 were selected and that equates to 44 percent. So you see the actual percentage is a little different, but when you start to look at some of the reasons why it makes sense. The designs are different. One is passive. One is active. Also some of the ways the ITAAC were constructed were a little different as well.

The third bullet just references that we do have reviews in process to try to estimate how much resource will it take to complete the baseline program. That's an important effort ongoing.

And then the last bullet talks about the assessment process that we've mentioned over and over and that gives the ability to expand our samples if we find problems. So that's an important element.

DR. APOSTOLAKIS: Good.

MR. LAURA: And for the conclusion, these are again the real high level statements. The baseline inspection program consists of ITAAC selected, the direct inspection, using a defined prioritization process. The prioritization process optimizes NRC resources. Completion of this program will provide reasonable assurance that a significant construction or design translation error does not go undetected. So those are all of our --

DR. BANERJEE: So the experience with all the previous inspections of these 104 plants is really going in through the expert panels. Is that how it's being factored in?

MR. LAURA: In one way, but also through they become the starting point for the inspection procedures. You know, as we write the new ones going forward, a lot of the processes are still the same. You know, welding to some extent is welding.

DR. BANERJEE: Right. But what was found in the previous 104 plant inspections which were more randomized I take it? There was some safety significance and all this.

MR. LAURA: I believe --

DR. BANERJEE: How is that factor in.

That's really what I'm asking.

MR. LAURA: I believe, and correct me if I'm wrong, but I believe there were some reviews done maybe by Research that looked backwards at construction.

MR. RASMUSSEN: Correct. We wrote some NUREG, I forget the number, that documents a lot of those construction experience issues and we're factoring those into our program. We're also looking at ongoing international experience right now. How to inspect (Microphone hit.) over a couple months, observing the construction there. We're expecting some feedback on that process. We're setting some international dialogues to try to inform us with the issues that are being seen in this new generation of plants.

In terms of the old inspection, we have the inspection procedures as a starting point. Elements of those really aren't appropriate in our process because they were evaluating the adequacy of the design in parallel with inspecting the quality and the construction. So we were able to -- Since the design is agreed upon through the certified design process, we're really more focused on simply the implementation.

PARTICIPANT: I think Tony and I bring to this project a lot of experience under the construction of the 104 plants you talk about. I was assigned with Midland, Zimmerman, Marble Hill. So I have some experience with problems and we looked at --

(Laughter.)

PARTICIPANT: We looked at the issues that came up during those plants to see if our baseline would give us coverage of areas like that and again, one of the things that we learned, I think, over these years from the original 104 was the NRC needs to be reactive in a quicker manner than we were under the Part 50. We need to be able to have assessment that's more effective and quick responding to issues rather than allowing them to fester. And I think this process creates that. We didn't have a real separate assessment process under Part 50.

DR. BANERJEE: How is this -- You know, these plants for construction might be in the next 10/15 years. Who knows when they'll come. Right? There's lot of opinion about that. But how is this knowledge going to be passed on? That's the basic issue that I'm asking about.

PARTICIPANT: Well, we still have the bulletins, the circulars, all the information notices that was generated and I wrote a bulletin in 1982 and we've all been involved in a number of generic issues. Those issues are still available for us to feed to our inspectors to --

DR. BANERJEE: Isn't there sort of a primer that's being generated?

DR. CORRADINI: They're looking for inspectors.

MR. RASMUSSEN: Let me address that. I think one of the things that is underway is -- You've probably been briefed on the Wizard system for the license application review process. Well, we have our SIPMs database and one of the elements that we're evaluating is tying those lessons learned to the specific ITAACs as we identify them and see them applicable through that process. Also an effort that the Region 2 is working on right now is to develop inspection plans for these families of ITAAC and part of that inspection planning process is rolling those lessons learned in so that they can -- When they brief that inspection plan, the inspectors will be aware of those issues.

DR. BANERJEE: Is there some sort of cross reference into this database associated with ITAACs so you can go and look up previous experience, things like that?

MR. RASMUSSEN: Right. That's planned. It doesn't exist yet.

DR. BANERJEE: Planned.

DR. CORRADINI: Other comments?

DR. APOSTOLAKIS: Is the Commission -- Go ahead.

DR. ABDEL-KHALIK: You indicated that there isn't really a difference in the resources required to conduct the inspections using this procedure versus the random process. So what do you mean by the second bullet?

MR. LAURA: What we mean by that is we're going to focus on the most important elements that maybe we might have missed before. So it optimizes our inspection.

DR. ABDEL-KHALIK: That way you're using the same resources.

MR. LAURA: Right.

DR. ARMIJO: You're putting them in the right place.

DR. CORRADINI: You had a question.

DR. ARMIJO: Yes, I had a question and this is probably beyond the scope. Let's say, and I'm going to just focus on this question of welding. What is the level of detail that your inspectors will look at? Will you look at the, let's say, welding procedures that the licensee is going to use before they start welding as well as their inspection procedures to see that all the lessons learned of the past with all the grief we've had with all these problems that those are incorporated into the construction plan? You know, anybody can give you a nice clean radiograph and say that's a nice weld. But if you look at the rework, if you look at whether there was post weld grinding, a bunch of stuff can be done because people have forgotten what caused a lot of the problems we've had in the industry. That's where that level of detail -- You can't see it from here, but I just wanted to get a feeling for it.

MR. RASMUSSEN: And inspection with the welding family, if you will, has both the individual welding processes and in the welding program, one of the inspection that the region will do periodically and there's a number of things that will drive this inspection, change outs of crew, maybe some periodicity, but they will go in and look at the training qualifications of the actual welders, even interview the welders that are doing the work to see if they are, in fact, qualified to do those welds and look at those deeper issues.

I don't know. Mark, do you want to add anything on that? Mark Lesser from Region 2.

MR. LESSER: Is this working? Yes, I'm Mark Lesser, Branch Chief in Region 2 in the Division of Construction Inspection. What we'll be doing is using our inspection procedures which will incorporate a lot of the lessons learned from past construction projects, but it will -- An example like that would look at the welding processes, welding qualifications, welding materials, actually observe welding in progress, review completed packages, observe and review NDE results. So it will span the gambit of welding, what's going on, and it will target certain welds that are dictated by the prioritization process. So we get snapshots by both the resident inspectors and regional inspectors and these are the kind of things that our inspectors are actually planning, starting to look at and delve into the ITAAC to see how that would actually be done.

DR. CORRADINI: Thank you. Other questions?

DR. APOSTOLAKIS: Is the Commission aware of all this? Have you --

MR. RASMUSSEN: The Commission was given

a higher level briefing of this through that SECY paper 07-0047 that prompted us to come here.

DR. CORRADINI: May 16th paper.

MR. RASMUSSEN: Yes, that's the latest time. But in general, I think the level that the Commission would understand it at is we're doing the sampling process that informed by a prioritization.

DR. APOSTOLAKIS: There's an eminent decision on their part?

MR. RASMUSSEN: No. In general, they approved it and --

DR. CORRADINI: We're asked to comment on it per the May 16th letter. But they've already commented and issued what they wanted.

DR. APOSTOLAKIS: Okay. So our letter is not that significant.

DR. CORRADINI: It depends on what you say.

DR. APOSTOLAKIS: Depends on what we say. Okay. I'm happy.

DR. CORRADINI: Mr. Chairman, I'll -- I'm sorry. Dana.

DR. POWERS: One question. Why was the AHP methodology selected?

MR. RASMUSSEN: Scott may be the best

person to answer that.

MR. NEWBERRY: I'll do my best. Scott Newberry. Just a background comment first. I had a team made up of decision making expertise, statisticians, risk assessment, etc., Dana, and the recommendation from my decision maker person was that it was readily available and applicable. He was familiar with other applications and also problems with AHP that I'm not familiar with, but I think it seemed to fit the bill and was easily applied for this process.

And again, there is some misunderstanding. Really, the AHP was solely used for the relative weighting and there's always confusion about that. It was solely used for the relative weights on the attributes. It had nothing to do with the decision.

DR. APOSTOLAKIS: Yes. There was a misrepresentation, I think, earlier when somebody said that this is based on the AHP. That's not true. It's decision analysis. The AHP helps you find pieces of it like the weights. So there are problems that exist in the literature that really don't apply because the ultimate decision is not based on the AHP.

DR. POWERS: I guess I don't quite understand that. If I took the AHP results out of this process, I don't think I end up with the same decision, do I?

DR. APOSTOLAKIS: No, you would because then you would ask your subjects to give weights directly instead of deriving the 0.33 from AHP. So essentially, what happens is you go through the AHP and then they look at them and they say, "Does this make sense?" And the subjects are free to change.

DR. POWERS: I understand that.

DR. APOSTOLAKIS: What?

DR. POWERS: I understand that, but you would come up with a different result if you did not have --

DR. APOSTOLAKIS: I don't think so because they agreed on the 0.33. The 0.33 is really what is derived from the AHP and if the staff disagreed, they wouldn't assign it. So the AHP is just a method of facilitating the process. But its results are subject to a deliberation by the experts in fact. So it's really a small part of the process.

DR. POWERS: Let me ask a different question then. Suppose that I had substituted in a different methodology such as multi-attribute or something like that.

DR. APOSTOLAKIS: Well, that's what it is.

DR. POWERS: Well, it is but it's a little better than a multi-attribute. Would I have gotten a different answer?

DR. APOSTOLAKIS: No. What they are doing is multi-attribute utility theory. That's what they're doing. It's just that the AHP is just a supporting method to get the weights which then are subjected to the evaluation of the staff. So the AHP is really -- It's a misrepresentation to say that this is an AHP-based method. It's not. You could use any method you want to get the weights or even a direct estimate and say "We think safety is 0.4." Then the issue doesn't even arise. But the essence of it is multi-attribute utility theory.

MR. RASMUSSEN: I would also add that our cutoff point of 0.4 for the targeted versus nontargeted and then our sensitivity studies of that selection provides some validity to the fact that if a different methodology was used, it probably wouldn't wildly swing where we ultimately drew that line --

DR. APOSTOLAKIS: I think the problem with AHP is that it was oversold by the original developer as a decision making methodology, ignoring these issues of utility and all that and that's when the decision analysts came back with criticisms. But you have rank reversal and all that. But this is when you use it as a decision making theory which is not being used here.

MR. RASMUSSEN: Right.

MR. LAURA: It's very subtle in the green book. It's an easy --

DR. APOSTOLAKIS: Don't say that it's based on AHP. That's a misrepresentation.

MR. LAURA: Right. And if you look at our slides, we have it correct that the AHP was used just for the weights.

DR. CORRADINI: Mr. Chairman. Thank you very much.

CHAIRMAN SHACK: Thank you very much. Any further comments or questions?

(No response.)

CHAIRMAN SHACK: Time for a break. Be back at 10:35 a.m. Off the record.

(Whereupon, at 10:18 a.m., the above-entitled matter recessed and reconvened at 10:35 a.m. the same day.)

CHAIRMAN SHACK: On the record. We can come back into session. Our next topic is on dissimilar metal welds. As you'll recall, dissimilar metal welds, we have nickel alloy welds that are used to join typically ferritic components with stainless steel components and they're subject to cracking. Industry has had an inspection and mitigation program for these kinds of welds in place, but it was sort of given kind of a boost here by an incident at Wolf Creek where we have circumferential flaws which ups the ante a bit.

And so we have a combined NRC industry program to address this and we're here to hear progress on that today. And I guess, Ted, you and Al are leading off.

MR. SULLIVAN: Right. So I'm going to lead off with a very quick summary of the information that we went over earlier this year. We had meetings with ACRS in February and March and the opening occasion for this project really was the Wolf Creek inspection findings which are listed on this first slide.

We found -- Actually, the utility found five circumferential flaws in the pressurizer nozzle dissimilar metal welds. There was a large one in a relief nozzle. There were three indications found in the surge line nozzle and one in the safety nozzle.

And our concern was that this was the first case where we'd seen more than one indication or flaw in the same weld and they were all circumferential and we'd saw quite a large indication compared to what we'd seen in the past.

We thought we'd put this up. This is maybe a visual summary of the opening remarks that Dr. Shack was making. I think, if you look at the figure on the right, I'd like to talk to that first briefly and indicate that, of course, the darker component there is the low alloy steel nozzle.

It's eventually going to be mated up with a stainless steel piping product. The welding approaches used in the United States have a butter which is shown in, an Alloy 182 butter which is shown in, the color yellow and that's to facilitate the heat treatment of the low alloy steel which has to be done subsequent to welding to restore the fracture toughness of the properties.

So after the butter and heat treatment, a stainless steel safe end is welded on. That is the dissimilar metal or Alloy 82/182 weld that's used to attach the safe end as shown in red and then the component is ready to be shipped to the field for the field welding of the stainless steel product.

In the figure on the left, I just wanted to point out that there's a fill-in weld that is applied over the butter and the weld to the safe end and there's also a thermal sleeve shown in this particular diagram which is common for the surge nozzle welds.

When we took a look at the inspection findings from Wolf Creek, we concluded that we needed to do a fraction mechanic study to try to understand what could possibly happen as a result of these flaws. The reason I'm kind of into mixing between flaw and indication is that the inspection findings turn up indications, but when you do the fraction mechanics evaluations to evaluate integrity, you re-label them as flaws. So I don't mean to be confusing about the terminology I'm using.

These flaws, as I indicated in the earlier presentations this year, were concluded by the license DV most probably attributable to or due to PWSCC. As part of this study, what we were doing was fracture mechanics evaluation using ASME Section 11 approaches and the point of it was to calculate the time for the indications or flaws as they were measured to grow to a size where they would produce leakage and then from there to calculate the time from leakage to rupture and also to calculate leak rates. And in regulatory terms, what we were trying to do was determine whether or not the inspection schedule that the industry was pursuing was adequate and whether or not the leak detection methodology needed to be enhanced in some way. And we showed these results previously, so I won't dwell on them other than to say that for the relief line we saw that most of the cases were leading to rupture and leakage at the same time and even for the safety nozzle, some of the cases were showing the same result.

As a result of all this, as shown here, we concluded that the inspections needed to be accelerated for some plants. What we concluded was that we thought that the inspections should all be done this year, not continuing on into 2008. And we also concluded that we wanted enhanced leakage monitoring frequency and action levels established.

The basic programs that industry uses for leakage monitoring we thought were fine, but we wanted to find frequency and action levels that may have been different from what the utilities would have followed. So we obtained agreements from the licensees to address those two concerns of the staff. We issued confirmatory action letters indicating, you know, what I just discussed and industry proposed that they wanted to undertake some advanced finite element work to try to address our concern and if it could be addressed, if NRC could reach reasonable assurance that the concern was such that the inspection schedules could continue on the original path, then that would be a possible outcome.

So industry has undertaken a program that they're going to start describing in a couple minutes of doing an advanced finite element fraction mechanics analysis. I think one of the main features of it is that the artificial conservatism of a semi-elliptical flow was removed from the analysis methodology and this allows a more realistic progression of the crack growth. And I guess as we've talked about several times, the objective is to determine whether or not it's viable to expect leakage prior to rupture for the nine plants that are effected by or most effected by the CAL.

So I think with that, I'll be glad to answer any introductory questions and otherwise we'll go to the industry.

CHAIRMAN SHACK: Just a question of schedule. When does the decision have to be made whether they will have to accelerate the mitigation or not?

MR. SULLIVAN: I can answer it now or I

can answer it at the very end of the presentation.

CHAIRMAN SHACK: Why don't we go to the very end?

MR. SULLIVAN: Okay.

MR. ARMIJO: I had a quick question on the Chart Number 3, the picture. Now, these are ideal weld geometries. But in reading the material that you sent out, there's been a lot of repair work that was done on some of these welds and you may answer it now or later, if it's in the presentation, but was that -- was a weld cracking, did it correlate with those repairs or not?

MR. CSONTOS: There wasn't a one-to-one match with the repair. There's not enough information in the fabrication records to link up one-to-one to where they're located, the cracks are located to where the repairs were. The industry has a slide or -- not a slide but they have a schematic in one of their first reports that show where the repairs were. What we know is they were roughly in the butter, the cracks, and also the butter was repaired several times on the relief line. I can't remember how many times it was.

MR. ARMIJO: I know, it's very complicated so --

MR. CSONTOS: Nine, eight or nine times.

MR. ARMIJO: So a lot of complicated fabrication which leads to complexities in the analysis and --

MR. CSONTOS: We'll get into that in the second part of the slides and I'm sure the industry will get into that as well. But we did evaluate cases for no repairs and repairs. We've also looked at fabrication records for the nine plants and we'll get into that and to see about repairs and fabrication.

MR. SULLIVAN: I do want to just add, though, it turns out that the more conservative cases are no repairs.

MR. CSONTOS: Yeah, and we'll get into that.

MR. SULLIVAN: And that will be explained.

MR. ARMIJO: So repairing is good.

MR. CSONTOS: For this case.

MR. SULLIVAN: Well, if you're going to get -- if you're going to get crack initiation, the repairs are good because they're much more likely to lead to leakage.

MR. ARMIJO: You mean, it will accelerate the --

MR. SULLIVAN: They tend to drive the

crack through one side of the pipe. Maybe that's one way to say it.

MR. CSONTOS: The weld -- stresses develop from the repairs will drive a crack to grow through wall locally and not globally 360 around. And so in that respect, it's beneficial in this case where we will drive a crack to a leakage with a repair versus growing 360 which we'll show you in the typical fabrication.

MR. SULLIVAN: So that outcome kind of alleviated our concerns that we may not be able to fully grasp all the repairs that were done or may have been done. It works out to be beneficial.

MR. CSONTOS: Of course, the repair, it depends upon how deep the repairs are etc., but that's a nuance that --

DR. MAYNARD: It'S beneficial once a crack is there. It's not beneficial --

MR. SULLIVAN: Right.

MR. ARMIJO: It nucleates cracks. But having done that, it has a --

DR. MAYNARD: Once given if it's a crack, that's an event.

MR. CSONTOS: But again, it depends on the type of repair. I just want to make that caveat.

MR. ARMIJO: Okay.

MR. SULLIVAN: So with that, we'll turn it over to Industry.

MR. SHAHKARAMI: Good morning, Mr. Chairman and Committee Members. We appreciate the opportunity to be here to show you the progress of our analysis that we have undertaken. I'm Amir Shahkarami. I'm a Senior VP for Exelon Nuclear. I have engineering, project management, fuel and other responsibility for the fleet. And I have with me Glenn White who was instrumental and our contractor that helped us with the analysis and updating the finite element software that helped us get where we are today.

The reason I'm here is not that much from the Exelon perspective but we have an organization, industry organization, called PNMP. An underlying committee under that is a Steam Generator and Material Reliability Program that addresses all the material issues with the PWR topics. It's similar to what we used to BWR VIP. This is the mirror image of that and I serve on the Executive Committee of the PNMP as well as MRP and I was selected as the Executive Sponsor for this analysis. And that's the reason I'm here to give you the update. And I'm going to ask Glenn on a few slides to jump in and help me out with that. We believe going through all this analysis the-leak-before-break approach that we have used for centuries remains intact and what we're going to show you is going to support that.

Let me talk about the objective of the plan we put forward. We basically wanted to prove that we do get through-wall leakage prior to the rupture of the pressurizer nozzles. We did a similar valve that Ted talked about. We have nine PWR that their outage right now is scheduled for the spring of 2008 and we've done the PDI mitigation which we were planning to do that during those outages and, just remember that in the fall of 2007, there are numerous plants that have to go through such inspection or mitigation process as well. So we are challenged with the aspect of resources and how are we going to implement that. I'll talk about that later.

Let me get to this slide because I think Ted touched on these things. The semi-elliptical crack shape progression that has been used in the past is extremely conservative when we take that and use an arbitrary crack shape progression. And what it does is rather than uniform ligament tearing up, we see on the right-hand side that you actually collapse that, you either arrest it or you get to the point that gives you much more realistic picture and allows you to have more ligament still intact. So that's the big difference between the two and this was the biggest input into our analysis that we have performed.

As I said, as the Executive Sponsor, we formed a team. We had Dominion Engineering which Glenn is part of it. We had Quest Reliability that had the software, original software developer. We put the panel together and, as you can tell, some of these people, maybe family are with you, very, very experienced individuals and when it got to who's going to be there with a fresh eye, we asked Dr. David Harris who has been away from Alloy 600 topic for awhile, to come back and give us that oversight and make sure that every step of the process has been looked at and challenged.

We also had up-to-date seven NRC public meetings. So as we start having a scope of our work, the detail of the charter, how are we going to go about doing these things, we interacted with NRC staff and I think that has helped really to address some of the issues that we had in the past. But again, I think the technical counterpart on both sides being able to discuss and address the issue was definitely instrumental in where we are today.

So some of the activity that involved our project; first, we had to get the software do the things it wasn't doing before. And that took tremendous amount of energy to update that. And then, we start looking at the crack size calculation to define the end point for the crack growth and that was the picture that I showed you, that, you know, you get to the real progression of the cracking by doing it that way.

And then the individual plant had a different loading. They had different configurations. We had to take those into account. So it was very hard to do just one piece and we bound all nine units at all six locations. So we went to a very specific way of doing it. The leak rate calculation, we used the EPRI software as well as the NRC model that was developed and did a lot of sensitivity metrics of the welding and I'm going to get into the detail of that including the residual stresses that could have been imposed during the installation and the repair.

We also implemented a parametric sensitivity case matrix that we get into detail on that as well and then the validation of the software, you know, updating it and how we're going to validate that, and then continuous input from expert panel that I talked to you earlier.

On evaluation case metrics, the central element of the project is the extensive metrics of base and sensibility cases that were evaluated in order to sketch an initial picture and then fill in the significant details such that meaningful conclusions could be drawn. These micrometers (phonetic) were identified to explore the effects on crack growth, leakage and critical size determination. These are addressed in a bit more detail in the next slides.

Let me just touch on plant specific because we had to go back site-by-site and understand where everybody was at the time we started this. If you look at it, typically this pressurizer have six nozzles. But if you say nine times six gives you the number that is more than what we have here and I'll give you the reason. On the safety and relief nozzles, you had 35 of those and one plant has already -- the design feature only had three of those. So that accounts for one of the ones that I was talking earlier. So we were able to get this 35 and represented by five geometrical configuration.

The spray nozzle, there were eight and the reason is one was PDI in 2005 and we were able to group those in a four geometrical configuration. And the surge nozzle, eight again, and one was already overlaid, well overlaid, and that was represented by two configurations. So we planned a specific nozzle geometry were investigated for each nozzles in the subject population as well as Wolf Creek by review of design drawings. Based on this review, the nozzle were grouped to combine nozzles with sufficient similarity and from a geometric perspective and optimize the number of geometrical configuration that is reflected in our metrics.

Now, I want to talk about plant specific piping loads. I addressed that earlier that they are different and, what we did, we maintained the pressure at 2,235 pounds for the analysis. But there was a range of actual members of stress loading as well as range of bending the stress loading that had to be taken into account.

Crack growth load included dead weight, normal thermal pipe expansion loads in addition to the internal and crack phase pressure. Critical crack sizing calculation also included normal operating thermal loads in addition to internal and crack face pressure and dead weight loads. Basic element in the treatment of finding specific piping loads used to calculate crack growth and critical crack sizes. Cases were analyzed for the range of actual members and bending and stresses for all nine plants.

Now let me touch on residual stresses. Source of input information for welding residual stresses consideration, a noteworthy factor is they are identified as being particularly relevant to the final residual stresses profile. In addition to studying the variation in welding residual stresses distribution, the method of defining a welding residual stresses in the crack growth finite element analysis was also studied.

As you can see here, fabrication, a step that would effect such residual stresses, and I think it goes back to what you had asked earlier in respect to repair, is when you have the fillet weld on the thermal sleeve. That happens at the surge line and then fillet weld for the safety and relief valve and a stainless steel fillet welt to the pipe. Those are the configuration that could induce, as well as when you do the repair, the ideal repair has an impact on that.

MR. ARMIJO: Now, some of those repairs were just welded, you know, chipped out for the defect and rewelded and some had post-weld heat treatment of that local repair, I think.

MR. SHAHKARAMI: Right.

MR. ARMIJO: Now, did you treat all of those in your analysis to see if that combination of non-standard fabrication would lead to something different?

MR. WHITE: Yes, we came up with a series of cases to look at weld repairs. We did some different types of repairs in the welding residual stress simulations and then carried those results forward into the crack growth calculation.

MR. ARMIJO: Okay, so you deliberately looked for the worst case fabrication to see if that somehow could leads --

MR. WHITE: Right. Repair for example, yes.

CHAIRMAN SHACK: Of course, the worst case is kind of a tricky thing here.

MR. ARMIJO: Well, worst case from initial fabrication could it possibly be --

MR. SHAHKARAMI: For the case that was considered.

MR. ARMIJO: Yes. Right.

MR. SHAHKARAMI: So even thermal strain

applied to simulate the residual stress profile or we used the finite element result directly to input in a crack growth model.

DR. ARMIJO: Just let me come back to that for a second, too. On the pipe bending again, I always think the code is giving me conservative calculations of the pipe bending which is conservative for some things, but, in fact, it's non-conservative for this case because it gives me more non-axisymmetry that helps me out.

MR. SHAHKARAMI: Right.

DR. ARMIJO: I assume that you sort of covered that with your range of pipe bending loads.

MR. WHITE: We looked at the full range. For each configuration, we went from zero bending all the way up to the maximum bending reported for any of those welds in that category of the full range.

MR. SHAHKARAMI: Next, the crack growth rate equation. Although the crack growth rate of this material as presented in MRP-115 is generally accepted as the best available information is not without some uncertainty and as part of our uncertainty evaluation, we did consider that. I'm not going to go through the detail, but you know what percentile we used and how we combine it was considered and there was no credit taken for the primary water and stress corrosion cracking growth of *** 11:00:16 threshold.

The initial flaw geometry. Early in our analysis process, the effect of initial flaw shape was investigated to determine what effect this would have on crack growth using the new arbitrary crack shapes analytical capability. These studies determined that the true wall flaw shape is insensitive to the initial flaw shape for a given aspect ratio on depth. This behavior has been confirmed in the final metrics of the cases.

The sensitivity for the initial flaw geometry considered initial depth, initial aspect ratio that is a function of ID and the depth for the uniform depth surface flaw and initial shape factor. Sensitivity case indicate the crack upon true wall penetration is insensitive to initial as I've described earlier. I just wanted to reinforce that. Next.

This is another issue that Mr. Sullivan talked about, the effect of multi-crack initiation that we had at Wolf Creek. This points out that multiple cracks such as those reported for Wolf Creek surge nozzle were considered in this project. Because the presumption of multi-flaw imposes a number of new variable, if one is to explicitly add this to range of possible relative orientation, circumferential spacing, interaction, etc., bonding approaches were applied which incorporated potentially significant conservatism, for example, assuming that initial flaw that is 360 degrees in length.

Enveloping of multiple initial flaw with one model flaw modeling a part depth to 360 flaw and doing multiple individual flaw and then combining on a single weld cross-section for a stability calculation that I'll get into later.

Page 13. Evaluation case metric description. The next two slides summarize the case micrometer category for the final metrics. There were 117 total finite element analysis performed with five cases still being finished in the next week or so. The basic set of 53 cases were evaluated with from one to three different welding residual stresses. So you get 53 plus some variation among those that called for 108 of 117 total analysis. Nine supplemental finite element analysis were performed to address the specific surge line issues.

So if I go through here on a geometry and load base cases, that's case 1 through 20 when we went through to look at axisymmetrical residual stresses with moment load varied to maximum as you asked before, the ideal repair base cases, that's Case 21 to 26 and again, we looked at non-axisymmetrical residual stresses on ID and repaired with respect to what we did finite element model. We also looked at further bending moment sensitivity. That was Case 27 through 30.

We also looked at sensitivity cases in investigate potential uncertainty in an as-built dimension and that was Case 31 to 32. And we get plus or minus 10 percent variation in the weld thickness. Axial membranous load sensitivity cases, that was Case 33 to 34, when we focus on relative narrow ranging membranous load for each geometry. The effect of length over which the thermal strength simulating residual stresses were applied, that was Case 35. Simulation of elastic-plastic, the distribution of a stress in ID, that was Case 36. The effect of initial crack shape and depth, Cases 37 through 41. The effect of a stressing intensity factor dependence on crack growth rate equation, that was 42 to 47 and effect of pressure drop along the leak crack was Case 48. We also took into account a fact of relaxation of normal operating thermal loads for Cases 49 and 51 through 59.

DR. BANERJEE: Can I just ask you a question?

MR. SHAHKARAMI: Yes.

VICE CHAIR BONACA: Each of these cases, how many nodes did you used?

MR. WHITE: We used on the order of 80 to 150 nodes along the crack front. And then for total nodes in the model, I believe 20,000.

DR. BANERJEE: Is this sufficient resolution?

MR. WHITE: Yes, we've done node convergence studies.

DR. BANERJEE: Do you talk about those?

MR. WHITE: Space convergence studies and time convergence studies to --

DR. BANERJEE: That convergence studies?

MR. WHITE: That's right, so we get the same result when we increase the normal density to show that we do have convergence on the finite approximation.

DR. BANERJEE: So each of these runs with 20,000, that's not a very high degree of nodalization.

MR. WHITE: I'm going on memory of --

DR. BANERJEE: It's relatively coarse.

MR. WHITE: We have some pictures of

meshes.

MR. SHAHKARAMI: We're going to show you.

MR. WHITE: There's a good -- let me get back to it.

DR. BANERJEE: All right.

MR. SHAHKARAMI: I think what you mentioned is the element along the crack length.

MR. WHITE: Yes.

MR. SHAHKARAMI: But overall, you're going to see there is much more meshing involved.

The effect of nozzle to safe and crack growth model, there's a standard cylindrical that was 52 to 53. That's where we investigated the effect of the detailed geometry and then in addition to those 53 cases, we had eight supplemental cases specific to the effect of multi-flaw and a limiting surge line and that was specific to that nozzle.

What I'd like to do is maybe turn it over to Glenn to cover the next two pages as far as the calculation for critical crack size and then the leak rate.

MR. WHITE: Yes, thanks. Critical crack size defines the end point of the calculation, of course, and this was a major activity with the expert panel to define appropriate methodology here.

The first step is that we assume the flow strength of properties based on the safe end material. There's work showing if the flaw is located close to the safe end then those strength properties govern the net section collapse. So even though we have results showing the limiting stresses are more towards the butter region, we're assuming safe end strength properties. There is a procedure worked out by Rahman and Wilkowski that's been published on an arbitrary flaw shape solution. So we can, in spreadsheet form, go around and input the crack profile and arbitrary profile all the way around the circumference and calculate the mid-section collapse.

DR. ARMIJO: Could you just go back to that first bullet?

MR. WHITE: Sure, yes.

DR. ARMIJO: The cracks are either in the butter or in the weld to the safe end. Which one is -- where are the cracks?

MR. WHITE: Well, they can be -- hypothetically, they can be at any location, more in the butter, in the middle of the dissimilar metal weld or perhaps, at the end of the dissimilar metal weld that's right adjacent to --

DR. ARMIJO: At the fusion line, or

something like that.

MR. WHITE: At the fusion line.

DR. ARMIJO: For the Wolf Creek, did you have enough resolution to say where the indications were?

MR. WHITE: Yes, they were indicated to be more in the butter region where there would be better strength.

DR. ARMIJO: I don't understand why you use material properties for the safe end and not the material properties for the actual component that's cracking. Can you explain that?

MR. WHITE: Because the safe end has stainless material that's a little bit lower strength than the Alloy 182 nickel weld material and lower strength still than the low alloy steel nozzle, and it just so happens when you have these multiple materials, how the plasticity behaves can be limited by the strength properties and the lower strength adjacent material. So the plastic zone is not just confined in the nickel alloy material.

DR. BANERJEE: Does this mean that you sort of homogenize the properties in the other domain or you use different properties in different regions?

MR. WHITE: Well, this is a spreadsheet

type calculation that is done. There are net section collapse equations that are just assumed that you reach closed stress level stresses, tensile on one side of the plastic hinge and compressive on the other. And so that is just for homogeneous material.

And then the question is, if you have a weld with multiple materials, what is the appropriate effect of strength material to use? And there is test data with full size samples that supports using the roller strength adjacent based on material in the strength.

MEMBER BANERJEE: That is sort of empirically based?

MR. WHITE: Yes, with some finite element work, not done in this project but done by others, showing -- explaining why that behavior is --

MEMBER BANERJEE: Is this work going to be peer-reviewed by an independent group or not?

MR. WHITE: Yes. Well, within the industry --

MEMBER BANERJEE: Outside the industry, are there going to be some academics at all looking at this stuff or is it just industry people peer-reviewing this?

MR. WHITE: Well, as we mentioned, we

brought in one industry person that hasn't been involved in an alternate plan. We have brought in Dr. Ted Anderson, who is a fracture mechanics expert that works mostly in other industries. And we're using him as an independent reviewer as we move along.

MEMBER BANERJEE: A lot of these arguments are very intertwined and technical, I mean, partly empirical, partly finite element. It's sort of a mish-mash of stuff that you're telling us?

MR. WHITE: Yes. We're building on a tremendous amount of work that has been done, piping integrity program work over the last 25 years that's largely been sponsored by NRC and done at Battelle. So there's been a tremendous amount of work that's been done to develop methodologies for looking at failure of --

MEMBER BANERJEE: It would be nice if somebody could take a cold-blooded look at this who has never been involved in this from a university or something where they do this sort of stuff for a living, you know.

CHAIRMAN SHACK: Haven't taken a look at it, then?

MEMBER BANERJEE: Well --

MR. CSONTOS: Can I mention something

here? But on the NRC side, we have Engineering Mechanics Corporation of Columbus as our contractor. This is Al Csontos, staff.

We have another contractor, Battelle Memorial Labs, that will be doing an independent review. They have not been involved in this analysis at all, but they have been well-aware of all of the work that has been going on in this area for the past 10-15 years, 20 years. And they will pull it all together and see whether or not -- they will be an independent review for NRC's evaluation, too.

MEMBER BANERJEE: Anybody who has not been an NRC contractor involved?

MR. CSONTOS: We will be presenting this at international conferences that are specific to this type of evaluation protocols, I mean. That is the only outside academic --

MEMBER BANERJEE: So there won't be a journal article, which would be --

MS. CSONTOS: Yes, there will --

MEMBER BANERJEE: -- peer-reviewed by --

MR. CSONTOS: Yes, there will be. In fact, there is already one going out right now.

MEMBER BANERJEE: Well, we will return to this. Let's carry on.

MR. WHITE: I'll just quickly step through in here, finish up this slide. Then there come some fundamental choices to make in this sort of methodology. One is that we included the full thermal stresses, the thermal piping stresses, in the critical crack size calculation.

So these are secondary type stresses. And there are test data and additional evaluations that were done as part of this project that tend to indicate that these loads would relax as the cracks grow, get a rotation that the crack tends to relieve the display control logs, but we are not taking credit for that in the calculations. We are putting no normal operating thermal loads.

And also, even though there is data that doesn't show evidence that an EPFM failure mechanism is controlling, we are including a Z-factor or approach based on data that has been published, to include the EPFM failure mechanism. So there are some conservatisms there.

And then we take these models, and we apply them on the crack growth profiles that we get from the crack growth calculation and then track the stability over time, how the stability's margin factor is reduced as the cracks grow.

And then, of course, the leak rate calculation is another post processing that we have to do to the crack growth. We're using both PICEP and SQUIRT. PICEP tends to give a little bit of a smaller leak break. So that's conservative from this leak before break point of view.

We're using PWSCC morphology parameters. And we're taking the crack-opening areas of displacements directly from the finite element analysis and applying those into PICEP and SQUIRT, rather than using the COD inside those programs.

MEMBER BANERJEE: So does this PWSCC more forwardly give you some sort of a roughness or what does it do?

MR. WHITE: That's right. It is a surplus roughness and a tortuosity in terms of number of terms per inch.

MEMBER BANERJEE: So if it wasn't PWSCC, what would you do?

MR. WHITE: If it was transgranular fatigue cracking, it would be a much less torturous path. And you would get a higher leak rate for the same size crack.

MEMBER BANERJEE: Is this sort of bounding in terms of --

MR. WHITE: Well, these are best estimate types of codes. We have evaluated. There have been, of course, leak rate experiments done. And we have statistically evaluated that. And there was about a factor of one and a half uncertainty.

And then we're actually applying a factor of four margin factor, as we will see in an additional slide, to make sure we take care of other potential sources of uncertainty.

MEMBER BANERJEE: So these codes take flashing into account and --

MR. WHITE: Correct.

MEMBER BANERJEE: -- the tendencies and all of this stuff?

MR. WHITE: It's a two-phase choke flow, non-equilibrium thermal hydraulic code that's been calibrated against test data. That's how they work.

MEMBER BANERJEE: Is this partially data that Schropp took or whose data is it?

MR. WHITE: Well, a lot of the testing was done at Battelle.

MEMBER BANERJEE: No. I mean the data. Where did the data come from?

MR. WHITE: I believe that the experiments were done at Battelle largely.

MEMBER BANERJEE: Through PWSCC cracks?

MR. WHITE: Well, through IGSCC cracks, but the parameters are slightly different between IGSCC and PWSCC. So we have adjusted them to the PWSCC. They were --

MEMBER ARMIJO: They are both intergranular cracking, right?

MR. WHITE: That's right.

MEMBER ARMIJO: So it's pretty much the same.

CHAIRMAN SHACK: I mean, highly tortuous compared to a fatigue crack.

MR. WHITE: That's right. So the codes have been benchmarked against --

MEMBER ARMIJO: IGSCC.

MR. WHITE: -- the appropriate type of morphology.

MEMBER BANERJEE: Okay.

MR. SHAHKARAMI: Okay. Evaluation criteria. Significant discussion has been devoted to the issue of evaluation criteria. For the purpose of the technical report of this project, we have chosen to apply a more limited set of evaluation criteria against which is the available margin, can be assessed and presented.

Let me just explain this. Maybe to get up and explain it would be easier to do that.

CHAIRMAN SHACK: The microphone is a problem. You have to have a microphone.

MR. SHAHKARAMI: I'm sorry?

CHAIRMAN SHACK: You need a microphone if you are going to get up. Can you do it from sitting somewhere, maybe off to the side a little bit?

MR. SHAHKARAMI: Yes. That may help.

CHAIRMAN SHACK: You might want to sit on the side of the table there so you can look at the screen and still speak into the mike.

MR. SHAHKARAMI: So basically what you see here, .25 gpm Mr. Sullivan talked about are enhanced leak monitoring that we have imposed on all PWR. That's where we feel we can detect maybe even below .25 gpm if you look at the leakage that we have experienced. So what we did, we multiplied that by a factor of four to account for any kind of calculational variance to say it is detectable at one gpm. We feel very confident.

And then this red curve right here is a leak rate. And on horizontal axis, you see the time after the initial through-wall crack in days and the leakage rate in a gpm and then the stability margin on the right vertical axis.

So if we go to where we detect the one gpm and then go seven days after, we feel very comfortable that in seven days, the operation can take the unit to mode 5. And that really probably happens much earlier than that, but we thought that was reasonable.

And if we draw a vertical line from there and look at the inner section of the leak rate with the stability margin with a factor that we use as 1.2, you will see that what it takes from the time you leak to the time that we have concern is a matter of 30 days or so.

I think that we had only 2 cases if I recall that do not meet the 30 days' duration, but, as I told you, this is the area you are probably going to already be in a mode 5 from an operational perspective.

So a big picture of how we set the criteria. Any question about that or --

MEMBER ARMIJO: So you say you believe you can detect it in seven days? Well, let's say .25 gpm.

MR. SHAHKARAMI: We can detect .25 or less, but we use one gpm as a detectable point.

MEMBER ARMIJO: All right. So that means you could detect this one after 30 days. I don't understand what the seven days is after.

MR. SHAHKARAMI: The seven days. Once you get to the one gpm, we feel comfortable that in seven days we would have taken action and take the unit to mode 5.

MEMBER ARMIJO: Okay. And then would, of course, come to a stability margin of 1. something, 1.6.

MR. SHAHKARAMI: Two. 1.2. Is that --

MEMBER ARMIJO: At seven days? It's even better than that, isn't it?

MR. SHAHKARAMI: But this is constant, 1.2 right here.

MEMBER BANERJEE: What is that blue point hanging up in the middle there?

MEMBER ARMIJO: Yes. See, I don't understand that.

MR. SHAHKARAMI: The stability margin?

MEMBER BANERJEE: No, no, no. The --

MEMBER ARMIJO: That is where they cross.

MEMBER POWERS: Where the arrow goes, does this point fall below the stability margin? What's that point?

MR. WHITE: That's the evaluation criteria.

CHAIRMAN SHACK: He is looking at how many days it gets them to 1.2.

MR. WHITE: That's right.

CHAIRMAN SHACK: There to 1.2.

MEMBER ARMIJO: But your actual stability margin after seven days is much higher.

CHAIRMAN SHACK: Is much higher, but the stability margin is going down, down, down.

MEMBER ARMIJO: And you never want to get below 1.2.

MR. SHAHKARAMI: That's right because that's the threshold we establish.

MEMBER ARMIJO: I understand. And you have other curves that say that it doesn't work out that nice if you don't have that much time. Is that right?

MR. WHITE: All except two cases in our matrix show more than 30 days. So this case shows about 45 days.

MEMBER ARMIJO: What is your shortest time?

MR. WHITE: Pardon me?

MEMBER ARMIJO: What case? What is the shortest time?

MR. WHITE: We have one case with 22 days and one case with 11 days. The 11-day case we don't think is not appropriate but assumes a 360-degree flaw. So we looked at additional cases. But the cases they were using to make conclusions start at 22 days and go higher.

MR. SHAHKARAMI: As I said, though, there are still a couple of cases that are being run, but those are not limited. In other words, we prioritize which ones are the most important. And we have already tackled those.

So what is left? We don't anticipate any kind of surprises.

MEMBER ARMIJO: If we put error bars on both of these graphs, what would be the uncertainty in that time period?

MR. WHITE: That's why we are addressing that. We are doing 117 cases. So by looking at many different parameters and doing sensitivities when that gives us a field for the uncertainty.

We also have chosen our sensitivity parameters based on the 5th percentile, 95th percentile values, for example, with the stress intensity factor exponent.

MEMBER BANERJEE: These are sensitivities to input parameters from what I understand, geometry and stuff.

MR. WHITE: Yes.

MEMBER BANERJEE: What about sensitivity to the model itself?

MR. WHITE: We have some of those cases also.

MEMBER BANERJEE: So, you know, with all the assumptions that you have made --

CHAIRMAN SHACK: This is one of those cases where the conservative model gets you into trouble sometimes because, you know, you guys are bounding the multiple cracks with a big crack, which is good, but that ups my leak rate; whereas, if I had a bunch of little cracks, I would be losing area.

My net section would be going down. But I have little short cracks. I wouldn't get nearly as much opening. You know, I suppose I took this crack an split it up into three little cracks. What would it look like?

MR. WHITE: We have done that sort of --

CHAIRMAN SHACK: Okay.

MR. WHITE: -- thing in those cases.

MR. SHAHKARAMI: What we have seen, the majority of these cases that we ran, arrest, you know, that the crack is an arrest.

CHAIRMAN SHACK: That's another problem.

MR. SHAHKARAMI: Right. So I think you are going to touch on that later.

MEMBER MAYNARD: There is a lot of conservatism in the leak rate detection. I mean, it is incredible to think you're not going to find anything until one gpm. I mean, that is going to really --

PARTICIPANT: A whole different --

MEMBER MAYNARD: In seven days to take one of these to cold shutdown is a lifetime.

CHAIRMAN SHACK: Yes. But when I split this sucker up into three cracks, that leak rate is going to drop like a rock. You're going to show me a case where that -- I have looked at three separate cracks, rather than one big long crack. And, you know, I would think I would get a very dramatically different leak rate curve, although the stability margin would look about the same.

MEMBER ARMIJO: So you are saying it would be hard to detect but --

CHAIRMAN SHACK: It would be harder to detect, but the stability would be going down. I mean, it's those little ligaments that are sort of left to cause problems for leak-before-break analyses.

When I put a big crack in there, that sucker opens up, and it leaks when I keep the ligaments in there and I narrow that crack down but I don't gain a whole lot in the stability margin from that.

You have some examples like that. So that is certainly something to be aware of as you go through this analysis, that that bounding crack may not be conservative if you are looking at leak-before-break kind of analyses.

MR. WHITE: We try to take --

CHAIRMAN SHACK: Try to address that.

MR. WHITE: -- solution by looking at a variety of different, starting off with different aspect ratios, a 61 crack, a 21 crack, a 360-degree crack, and then cases where the multiple cracks grew separately and then they combined.

PARTICIPANT: But as to Bill's point, do you have any cases where you have penetrating cracks, multiple penetrating cracks, that haven't combined into a single crack?

PARTICIPANT: No.

PARTICIPANT: Maybe it's something you want to look at.

CHAIRMAN SHACK: I think that's a case to look at.

MR. SHAHKARAMI: I mean like in a surge nuzzle, for example, you penetrate. You are not going to get .25 gpm. You are going to get a couple gpm due to the size and the nature of --

CHAIRMAN SHACK: Yes. Well, I must confess all of my calculations in my head come from steam generator tubes, which are slightly different geometries than you are dealing with here, but I think the problems still remain that you have to be careful about putting multiple cracks together and bouncing them because it is conservative in some sense, but it is not conservative in a leak-before-break sense.

MEMBER MAYNARD: On the leak rate protection, are you only taking credit for what you can measure in the leak rate or does it also take into account other mechanisms available, such as radiation monitors, temperature --

MR. SHAHKARAMI: Definitely, definitely. The letter that was sent out by all the utilities and responded to by NRC touched on almost all of these issues. A lot of times we detected not from the leak.

MEMBER MAYNARD: Right.

CHAIRMAN SHACK: But would you take action without a .25 gpm?

MR. SHAHKARAMI: Definitely. There is a whole systematic output that you go through to evaluate where you are in respect to what you detect, yes.

MEMBER ARMIJO: So typically the tech spec limits for unidentified leaks would fall in the .25 gpm?

MR. SHAHKARAMI: Tech spec is much higher level. Tech spec, technical specification, if I recall correctly, is like two gpm, one gpm.

MEMBER MAYNARD: You have one gpm unidentified, ten gpm identified.

MR. SHAHKARAMI: On the PWR?

MEMBER MAYNARD: PWR.

MR. SHAHKARAMI: Yes, yes. PWR is --

CHAIRMAN SHACK: Unless you've got leaking steam generators, right? Then you drop it.

MR. SHAHKARAMI: Should we move on?

CHAIRMAN SHACK: Yes.

MR. SHAHKARAMI: Okay. Go ahead and cover the three pages of graphical.

MR. WHITE: These are just nine examples of different meshes to show you what they look like in terms of the refinement. We have looked at this explicitly to increase the number of nodes.

The one on the left here is a safety and release nozzle. It's a 360-degree flaw. Then we have that same case growing to a through-wall flaw. And then leaking case 41 happens to be a different safety release nozzle sensitivity case.

We have some surge nozzles here: 19B and 17B. 19B is predicted to arrest or does arrest in a simulation. And case 17B here is the high moment load case for a surge nozzle. And you can see the long 21-to-1 flaw. And that goes through a --

MEMBER ARMIJO: What are the situations that cause, the load conditions that cause, a crack to arrest like your 19B? What happened with that crack, why it stopped growing?

MR. WHITE: Well, the first thing to realize is that for the axial stress if it's axisymmetric, it has to be self-balancing at each circumferential position.

That's very different than the hoop stresses that drive axial cracks. Where that tensile stress is balanced by the base metal, it's upstream and downstream from there.

So you don't have to be -- you can have all tensile stresses for a hoop stress. And, in fact, in practice, we have seen the axial leaking cracks.

We have not seen through-wall leaking circumferential cracks except for the Duane Arnold BWR experience, which had different conditions.

So to the extent the stresses are axisymmetric, they have to be self-balancing, which means they have to become compressive. That doesn't automatically mean arrest. It depends how much you're pulling on the crack in other areas in tensile stress. But if it becomes significant, compressive enough, then you will see arrest. In fact, in about half the cases we have run, we're getting arrest.

Those are more nominal than on the residual stress assumptions. Then we have used more conservative welding residual stress results. So we didn't take credit for the stainless steel weld access to lower the stress. If you don't take credit for that and use that, then we start to get more growth. But in general, we have to tweak the results, our nominal results, in order to make them grow through-wall.

If we look at the Wolf Creek experience, we had three different nozzles. They're all showing cracks about 25 percent through-wall. In fact, they are between 22 percent and 31 percent, a very narrow band for plants of that age to find cracks in that narrow band in different nozzles with different conditions at different piping loads. It seems exceedingly likely that they were all growing very rapidly at the time that they were detected.

And it is consistent with what we are seeing now in our welding residual stress analyses and crack calculations.

MEMBER ARMIJO: So is it your best estimate that the Wolf Creek indications are arrested cracks?

MR. WHITE: If they are, in fact, service-induced degradation, that would be the most likely conclusions. But the stresses became sufficiently compressed up to either greatly slow their growth or to arrest them.

MEMBER ARMIJO: I am looking at the two cases and the deformation of the mesh between these two in case 17.

MR. WHITE: Yes.

MEMBER ARMIJO: Is this a LeGrangian calculation or is it an Eulerian calculation?

MR. WHITE: Of the mesh?

MEMBER ARMIJO: Right.

MR. WHITE: Well, there are different meshing options.

MEMBER ARMIJO: What causes the deformation of the mesher between these two steps?

MR. WHITE: It depends on the type of mesher. So this, the crack in the middle is a surface flaw. And that has one meshing algorithm. And this crack over here is a through-wall crack. So the strategy, there are different routines that are doing the meshing because they are different types of cracks.

CHAIRMAN SHACK: He's thinking that you are getting a distorted mesh is the thing he is doing; whereas, you are really building that in the geometry of the mesh.

MEMBER ARMIJO: So it is an Eulerian mesh? The mesh doesn't deform as you do the calculation?

MR. WHITE: As you do the growth calculation, you update the nodal positions on the crack front and then use that and completely remesh it for the next growth step. So there is no memory of what the mesh looked like from one step to the other.

CHAIRMAN SHACK: It's an Eulerian mesh, you know, step-wise.

MEMBER BANERJEE: It's adjustable.

CHAIRMAN SHACK: It's adjustable mesh.

MEMBER BANERJEE: It's very hard to do

convergence studies with adjustable meshes. You are going to tell us about your convergence studies, right?

MR. WHITE: We have one slide. I don't have other prepared material other than one slide on the time convergence.

MEMBER BANERJEE: So what about nodal convergence? You said you had some nodal convergence?

MR. WHITE: I don't have a slide on that, but yes, we have looked at that. And we have also done comparisons with EMC^2, NRC contractor on stress intensity factor results. And we get exact agreement when we do that.

MEMBER BANERJEE: He used a completely different mesh?

MR. WHITE: Used a completely different mesher and different finite elements, software, and different methodologies. It's completely independent software programs, which gives us very good confidence. And here are some examples of repair cases. So this is another safety underneath nozzle case.

MEMBER POWERS: Could you just take two seconds to explain to me a little bit because it is confusing if you have things like a K(17)(b), which is your label, you have a name for it, and then you have a step.

MR. WHITE: Yes.

MEMBER POWERS: What is the step referring to?

MR. WHITE: So each of these is a time calculation. So we start with an initial flaw. We call that step zero. And then we calculate the stress intensity factors on the crack front, put that through the crack growth rate equation, calculate the crack increment based on a certain time step assumption, and then we have a new crack profile that is larger than at least that one.

MEMBER POWERS: If I look on page 18, I see step 10, it looks decidedly more damaged than step 15. There's something I'm missing.

MR. WHITE: Step 10 after it goes through-wall, we have to reset the program. So, really, we should have labeled that step 15 of the surface wall, and this is step 10 of the complex. So we are just renumbering. We are starting over to renumber once we go through-wall.

MEMBER POWERS: Okay. So your stepping number is absolutely useless to me. It doesn't tell me anything, right?

MR. WHITE: No.

MEMBER POWERS: It's just there to confuse me.

MR. WHITE: Well, we have a draft report that is available that would explain it, yes.

MR. SHAHKARAMI: This step corresponds to what is reflected in the report as well.

MR. WHITE: Right. That is ten steps after it goes through-wall. Okay. So this is the repair case that shows the crack front being driven through-wall.

MEMBER ARMIJO: What page are you on now, 20?

MR. WHITE: We are on 20.

MEMBER ARMIJO: You skipped 19. Is there any reason to --

MR. WHITE: We briefly talked about 19.

MEMBER ARMIJO: There wasn't much you wanted to say about it. Okay.

MR. WHITE: I would just add one more comment. In the middle, you see that there is a thin ligament at the top. When we go through-wall, we assume that any ligament that is less than ten percent deep is instantaneously cracked through. There's locally those sort of ligaments to elastically collapse, even though globally the crack is stable.

So when we punch through from something like the submittal case towards getting a through-wall crack, like on the right, we instantaneously get rid of that ligament. And we see leak rates that can be two and a half, three gallons per minute or more as soon as we break through.

So some number of our cases, these surge nozzle cases, we also pay attention to how high the leak rate is initially. It can be detectable from instantaneously.

And this just shows that example of how you can get a thin ligament.

MEMBER WALLIS: Can you tell me how you increment the calculation? Do you increment C? Is that what you increment? What is the increment as you go from one step to another? It looks as if it's C, delta C.

MR. WHITE: It's every point on the crack front. We calculate the normal direction to the crack front. In fact, we grow each individual point on the crack front.

MEMBER WALLIS: So you increment the normal direction. That's your step size for the steps?

MR. WHITE: Yes.

MEMBER WALLIS: Okay. Because I was puzzled why that was a constant. Then the time is backed out of it somehow?

MR. WHITE: Exactly.

MEMBER WALLIS: Okay. Thank you.

MR. SHAHKARAMI: Let me talk about preliminary results. Again, I am going to reinforce that the draft report was issued already. And I think NRC should have a copy of that and a final report be issued by this month. A lot of these details are in there.

All 103 completed cases in a main sensitivity matrix show either they have been arrested, which was about 59 cases, or the crack leakage and crack stability result satisfied our criteria that are presented earlier. Then that was 44 cases, generally considerable margin beyond seven days that we established.

We also ran several supplemental cases to further investigate potential effect of multiple flaw in a soft assertion. I know that was an issue with the assumption of an initial 360-degree flaw, a conservative approach to address the concern for multiple flaw initiation on growth. I needed to go back and see what we do in a multi or smaller case, which wasn't really Wolf Creek but to take a look at that.

I think you already discussed the surge line and reach back to why we don't think what we have seen is realistic. On the next two pages, we have some examples from Duane Arnold. I don't know if you are interested to go through those or not for the sake of time.

Okay. Go ahead. Cover those two.

MR. WHITE: This is the most significant experience in light water reactors with circumferential cracking. And so we took the information on how the component was fabricated and what residual stress calculations were performed. And then we ran that through our crack growth model.

This just shows the configuration of -- what is different here from the PWRs is the presence of a crevice and, of course, the difference of BWR environment.

This shows the stress profile was calculated in the -- there was a simple, the blue line, and then this is the curve fit that we assumed. And we started off with a crack that was 360 degrees and 30 percent deep. And then we drew that around.

And this shows the simulated profile. And then it has roughly the same appearance as the actual crack profile. It gives us some confidence that this sort of modeling is consistent.

MEMBER WALLIS: Is that the first time you have tried or did you try various things before you agreed?

MR. WHITE: Yes. If you try, there is some uncertainty on what the appropriate initial crack size is. You have a crevice here, which complicates the geometry. The actual cracks are starting in the middle here, but we have to model a planar-type crack. So yes, if you try something that's like only ten percent deep and still in the compressive zone, you are going to get a different result.

So there is this complication where the actual geometry is very 3-D and our model doesn't work that way, assumes planar flaws. So we can't draw too much from this. That is why we are showing all the details here. But since it is the most significant example, we wanted to try to take advantage of special --

MEMBER ARMIJO: If you were to do this calculation for Wolf Creek before the flaw was detected, what would you have gotten?

MR. WHITE: Before? Well, I'm not sure what you mean exactly.

MEMBER ARMIJO: I mean, if you had predicted.

MR. WHITE: We assumed very small initial flaws and then grew them at Wolf Creek.

MEMBER ARMIJO: Whatever information people would have had prior to the point of flaw detection at Wolf Creek, that knowledge base, if you were to apply your model, what would your model tell you?

MR. WHITE: Well, in fact, with our nominal welding residual stress, about 20 to 30 percent deep, we are getting the rest. And that is what the cracks were found to be. So under our axisymmetric assumption, we seem to be getting consistent results from how deep the cracks were found.

Just being able to come up with exactly what was seen depends on what initiated. And that is beyond our ability to do deterministically.

MEMBER ARMIJO: Would your model predict at that particular point a Duane Arnold crack would go unable and rupture?

MR. WHITE: We have not. We should look

at that. I believe those detailed calculations were done previously and I --

MEMBER ARMIJO: Because it actually didn't, right?

MR. WHITE: Right. It's stable.

MEMBER ARMIJO: It's stable. So it didn't rupture. So we didn't have that. And that's a lot of cross-sectional area that is gone. I just wanted to see if you could use that.

MR. WHITE: That's a good point.

MEMBER ARMIJO: Okay.

MR. SHAHKARAMI: Any more on Duane Arnold?

(No response.)

MR. SHAHKARAMI: Okay. Let me --

MEMBER BANERJEE: Any other experiments you have compared it to other than Duane Arnold?

MR. WHITE: Well, there's been a very important study -- it's called MRP-107 -- that the industry sponsored. We made capsules out of alloy-182 weld metal and then pressurized them and looked at stress corrosion crack initiation and growth.

And what was seen is that the flaws tend to grow more through-wall than around than in the lateral direction. And that is consistent with what has been seen in plants for the weld metal specifically. And this is more finger-type crack growth.

So we can't really use that information directly to try to grow fingers in our model, but we think that that generally shows that the modeling is conservative versus real life that shows more growth in the depth direction than in the lateral direction around the circumference.

There aren't a lot of other experiences. The Duane Arnold experience is the most directly relevant experience, but there are other studies that we are using as input.

MR. SHAHKARAMI: All right. Our last slide here is what we can draw from our work that we have done. I am going to just restate a couple of the very important issues.

The new refinement in crack growth model eliminates the need to assume that the crack should remain in a semi-elliptical growth on the basis of a stress intensity factor at the deepest and surface points.

Assumption of semi-elliptical crack should result in a large overestimating of the crack area and, thus, underestimating of the crack stability at the point at which the crack penetrates to the outside surface.

All 51 subject welds are adequately covered by crack growth sensitivity cases that satisfy the evaluation criteria.

A large number of crack growth sensitivity cases showed a stable crack arrest prior to through-wall penetration. The area is consistent with the relatively narrow band of relative depth reported for the four largest wall penetrations that vary from 23 to 31 percent through-wall.

To the extent that the through-wall weld stress profile is axisymmetric, it must be self-balanced -- I think Glenn talked about that -- at the particular circumferential position, meaning that the significant portion of the wall thickness must be in compressive actual weld residual stresses.

Two sensitivity cases show a greatly increased time between a leak rate of one gpm and the load margin factor of 1.2 being rich when it is assumed that the piping thermal constraint loads are relieved upon through-wall penetration. These cases confirm the expectation of large benefit if the piping thermal constraint loads are significantly relaxed once the crack goes through-wall.

Detailed evaluation tends to support this kind of behavior, but such relaxation was conservatively not credited in the base assumption of the critical crack size methodology to develop the study that we undertook.

This really summarized what we wanted to talk about, give update. And, as I said, we continue to work with the staff on any open issue and definitely the couple of items that were brought up today to go back and see how was that included as part of our study or needs to be included.

MEMBER MAYNARD: I don't think the last time we met that all the spring inspections had been done. Have there been any additional inspection findings in taking a look at any of these since Wolf Creek?

MR. SHAHKARAMI: Most of the work done so far has been more mitigating than real inspection. The time that it takes and the technology to go do this is not something that a lot of utilities consider. They would rather do it.

MEMBER MAYNARD: I understand. I am just --

MR. SHAHKARAMI: No.

MEMBER MAYNARD: I am assuming that there have been no more indications identified.

MR. SHAHKARAMI: Not on the pressurizer, no. We have seen them on a CRDM on the head. Those pipings we have taken both samples, analyzed that. We understand what drove those but not in this area.

MR. SULLIVAN: This is Ted Sullivan from the staff.

I don't have a lot of the details, but I am aware of one indication that was found on a surge nozzle at Farley --

MR. SHAHKARAMI: Farley was --

MR. SULLIVAN: -- that had both an axial -- there was an axial flaw found or indication as well as a single circumferential. The circumferential indication was only about ten percent arc length. And I don't remember the depth. I don't think it was very deep.

CHAIRMAN SHACK: I think we have to move on here to maintain the schedule.

MR. CSONTOS: There was one more as well in a European plant, but we can't discuss that at this point. And that was a circ indication.

MR. SHAHKARAMI: But I thought the question was at the level of Wolf Creek, what the finding was or the question was more general because --

MEMBER MAYNARD: It was a little more general. I mean, are we finding any other circumferential cracks in these areas?

MR. SHAHKARAMI: I see. I see.

CHAIRMAN SHACK: Thank you very much for your presentation.

MR. SHAHKARAMI: Thank you.

CHAIRMAN SHACK: A very interesting piece of work.

MR. CSONTOS: All right. Good morning. My name is Al Csontos in the Office of Research. I would like to acknowledge the team here at NRC that worked on this project, Ted Sullivan from NRR. We have Tim Lupold and Simon Sheng from NRR and also our EMC^2 counterparts contractor, Engineering Mechanics Corporation of Columbus, who did the bulk of this on the finite modeling and the development of the model.

You have heard a lot about the program from the industry side. I would just like to talk about what we are doing in our confirmatory program. We developed a corollary program that we used to evaluate review, benchmark, verify the industry's results and the quality of their results.

We are interacting with the industry representatives at DEI, all sorts of the different nine plants' representatives, Areva, et cetera, as we saw at the expert panel meeting that they were talking about. Most of these were; in fact, I think all of them were, public meetings. We have been interacting with them.

We provided a letter back in March to go over some of our concerns with some of the analysis and some of the beginning parts of the methodology. They have responded, the industry has responded, in the presentations at these public meetings. We have reached an agreement on pretty much all major technical issues related to development of this advanced finite element program and also the sensitivity matrix.

I think Glenn was talking about 110 cases or 109 cases they have completed. They have 117 cases that they are looking from this meeting, maybe 118.

So we'll go to the next slide. We have already brought this up. We have independently developed the finite element program, advanced finite element program, to do exactly what Glenn said, evaluate the crack all along the crack front, not just at two points in the crack front, with the case solutions.

We have also developed separate

independent weld residual stress patterns for the various geometries or the fabrication conditions that have developed with these different nozzles that Glenn talked about.

We have also benchmarked -- and I think you mentioned something about this, Bill -- the K solution benchmarking that we had excellent confirmation with industry's results. And these were separate program, separate analysis techniques. And we came up with nearly identical K solutions for arbitrary cracks, complex cracks.

Our weld residual stresses, our benchmarking showed good agreement. And what I mean by that is not actual magnitudes. I am looking at trends.

You saw the trends for the weld residual stresses. And that is what we have good agreement on. Some of the actual magnitudes may be a little bit different, but the trends are in good agreement, which is what we are interested in because we can do sensitivity of those trends in the magnitudes through the analysis.

We have also conducted a review of the fabrication drawings and the records for the nine plants that are scheduled to perform the inspection litigation in 2008. Those nine plants, we reviewed the fabrication because there were certain issues. We had talked about repairs, but what we were concerned with are, what are those typical fabrication processes that could actually create this 360-degree crack.

What we found in the fabrication drawings -- and for certain Westinghouse plants, not all of the Westinghouse plants but for certain Westinghouse plants -- is that they have this backchipping and a 360 ID weld.

Let me go back to slide 3 to show what we are talking about here. What we have here -- I will just use this one on the right. For about four or five days, Westinghouse plants, what is done is that they have these welded up.

And the lands, which are the points where the two materials meet and they put the root pass around --

MR. SULLIVAN: Underneath the red.

MR. CSONTOS: Underneath the red right there. That was backchipped, which basically means they machined out about 10 to 15 percent of that ID and rewelded back in. The reason for that is that they thought that they couldn't pass the inspection criteria for that root pass.

And so that typical fabrication process was a --

MEMBER ARMIJO: It gives you 360 degrees around?

MR. CSONTOS: Yes, right. And it's a 360 all the way around. And that's where in our initial Wolf Creek scoping study we had a 360 ID tensile stress that we had placed into the model and to show we would get this how many cases, 20 out of 24 for the refine, showing no time between leak and the rupture.

And we were criticized for having that 360 weld residual stress in there because it was axisymmetric. It was non-realistic is what we were told. And what we found is that for about a third -- well, half of the cases for these nine plants, that was the case. I mean, they have the typical fabrication process that does this backchipping and reweld.

And for the surge line, there is actually an additional Phillip weld that goes on. So that is even maybe 20 percent. I don't know. Is it 15, 20, 25 percent? Somewhere in that neighborhood of the ID. And that produces 360 tensile ID stresses. And that is what we were concerned with.

The repairs were additionally another

concern on top of that. So that is the fabrication information that we obtained that really drove our concerns. And so that was something that we were interested in with this fabrication review.

Another corollary part to this was that the safe end -- again, let me go back. What we found was that that process produced tensile ID stresses, but placing the safe end weld here actually reduces that tensile stress considerably.

And so some of the results I will show are with and without that weld right there, that stainless weld right there. That reduces the tensile stresses at this 360 ID weld.

MR. RUDLAND: That's depending on the length of the safe end, of course.

MR. CSONTOS: That's right. That's right. There is some sort of attenuation that goes on, however far away it is. For the ones that we were concerned with with the Westinghouse plants, those are the ones that are about two and a half, three inches, I think, --

MR. RUDLAND: Yes, yes.

MR. CSONTOS: -- 2.2, something along those lines. And so in that case, we have run cases with and without --

MR. RUDLAND: It's a local bending on the pipe. Local bending caused the ID stresses to g compressive farther upstream there.

MR. CSONTOS: So that was the fabrication information that we reviewed and confirmed the industry's information on. That drove a lot of our cases. All that information that we just provided, the loads, weld residual stresses, all that was placed into the modeling, as Glenn talked about.

We are also engaged right now in developing a validation of our weld residual stresses. And that validation at this present time is through an EU report that was done on a round robin study to look at weld residual stresses and doing a mockup and doing some neutron diffraction measurements and then comparing those to modeling results.

NRC has had one of our contractors, Battelle, run that. And it's come about similar to what the European Union has shown.

MEMBER ARMIJO: So is that completed, that --

MR. CSONTOS: That part is completed from another contractor. EMC^2 is running a lot of cases right now. And so they are starting that or they have started. You will be getting that soon, right?

MR. RUDLAND: At the end of the month.

MR. CSONTOS: Yes. So we will be getting those results. And I know the industry is working on it as well.

CHAIRMAN SHACK: What is this mockup again? It's a mockup of this weld or it's a butt weld?

MR. CSONTOS: It's a butt weld. And the butt welds are just I think two stainless pipes. And they do a butt weld on it. And that's what they have modeled.

MR. RUDLAND: It's a carbon steel, stainless steel, but it's a stainless steel weld and not an Inconel weld.

MR. CSONTOS: 309, I believe. So that's what the Europeans are using in terms of --

CHAIRMAN SHACK: Where did they do the neutron diffraction measurements?

MR. RUDLAND: Where did they do them?

CHAIRMAN SHACK: Yes. Missouri or --

MR. RUDLAND: I'm not even sure. It's in the report, but I don't remember off the top of my head. They did some deep hole drilling also, I think.

MR. CSONTOS: One case, yes. But for the most part, it's neutron. And we're worried about trends because we can manipulate to our sensitivity case. We can evaluate different magnitudes. So the trends are what we are most concerned with from those analyses.

CHAIRMAN SHACK: Just on that welding residual stress, when you do all of these geometry things, does it really make a difference if you vary things like heat input and yield strength of the weld material? Does that have a big impact in itself?

I mean, I never see those varied or any kind of --

MR. RUDLAND: Well, the yield strength.

CHAIRMAN SHACK: Would.

MR. RUDLAND: Yes. He didn't put, really, is driven by the procedure that you particularly use. You know, a lot of times we are making estimations, axisymmetric estimations of these things. And so we input the E to melt the size bead that we are approximating.

If you are doing a moving arc type of analysis, then yes, that will affect it. The heat strength is going to affect more because the magnitudes are on the order of yield strengths.

MR. CSONTOS: And the number of passes.

MR. RUDLAND: That's right, passes.

MR. CSONTOS: When you finally review the reports that the industry provided and we provided, you will see a difference in how we develop our weld residual stresses modeling it. You'll see more passive with ours.

MR. RUDLAND: We make different assumptions than the industry did on passes and --

MR. CSONTOS: Right. So for all of these cases, when we did the independent finite element development, the code development, as well as the weld residual stresses, you will see there are substantial differences between the two.

So we have broken down the advanced FEA project into two parts: phase 1 and phase 2. Phase 1 is reevaluating the scoping analysis that was done back in November of '06 that Ted discussed earlier.

We did that for the relief line specifically. We didn't want to go through all of the different cases there, same some time. But we went over the relief line. And I'll show some results on that.

Bottom line, we got good agreement with the industry. I'll show you a video here, the results between the two. The difference, what Glenn had mentioned, they had arrest. All right. That was because they had that stainless steel weld that they placed into the weld residual stress analysis.

What I will show is when we don't have that stainless steel weld. And we will show how the crack propagates and grows. With the stainless steel weld, on our analysis, we get the same results as the industry. We get crack arrest. Okay?

And so bottom line from this work was that we get margin out for those cases and the relief line that we showed that we didn't have margin that had been with this new advanced software that changes the assumptions of a semi-elliptical or crack growing to whatever shape it wants.

We also have a phase 2 parametric sensitivity work. That is what Glenn brought up. We --

CHAIRMAN SHACK: So you are starting from the actual Wolf Creek geometries, rather than the industry, which sort of seems to use the nominal geometry. Is that --

MR. CSONTOS: No.

MR. RUDLAND: Both.

CHAIRMAN SHACK: You did both?

MR. RUDLAND: Phase 1 work was the Wolf Creek geometry. And the industry did the same thing.

CHAIRMAN SHACK: Oh, okay.

MR. RUDLAND: Phase 2 is the more generic.

MR. CSONTOS: For the phase 2 portion of it, nozzle geometries, loads, everything is to those nine plants that are remaining for phase 2. Phase 1 is just reevaluating the Wolf Creek-specific information: loading, nozzles, geometries.

CHAIRMAN SHACK: Is anybody growing multiple cracks unlinked?

MR. CSONTOS: We have done that. It's very tentative in terms of a bottom crack. What we have done is we have taken occasions going into the phase 2 portion of this.

But we have taken a pipe or where have -- if I could have my schematic -- and we have a bending moment on it and we have a crack, instead of having it on the top, which is where I think we have with a maximum bending moment, that the industry has placed the crack up here.

We have also run a case where the crack is on the bottom, where it has the least bending moment or are compressive. And what we get is a crack that grows and comes out at about 30 degrees that goes through-wall at 30 degrees.

And so that symmetry plan if you take a

look at that, it's on both sides. So we have two flaws coming out at the top. And that is the only case that we have run so far.

MR. RUDLAND: But the software itself cannot handle independently multiple --

MR. CSONTOS: Cracks.

MR. RUDLAND: -- multiple cracks growing.

MR. CSONTOS: That would be another revision, another advanced advanced FEA code.

So I will come back to the phase 2 in a second. Let me go to the video here. This is a video. Again, this is without the stainless steel weld. This is our results from the phase 1 work comparing the original scoping study, Wolf Creek relief line case, with our advanced FEA software. Why don't you run the scoping study?

This is what we saw with the scoping study. And you can see the crack grows. What we're doing here, we are evaluating the crack at this point and at that point. And the crack grows in a semi-elliptical way. And just at that point, it ruptures before it leaks.

In this case, we are getting the crack to grow along the entire every node that's there to grow wherever the K is growing. And that's basically what the industry is doing as well. We just put all the time steps in that imation.

And you can see here that the crack grows 360 and then the bending moment throws the crack or pushes the crack through-wall at the highest bending moment there and then the crack grows around. So we have a leakage.

This is, again, the case. There was no stainless steel weld there, safe end weld.

MEMBER ARMIJO: So residual stress alone is not sufficient to take it through-wall? It runs out of stress?

MR. RUDLAND: No. And the problem again is because the axial stresses need a balancing thickness. And so there is going to be a point where they go compressive. Because of that, if there are no other loads, it is going to arrest.

MR. CSONTOS: And that is what happens. When you put the stainless steel safe end weld on there, which is a realistic assumption to use, then you get crack arrest. And this crack stops it.

MR. RUDLAND: And you see on the bottom side the crack has arrested basically in the thickness correction. That's because of that, for that reason. But it was driven around circumference on the ID surface by the ID tensile residual stresses.

MR. CSONTOS: Which from that fabrication process, that backchipping and ten percent ID 360 weld, that is what is driving that crack from the weld residual stresses? Those kinds of stresses are driving that crack 360? Okay.

So that was our phase 1 work. And, again, we had agreement with industry on the phase 1. That was done a month or two ago. And the phase 2 work is ongoing still.

The industry has looked at those nine plants. We have developed a list of all of the plant-specific information that is required to run this analysis. Industry is running around 117, maybe 118.

We right now have 20 cases run. We are approximately going to run about 25. So we will probably have another five or maybe more depending on when we see or less, I guess, but we are looking a specific issues. And I will get to those.

Can you go two slides forward? So of those 20 that we have run so far, 4 have been the base cases from the safety relief line, 3 have been from the spray, and 3 from the surge lines.

We have added some modifications to it,

changing the initial crack shape, sizes, different weld residual stresses, locations. And that is where we get the additional ten cases.

We will probably run several more because when we get a case, we find the same issue when we have -- we have a couple of cases showing arrest that confirm the industry's arrest cases. We have focused in on those cases that they have shown substantially less time, those 11 days and 21 days, I believe. And we have focused in on those. And then we have run a sensitivity study within a sensitivity study to see what parameters affect those results.

CHAIRMAN SHACK: But this is basically axisymmetric residual stresses with a bending moment to --

MR. CSONTOS: Right, right.

CHAIRMAN SHACK: -- drive it through the wall.

MR. RUDLAND: And because of the non-axisymmetric residual stresses, we confirmed that there will be leakage with a lot margin.

MR. CSONTOS: Right. That's right. And we are also using industry's weld residual stresses as well as ours.

MR. RUDLAND: But realize that when we

talk about axisymmetric residual stresses for these processes with this backchipping and this fill-in weld, you are going to get axisymmetric residual stresses in the absence of any weld repairs.

MR. CSONTOS: Right, right. So, again, we reserve the right to reevaluate more cases.

MEMBER WALLIS: How well do you know this bending moment?

MR. CSONTOS: Very well, I think. The industry provided it through the different plants. Different plants have --

MEMBER WALLIS: There is evidence? And it has been measured and so on?

MR. RUDLAND: Now, these are --

MR. CSONTOS: Design.

MR. RUDLAND: -- design load.

MR. CSONTOS: Yes.

MR. RUDLAND: These are design.

MR. CSONTOS: We were told --

MEMBER WALLIS: Field test design, right?

(Laughter.)

MR. RUDLAND: That's right.

MR. CSONTOS: Glenn, can you answer that?

MR. RUDLAND: There have been some sensitivity cases done on geometry between design and aspects, but --

MR. WHITE: I think I mentioned before we just take the reported design load as an upper bound and --

MEMBER WALLIS: Is that the way it was actually made?

CHAIRMAN SHACK: Well, I think you could probably assume that the assumption which is an upper bound is a pretty good one. It's a question of how much lower it is when it is providing the non-axisymmetry that you want.

The code was set up to be conservative by making sure you calculated it to be an upper bound. In this case, you want the lower bound bending moment.

MR. CSONTOS: And we held a public meeting on this issue of loading. And we found that the ratio between bending and membrane loading is a big player in whether or not you get through-wall leakage or you get the circumferential crack to grow and possibly grow in leakage to rupture.

So what we have done is we have evaluated those bending-to-membrane ratios and come up with those cases. And we have basically bounded our cases to those cases that we are concerned with.

Ones that have high bending moments, like

Wolf Creek, we are not too concerned with. We see that those cracks would probably go through-wall before it would go to rupture. It's those ones that don't have a high bending moment that the residual stresses will then drive the crack to a 360 and maybe possibly grow it to a potential -- you have to have enough to generate to make the crack grow past that weld.

There's a weld residual stress weld. That is what Glenn was talking about where you have this arrest. So it's a fine line between what you get with arrest to then hit a through-wall crack or to a crack to rupture.

MR. RUDLAND: I think the industry did a good job of bounding that by choosing the moments, the maximum from the design and then the minimums just above the arrest to try to bound that result in both cases.

MR. CSONTOS: So we are running sensitivity cases with all of that information, the design information.

We don't have much time. So the bottom line from this work, the phase 2 work, for the limited cases that we have evaluated at this point, we have evaluated probably a dozen cases yesterday because we just received the report yesterday afternoon. I think it was 5:00 o'clock or 6:00 o'clock.

So we have been evaluating those cases. And for right now, generally we have good agreement with the industry in terms of leakage rates, stability margins, et cetera.

This goes into what we received so far. We received partial results of the 117 cases. I don't remember exactly how many of them, but it was just tables. And that was on Saturday. That's what we used to review some of the cases that we have looked at that we have evaluated from NRC's perspective.

We received the draft report yesterday afternoon. And we will be providing comments in public forums to the report tomorrow as well as next Tuesday. We will have public webcasts and teleconference.

We will provide our comments and also additional cases if we feel that there need to be additional cases run; for example, this flaw on the bottom that we have looked at. And they will provide a report. They are in line to provide a report July 31st to us.

NRC's contractor will have a draft final report on our evaluation on the 31st as well, but we will have updates to that in early August. We will have a public meeting in early August, August 9th, I believe, to wrap this entire project hopefully up at that time. We will prepare, NRC staff will prepare, a safety evaluation or safety assessment by August 31st.

And do you want to mention the last one?

MR. SULLIVAN: Well, we'll be using that. I mean, we haven't reached conclusions yet. We just got the report last night. And we have not really finished all of our analyses, as Al has described, but our plan is to wrap everything up by the end of August and in the safety assessment come to the conclusion that we come to regarding whether there is a reasonable assurance finding that we described earlier in this presentation, starting around 10:30. And we will be issuing that in letters to each of the nine plants.

There is no need to change the CALS one way or the other. The CALS have a commitment that is flexible. And we will be, like I said, making those conclusions in August.

MR. CSONTOS: Okay. So, in summary, we have developed an independent corollary program to evaluate the industry's results. Phase 1 showed good agreement between our results and industry's results. We show margin now for the relief line case that we have evaluated, unlike what we had in the scoping study.

For the limited cases that we evaluated in the phase 2 --

CHAIRMAN SHACK: When you say you have shown margin there, I mean, what were the actual times between detectable leakage and failure?

MR. RUDLAND: For the Wolf Creek case? Oh, boy. It was much longer than 30 days.

CHAIRMAN SHACK: Okay. So it was ample?

MR. RUDLAND: It wasn't days. Yes, it was ample.

MR. CSONTOS: And, again, if we have the more realistic case where we are with the same, we get arrest. And we are reviewing the phase 2 results from the industry, the industry results, the report, and we have not yet reached any conclusions.

MEMBER ARMIJO: You said that there were indications found at Farley?

MR. SULLIVAN: Yes.

MEMBER ARMIJO: Is there any way to use that information to verify your code or your model?

MR. SULLIVAN: I'm not sure how we would

do it.

MEMBER ARMIJO: I mean, assume Farley was one of the plants that was planning to do this next year.

MR. RUDLAND: We would have to take a boat sample to get an actual measurement of the --

CHAIRMAN SHACK: I would sure like to see that.

MR. RUDLAND: And, you know, that kind of stuff probably is not so realistic.

MEMBER ARMIJO: But you don't have that information for the nine plants either.

MR. SULLIVAN: I think one thing that was beneficial for Farley that wasn't done in the Wolf Creek case was that they used a qualified inspection technique to measure the depth of the flaw.

In the Wolf Creek case, they used a -- we talked about this in February, not that I would expect everybody to remember all this stuff, but we have been living it day in/day out since then.

In the Wolf Creek case, they used a manual technique, which was not qualified for depth sizing. It was qualified for detection and length sizing.

In the Farley case, through a sort of complicated chain of events, they used a phased array technique, which is set up on kind of a semi-automatic. It's semi-automatic in the sense that the probes are set up on a track, but they are moved manually. And the data is recorded, which was not done in the Wolf Creek case, which is also why we are a little bit ambiguous when we try to answer questions on exactly where the flaws were relative to the butter of the safe end in the Wolf Creek case.

So there is more data in the sense that we know much better. We believe we understand much better what the length and the depth of the flaw is, but I guess I would say that it's kind of bounded by the analyses that were done here in the sense that we assumed initial flaws about the same size, sizes that I think closely approximated over bounding over farther.

MR. RUDLAND: To truly benchmark these, we need at least two measurements, right? And one measurement is a little difficult to benchmark. The initiation is just difficult to understand, difficult to predict.

MR. CSONTOS: The only place that we could really evaluate the Farley would be in the probabilistic analysis. The industry had not included that into their draft report, but that is coming, I am told.

And that may be a part of their probabilistic or they have taken all of the existing flaws that have been found. And they placed them into a probabilistic analysis to see.

They can go into it in more detail, but it's circumferential indications, how large they were. And they have been running a probabilistic type of analysis to evaluate statistically what the probability is for something like this to happen to those nine plants.

MEMBER BANERJEE: So is the industry model and your model -- the basis of this is you do the stress/strain analysis? But then the crack tip propagation itself, is that model very similar in the two?

MR. RUDLAND: The methodology is the same. It was developed separately, but the methodology of taking the driving force along the crack front, the propagating crack perpendicular to the crack front, is the same.

MR. CSONTOS: That's an established fraction --

MEMBER BANERJEE: And is it the same relationship being used or is it a different relationship?

MR. RUDLAND: I'm not sure what you mean. The growth relationships are the same.

MEMBER BANERJEE: Empirical.

MR. RUDLAND: Yes, yes. The crack growth relationships are the same.

MEMBER BANERJEE: The empirical relationship is the same that you are using.

MR. RUDLAND: Yes, yes. The MRP-115 growth laws are the same.

MR. CSONTOS: Right. That's our best basis of data.

MEMBER WALLIS: When a big pipe like this breaks, is it usually just one crack that grows or as the crack grows and the stresses develop, do other flaws begin to grow? And what is the experience with the breaking of large pipes, that you get multiple flaws growing or do you get --

MR. CSONTOS: I think Bill mentioned it earlier.

MR. RUDLAND: Stress corrosion cracking -- correct me if I am wrong -- is a multiple crack phenomenon.

MEMBER WALLIS: Yes, it would be. Right.

MR. RUDLAND: And so --

MEMBER WALLIS: But you can't model that.

MR. RUDLAND: That's correct.

CHAIRMAN SHACK: Under his retarded growth through the wall, which is his axisymmetric case and his most likely one, you will get multiple initiations, but they will all kind of link up. And so he --

MR. CSONTOS: And that is exactly why we use the 360.

CHAIRMAN SHACK: That's why he uses the 360.

MR. CSONTOS: The 360, ten percent of flaw shape, initial flaw shape, bounds all the multiple cracks because what we say is that with the weld residual stresses --

MEMBER WALLIS: How do you deal with the multiple flaws?

MR. CSONTOS: Right. And you have multiple flaws, but what we found is that the crack shape and the final crack shape were fairly insensitive when we have this weld residual stress pattern that we have developed with the fabrication of this last pass ID 360 weld, that typically, even if you have different shape flaws, it was insensitive at the final stage because they would grow 360 because of the weld residual stresses.

MR. RUDLAND: At leakage, yes.

MR. CSONTOS: Right.

MR. RUDLAND: The flaw shape of that leakage was the same. Whether you started out with a short regular flaw or a 360-degree flaw, you ended up with about the same shape.

CHAIRMAN SHACK: But there's still a question in my mind whether I can get multiple flaws to go through-wall without linking up first and reducing my leakage. I don't think that's the case in this particular one, but if you were looking at a more general kind of situation.

PARTICIPANT: It would be hard to do, Bill.

MR. RUDLAND: Leak at the highest moment, location probably, right, first, whether or not they are going fast enough to link up before that first one leaks --

CHAIRMAN SHACK: Right. That is the question. You know, when you initiate them randomly around the thing, will they -- and, again, it's a balancing thing in the residual stresses. There's a family of residual stresses that will drive them through the wall. There's a family that will arrest them, which is probably the most likely case and then the one that might cause you problems.

MEMBER WALLIS: What's observed when pipes leak before they break? Did they squirt out through one hole or did they ooze out through lots of holes?

MR. SULLIVAN: I think we don't really have that much experience, but the experience that we have would say --

MEMBER WALLIS: We don't have experience.

MR. SULLIVAN: -- it leaks through one --

MR. RUDLAND: If we look at Duane Arnold, which is a 360-degree crack, it was just one location that it leaked out.

MEMBER WALLIS: I am thinking from other industries. I mean, there must be situations where pipes ooze or --

MEMBER ARMIJO: In the BWR thing, they were just single leaks.

MR. SULLIVAN: I think the closest experience we have is stress corrosion cracking in boilers. And, you know, that probably was attacked pretty aggressively. So it didn't go on for years and years before weld overlays and that sort of thing were applied, but from what I know of the data, which isn't that much, I was -- this is all sort of secondhand from the same questioning I have been asking.

But they did see 360-degree ID cracking on the ID for some of the stuff they cut out. And the leakage points were just at one location on the OD.

MR. RUDLAND: I saw a photo of the North Anna head leakage crack that was on the ID of the J-weld. And it had a location where it was actually -- it looked like two cracks that had a small ligament between, between it along the entire length of the crack. In that particular case, it was looking like it was a full crack, but that ligament may have been actually limiting the crack opening displacement.

CHAIRMAN SHACK: But, you know, I did lots of BWR pipe cracks in the good old days. In the four-inch lines, it was typically -- you know, it went through-wall pretty quickly because, again, you had the bad kind of welding. You gave a nice local stress.

And it would just, you know, sort of -- in the bigger pipes, where it was really harder to mistreat the weld so badly, you would get a more axisymmetric situation. So you would get lots of little cracks, but they would tend to arrest as you went through the wall.

MR. RUDLAND: And the BWR is a sensitized region a lot smaller than in the PWRs. And the alloy-182 welds is a lot longer region. So you get more of a probability of getting global cracks.

CHAIRMAN SHACK: Right. You have a much bigger place to kind of put things around.

Any further comments or questions? It was a very good -- you didn't show the --

MR. RUDLAND: No.

CHAIRMAN SHACK: I love that graph. I mean, you know, it looks like you misplotted the data. At least get this agreement. I mean, I couldn't believe that if he did the calculation one day and he did it the next day he wouldn't get agreement that good.

MR. CSONTOS: We had identical agreement, almost identical, for the K verification.

MEMBER BANERJEE: You had better not show that.

PARTICIPANT: Oh, yes. You don't want to show that.

MR. CSONTOS: I actually had it. I actually had it in Rev. 1 of this presentation.

MR. RUDLAND: It was done in different states by different people, different codes.

CHAIRMAN SHACK: Thank you very much. We

are going to recess for lunch. And we are due back at -- 1:15 is close enough. You can have a shorter lunch today.

(Whereupon, a luncheon recess was taken at 12:23 p.m.)

A-F-T-E-R-N-O-O-N S-E-S-S-I-O-N

(1:17 p.m.)

4) ACTIVITIES IN THE SAFEGUARDS AND SECURITY AREAS

CHAIRMAN SHACK: Back into session. Our next topic is "Activities in the Safeguards and Securities Areas." And Mario will be getting us through that.

4.1) REMARKS BY THE SUBCOMMITTEE CHAIRMAN

VICE CHAIRMAN BONACA: Yes. The reason for the update is that there are many activities going on in the securities and safeguards area. They are mostly led by NSIR.

We are only familiar with some of those activities, for a number of reasons; one, first of all, that there be waivers of SCRS reviews. So there are activities that don't come to our review, period.

Also, there has been from the beginning pretty much of a directive from the Commission that we will not get involved in issues to do with design basis threat, also for some issues of the kind.

And, third, of course, this is an area where, you know, need to know is a critical element. So unless we are informed, we just don't know what is going on. So occasionally we get surprised by the sudden request for a review.

And I thought that would be timely now since we haven't met with NSIR in a year or more to have an overview of what has taken place and then a sense of what is coming our way so that we can prepare ourselves, put it down on a schedule literally our review as participation, as leaders.

So, with that, I will turn it over to you, Mario, or to Scott.

4.2) BRIEFING BY AND DISCUSSIONS WITH REPRESENTATIVES OF THE NRC STAFF

MR. MORRIS: Yes. I appreciate that. And we certainly welcome the opportunity to give you --

VICE CHAIRMAN BONACA: Today we don't need any details or anything that would require a special room. I mean, it would be more like an overview of what is going on.

MR. MORRIS: Right. We are prepared to give you a high-level overview of the things that we have done in nuclear power. We are going to restrict the discussion to power plants, I guess, but a lot of these things apply more broadly.

First of all, I am Scott Morris. I am the Deputy Director of the Division of Security Policy in the Office of Nuclear Security and Incident Response. And I have been associated with a lot of these things, all the way back to 2002.

With me is Bonnie Schnitzler. She works in one of the branches that are in my part of our division. And her focus is principally rulemaking now, but certainly she has a lot of experience, both on the regulatory side but also as a former employee of TVA in the security arena with the cognizance of the security of a number of TVA power reactor facilities. So she can give you a fairly unique perspective on what we have done.

Quickly, obviously we have done a whole lot of things in nuclear security since 2001 and particularly since the office was formed in April of 2002. We couldn't possibly hope to get into any real detail in the time that we have allotted.

So what Bonnie is going to do is just walk you through sort of the high-level summary of things that have taken place, the things that are currently on our plate, and things that are going to involve some interaction with the ACRS as we move forward, particularly since some of the security requirements that we have proposed and the regulatory guidance that we're developing to support those requirements touches on safety, touches on plant operations. And so hopefully at the end of this discussion, you will have a better appreciation for what those things are.

And, with that, we will turn it over to Ms. Schnitzler.

MS. SCHNITZLER: Thank you.

As Scott said, I am from the Division of NSIR, Reactor Security Branch. And I am here to provide you an overview of security action since 9/11, kind of focusing on the rulemaking and guidance that has gone on.

I am going to talk to you a little bit today about the actions the agency has taken, talk about the Energy Policy Act and how that has impacted security, look at the objectives that NSIR wants to achieve in rulemaking and the specific rules to accomplish our objectives. I will walk you through the guidance that is in development that supports these rulemakings. And, lastly, we will look at specific rules and guidance where we think we need ACRS review.

Please feel free to ask questions as we go along. If the questions step into a safeguards arena, I will ask to save that until the end. And then if we want to do something in a smaller group at the end, that would be appropriate. Is that okay with everybody? Great.

Okay. The requirements for power reactor security are established in Part 73, Code of Federal Regulations. And at the base of those requirements is the design basis threat, or DBT.

The DBT is basically the largest reasonable threat against which a regulated private security force should be expected to defend under existing law.

This DBT is informed by threat information that the agency receives. It is reviewed periodically. And a report is put forward to the Commission and determination is made whether the DBT stays where it is or moved up or changed, whatever has happened to it.

MEMBER CORRADINI: It is different for all different facilities.

MS. SCHNITZLER: It is different for different types of facilities. Yes, sir.

MR. MORRIS: There are two design basis threats. There is one for power reactors. And that is associated with radiological sabotage. And there is another set of threat characteristics that apply to category 1 fuel cycle facilities. And that is not for radiological sabotage exclusively but also for theft and diversion of the nuclear material. So it's a little bit more of a robust set of threat characteristics.

So there are only two DBTs. The one that Bonnie is talking about is the one that is for radiological sabotage that applies to all power reactor facilities.

MEMBER CORRADINI: And non-power reactors, I assume?

MR. MORRIS: No. Non-power reactors fall under a different set of regulations, 73.16 and 73.67.

MS. SCHNITZLER: Okay. Following 9/11, there were many security actions, but the most important and comprehensive was the issuance of orders. The interim compensatory measures that was the first order that was issued provided immediate security measures for nuclear plants to implement some immediate security actions that were taken.

VICE CHAIRMAN BONACA: That was the B(5)(b)?

MR. MORRIS: That was a piece of it.

MS. SCHNITZLER: That was a portion of it.

MR. MORRIS: That was one small piece of it.

VICE CHAIRMAN BONACA: Please refer to that at some point to get a picture because we have seen some in the back.

MR. MORRIS: B(5)(b) is shorthand for section B(5)(b) of that order.

VICE CHAIRMAN BONACA: Okay.

MEMBER MAYNARD: There were many other things in that order.

MR. MORRIS: Yes.

MS. SCHNITZLER: And because it was safeguarded and classified, they named it the numerical name that it had.

MEMBER MAYNARD: It's the one that caused more interaction between the --

MR. MORRIS: Well, it's a fairly ambiguous requirement in the order. So that led to lots of discussion about what was really intended and what was required to actually satisfy their requirement.

MS. SCHNITZLER: The next issue was over time for security personnel. And that placed scheduling limits on the number of hours officers could work in a workweek or in an ongoing period to try to make sure that there is some oversight.

The order for training and qualifications delineated additional annual training for security officers. And the access authorization order incorporated additional background screening requirements for personnel working at nuclear power plants.

Lastly, the DBT, which we have discussed, was modified to more closely meet the increased terrorist threat. So that is kind of the big picture.

In addition to the orders, there were other actions that were taken. They include issuing security advisories, guidance on security topics, and conducting force-on-force evaluations, to determine successful incorporation of the revised DBT and new security requirements.

The NRC also reached out to other agencies to increase --

MEMBER MAYNARD: Okay. Force-on-force had been going on for some time.

MS. SCHNITZLER: Yes, sir.

MEMBER MAYNARD: The character of that case, and the core incorporated. But that was not a new --

MS. SCHNITZLER: It was not new.

MR. MORRIS: We had operational -- they were called OSREs, operational security readiness exercises. And we did those. Not every plant got one. We only did them every eight years at plants. And that program was terminated prior to 9/11 because there was another effort going on that basically pushed that all off on the licensees themselves, make it a self-assessment.

But then after 9/11, that program got resurrected and made much more sophisticated and robust. And it happens at every facility now every three years. And, in fact, the first three-year cycle ends this December. And so by the end of this year, this calendar year, we will have completed every power reactor site in the country at least once.

MS. SCHNITZLER: In addition, the NRC also reached out to other agencies to increase the flow of information and assistance. That included DHS, Department of Homeland Security; NORAD; and FAA.

MEMBER CORRADINI: Just again, if this delays you, you tell us.

MS. SCHNITZLER: That's all right.

MEMBER CORRADINI: Where is the dividing line between NRC's responsibilities and authority and DHS'?

MR. MORRIS: I'll take that.

MS. SCHNITZLER: Thank you.

MEMBER CORRADINI: Because being at a university, I am very confused.

MR. MORRIS: Yes, I know it's very --

MEMBER CORRADINI: Since we have to deal with chemical agents, biological agents, as well as --

MR. MORRIS: No. It's a terrific question. I mean, we get it all the time anyway. So it's appropriate. The NRC's regulatory authority ends with the design basis threat.

So to the extent that the domestic threat is this big, the design basis threat is some subset of the overall domestic threat present in this country.

And the Commission ultimately determines what part of that overall threat is reasonable for a private enterprise to be able to defend against with high assurance. That is the design basis threat. Everything else, any threat characteristic that exceeds that, is now in the purview, belongs to the government, belongs to the United States as a "enemy in a state" or whatever.

And that is where DHS and FBI and all the other law enforcement agencies are brought to bear. And so the challenge since 9/11 subsequent to the DHS, the Department of Homeland Security, being formed is to figure out how they are going to do that. How do you deal with the gap that exists between what the site is supposed to be dealing with and what the real threat is?

And so we have expended an enormous amount of energy and continue to to interact with our federal partners. And I have listed off a bunch of them: DHS, FBI, DOD, particularly NORAD when we start talking about -- and FAA when we start talking about aircraft.

So that whole integrated response is the focus of one entire branch within our division. And we can go into a lot more detail about that.

MEMBER MAYNARD: If you haven't coordinated with other agencies, you need to because there can be confusion as to who is really in charge of what part if something does go beyond the design basis.

MR. MORRIS: The short answer to the question is a document entitled the "National Infrastructure Protection Plan," which was published by DHS. And that National Infrastructure Protection Plan is sort of the over-arching document with a variety of signatories to it -- and we are one of them -- signed by Nils Diaz right before he left. We are a signatory to that plan.

And then there are 17 subsector-specific plans that have a lot more detail about the how to. And the nuclear sector is one of them. And that is where we appear.

MEMBER APOSTOLAKIS: So for threats smaller than the design basis threat, the other agencies don't get involved or --

MR. MORRIS: They get notified through the National Response Plan and a variety of other means, but it is fundamentally the responsibility of the licensee to deal with that.

MEMBER CORRADINI: If it falls within the scope?

MS. SCHNITZLER: Yes. And the licensee can many times call for assistance and has assistance pre-designated with local law enforcement and other groups as applicable.

MR. MORRIS: That's correct.

MEMBER MAYNARD: If there's any security issue -- and I guarantee you that all of the agencies will be notified to some degree.

MR. MORRIS: That's right. And part of the rulemaking --

MEMBER MAYNARD: It's a matter of who is in charge at --

MEMBER APOSTOLAKIS: Well, who's in charge and whether there are any plans.

MR. MORRIS: That's all defined in those, what called the NIPP, the National Infrastructure Protection Plan, and the Nuclear Sector-specific Plan. We are addressing some of those issues in our rulemaking that we are doing, specifically with reportability and integrator response.

There's a lot of things that touch on that, but I could spend the whole hour just talking about how we do that and are trying to accommodate that more efficiently and effectively.

MS. SCHNITZLER: All of these things that we have been doing since 9/11 have garnered an abundance of information, lessons learned, information we learned through inspection of the orders, evaluations of force-on-force, and through the security frequently-asked-questions process.

Then, in addition to this pile of information we had --

MEMBER WALLIS: I'm sorry. So when you learn lessons, you learn lessons from Iraq?

MR. MORRIS: Those types of issues are generally -- the short answer is yes? That's the short answer. There are a lot of ways that that happens that I won't get into here but yes.

MEMBER WALLIS: So all kinds of force-on-force --

MR. MORRIS: Absolutely. Absolutely.

MS. SCHNITZLER: Yes.

MR. MORRIS: Yes, both in terms of the threat, how you detect the threat, and how you mitigate the threat. I mean, all of those lessons --

MEMBER WALLIS: And what you need to do to respond.

MR. MORRIS: Yes, absolutely.

MS. SCHNITZLER: So in the midst of this, in August of 2005 came the EPA Act signed by President Bush on 8/05. A portion of this act focused on security. And there were several security issues for NRC consideration.

There were specific provisions for the NRC and DHS to interface on the siting of new security plants. That provision resulted in an MOU between the NRC and DHS delineating consultation between the agencies concerning potential vulnerabilities of the location of proposed new facilities to terrorist attack.

So that is one piece of the act that is already in place and that we're working.

MEMBER CORRADINI: So if I could just, if I am allowed to understand, so these provisions are different than the way in which you interfaced with the current plants?

MS. SCHNITZLER: No.

MR. MORRIS: The issue that she spoke to on the MOU, the memorandum of understanding, the Energy Policy Act introduced a new requirement in our licensing process, which basically mandates that we "consult" with the Department on Homeland Security as we review new reactor application but specifically just the siting, not the facility itself. It's the --

MS. SCHNITZLER: Where are you going to put it?

MEMBER CORRADINI: Got it, yes. Okay.

MR. MORRIS: So that MOU is --

MEMBER APOSTOLAKIS: That includes existing sites?

MR. MORRIS: Indeed, yes, which is interesting, but what are you going to do at that point?

MEMBER ARMIJO: Does DHS have an approval or disapproval authority in --

MR. MORRIS: They have a consultation role, the details of which are being ironed out. The devil is in the details. We have a three-page MOU that is very high-level.

What DHS is actually going to do when we hand them an application, saying, "Give us your opinion," frankly, remains to be seen. And we are --

MEMBER WALLIS: Who is responsible for doing the job right?

MR. MORRIS: We are the responsible for the licensing. If they --

MEMBER WALLIS: With consultation.

MR. MORRIS: With consultation with DHS.

MEMBER ARMIJO: The worst thing is to have two people in charge.

MR. MORRIS: The MOU makes that fairly clear.

MEMBER ARMIJO: Is the DBT site-independent?

MR. MORRIS: Absolutely. It only depends on if I am going to build a category 1 fuel cycle facility, I have to use this DBT. If I am going to build a power reactor, I have to use this one. It doesn't matter where it is.

MEMBER ARMIJO: Does it depend on whether it is on the coast --

MR. MORRIS: No.

MEMBER ARMIJO: -- or inland?

MR. MORRIS: No.

MEMBER CORRADINI: But I thought he was

about to ask, then, how does that fit in with the new provision, which makes you consult with them about the site if the DBT is site-independent?

MR. MORRIS: I guess I don't understand the question.

MS. SCHNITZLER: They are side by side.

MEMBER CORRADINI: But, I mean --

MS. SCHNITZLER: The DBT is a separate --

MEMBER CORRADINI: Right.

MS. SCHNITZLER: You know, you need to build your facility and your programs to match the DBT.

MR. MORRIS: Right.

MS. SCHNITZLER: Where you build your site, that is where you get into the consultation with DHS, you know, to give you some information about whether the place that you build it is a good place or has more risk or not.

MR. MORRIS: Right. Let me try it this way.

MEMBER CORRADINI: Okay.

MR. MORRIS: The only requirement, for example, when it comes to siting a power reactor that affects security is in Part 100. And I think it's 100.20(f) if anybody cares. But there is kind of a high-level statement in there that the site has to be such that an adequate security plan can be developed.

MEMBER CORRADINI: Okay.

MR. MORRIS: That's it. So the question is, what does that mean? And so we have to establish our own guidance as to what that means. Now the question is, well, what additional information or consultation can DHS provide to make that a better product?

MEMBER CORRADINI: Thank you.

MEMBER MAYNARD: For the existing plants, though, you may have different security. It may require different security response depending on your site. Maybe it would be the same DBT, but depending on where your site is and the site characteristics, one security plan doesn't fit all.

MEMBER CORRADINI: Oh, absolutely not. They are all different. Every single one is different.

MS. SCHNITZLER: You're right. The physical footprint of your plant, in addition to what you have immediately around you, will impact your program.

MR. MORRIS: There's no two security plans in this country that are -- I shouldn't say "plans."

The protective strategies are different everywhere within --

MS. SCHNITZLER: And specific to the site.

MR. MORRIS: Right, absolutely.

MS. SCHNITZLER: Okay? So the Energy Policy Act also said, you know, we need to consider some other things. It said you should consider the events of 9/11; that you should assess a range of threats and multiple methods of implementation, you know not box the threat in quite so much; ensure sites adequately planned for protection of public health and safety.

MEMBER WALLIS: That's quite different from force-on-force. I mean, the operators have to know what to do. A lot of people have to know what to do in the event of an attack, not just a security matter. It's a safety matter.

MR. MORRIS: Absolutely.

MS. SCHNITZLER: Right. And that's an excellent segue into how we are making some of those pieces match up.

And then the sites should consider the potential for fires of long duration, which you have heard, and then to expand the weapons capability of licensees and go forward with that.

MR. MORRIS: Just quickly to address the point that you made, you are absolutely right. The emergency preparedness folks are actively engaged in a lot of this. In fact, we are modifying our -- we are looking at some modifications to our exercise program, to include security elements and how the operators in those response organizations would deal with those sorts of events.

We are also looking at imminent attack procedures whereby the operators would become alerted to something and how they interact with the surrounding community, et cetera.

So there are a lot of other things that are happening that we are not specifically addressing in this presentation.

MS. SCHNITZLER: Right, but we are at this point proceeding towards rulemaking that had many objectives that we needed to accomplish and roll in.

VICE CHAIRMAN BONACA: Let me ask you about that, though. The previous slides were headed by "Energy Policy Act."

MS. SCHNITZLER: Right.

VICE CHAIRMAN BONACA: Now you are moving into security rulemaking, --

MS. SCHNITZLER: Right.

VICE CHAIRMAN BONACA: -- which is going to be --

MS. SCHNITZLER: -- which the items from the Energy Policy Act plus the other things we learned from implementation of our orders were put into objectives that we wanted to achieve --

MR. MORRIS: Through rulemaking.

MS. SCHNITZLER: -- through rulemaking.

VICE CHAIRMAN BONACA: Okay. So you have a rulemaking underway.

MS. SCHNITZLER: Yes.

MR. MORRIS: Yes. We have actually completed the design basis threat rulemaking. That was published as a final rule in April of this year. And then we have got a much more significant in my view rulemaking underway, which basically revises the entire set of power reactor security requirements, 73.55, and amends all the access authorization requirements in 73.56. And it takes on three of the appendices to Part 73 dealing with contingency response, training, qualification, reporting.

And then it further adds a new requirement that was granted to us under the Energy Policy Act that Bonnie didn't mention, which enables the NRC to preempt the authority of state law and enable the licensing of automatic weapons at facilities, which we have never previously been able to do.

VICE CHAIRMAN BONACA: Okay.

MS. SCHNITZLER: Okay. So we have a whole laundry list of things we want to include in our rulemaking. Now, we will make the orders that we have issued already generically applicable; incorporate the items from the EPA Act; add requirements based on the insights of prior actions; address security for MO_x fuel; and review and revise notification to the NRC for security events, and then address petition for rulemaking, PRM 50-80, requesting regulation that would ensure security/safety interface remains intact; and another petition for rulemaking requesting officers be placed at entrances to nuclear plants.

MEMBER APOSTOLAKIS: I guess I don't quite understand what it means to ensure a security/safety interface.

MR. MORRIS: Yes. Let me take it out of the abstract and give you a real-life example. We saw through the implementation of the requirements that we issued by orders cases where the security organization would erect some barrier or construct some thing to enhance security, but it actually had an adverse effect on safety.

And, again, to take that out of the abstract, fire hydrants that were placed around the facility, you know, fencing or barriers would be placed so now if there was a fire, the four firemen couldn't get to the hydrant anymore. That's the type of thing we're trying to deal with.

And so we actually approved that petition because it's a good idea. And so, of course, you know, how you build the specific guidance to deal with that is part of the ongoing discussion.

And we have seen it the other way, too, where security isn't notified of some operational thing that is going on and that would necessarily affect the protective strategy at that facility. That didn't know. So, in other words, we're trying to make the right hand talk to the left hand through this rule.

MEMBER POWERS: I will comment that we had a very similar situation at Rocky Flats, where the security organization change shut the exit doors for responding to a criticality of our --

MR. MORRIS: It's a problem. It's a problem. And so we're trying to get them to sit down across the table from each other and talk to each other about what they are doing.

MEMBER POWERS: Can I ask how you see the security of MO_x fuel being different from low enrichment uranium fuel?

MR. MORRIS: Yes. Well, mixed oxide, in fact, we have actually completed a licensing action you may or may not be aware of at Catawba, in which they are actually burning MO_x fuel.

And so we actually altered some of the security requirements that were applicable at that site when the fuel was on site but not in the reactor or I guess it was in the fuel pit because it's category 1. And category 1 requires a different DBT if you look at our regulations.

So during that period of time when the fuel was delivered on site but before it got put in the new fuel pit or in the reactor, there are some extra security provisions that deal with that.

MEMBER POWERS: So your concern is with the isotopic fraction in the fuel?

MR. MORRIS: Right.

MEMBER POWERS: So would that same concern exist if we made MO_x out of a reactor-grade plutonium?

MR. MORRIS: Yes, absolutely.

MEMBER POWERS: It would exist?

MR. MORRIS: I believe so. Category 1 is

--

MEMBER POWERS: Yes, it's Category 1.

MR. MORRIS: Yes.

MEMBER POWERS: Yes.

MEMBER ARMIJO: Regardless of the isotopic composition?

MR. MORRIS: Right. If it meets the Category 1, that's the way we have been dealing with it. You know, of course, you get into arguments about, yes, but it is too hard to reprocess. And we have had all of those arguments, but --

MEMBER POWERS: It's easy to reprocess. It's hard to make it detonate --

MR. MORRIS: Well, yes.

MEMBER POWERS: -- but not impossible.

MR. MORRIS: But then it comes into reasonableness and what does high assurance mean. You know, one thing you may or may not appreciate, in safety space, the regulatory standard is reasonable assurance, but in security space, the regulatory standard is high assurance. But it is still subjective. I mean, what does high assurance really mean?

And so those are the issues that we struggle with in licensing.

MS. SCHNITZLER: So here we were, all of this data, all of this information, and rulemaking on the horizon. And how did we split it up and start working on it?

The first rule that we worked on was 73.1, design basis threat. We modified the performance requirements that security programs are based on. It includes or addresses many provisions of the EPAct, including some of the key changes that are listed here.

It was published in March of this year and supplemented with two regulatory guides.

MR. MORRIS: The biggest change was the addition of the cyber attack, which we never had explicitly enumerated in the threat characteristics.

MEMBER APOSTOLAKIS: Did we cite attacks before?

MR. MORRIS: Yes.

MS. SCHNITZLER: The next one is Part 73, "Power Reactor Rulemaking." This basically touches all the regulations regarding security at power reactors. 73.55 is pretty much the heart of this project and deals with basic requirements and day-to-day security.

Included in the revision of 73.55 are

requirements for cyber security. And that applies to many computer systems in the plant, not just security computers.

MR. MORRIS: That is an important point --

MS. SCHNITZLER: Right.

MR. MORRIS: -- I just want to spend 20 seconds on. Not only did we change the design basis threat rule to include a threat from the cyber realm, but we have also added a fairly significant section in the physical security requirements, the section of Part 73 that deals with "Okay. Now that we recognize that the threat is there, what programs, processes, et cetera, do you need in place to deal with that?"

And so what Bonnie is saying here is that the systems that are within the scope of those requirements are not just security systems. They are safety systems, security system, and any system that is needed for emergency response.

MEMBER CORRADINI: So I have a generic question that I guess we are not supposed to know about, but it is just curiosity. So on all of these things, are these risk-based? How do you determine which one do you do and which one do you don't do? Based on a risk calculation?

MR. MORRIS: It's an interesting question.

The design basis threat is nothing --

MEMBER CORRADINI: In our land were risk-informed.

MS. SCHNITZLER: Right.

MR. MORRIS: Sure. The design basis threat itself is risk-informed. It is actually not risk-informed. It is threat-informed. But it is nothing more than a set of adversary characteristics. It doesn't tell you how to deal with it. It just says, "Deal with it."

Then you go to these things that are on page 11. And this is more of the how you deal with it. You have to have vehicle barriers. You have to have intruder detection systems. You have to have a central alarm station. You have to have a secondary alarm station. You have to have access authorization requirements.

MEMBER CORRADINI: But in terms of quality, this is more like the way safety was done 30, 40 years, where there is a laundry list of stuff that there is the thing you worry about and there is a laundry list of stuff to make sure you worry about it but there is no risk calculation if this stuff is better than that stuff, better than --

MR. MORRIS: That's true. That's true.

MEMBER CORRADINI: Okay.

MR. MORRIS: Now, that being said, we have done a lot to try to make this a performance-based rule so that we allow a fairly wide open means for licensees to implement these.

MS. SCHNITZLER: Right, right.

MR. MORRIS: We say you have to have a vehicle barrier system, but we don't say it has to be made of concrete or it has to be made of steel or that it has to be painted red. I mean, it is a performance-based requirement.

MR. WHITE: How do you do it for performance-based cyber? Do you just do it on the basis of prevention? Do you just prevent access to outside world into your -- do you have mitigation and response and all of that kind of stuff?

MR. MORRIS: I would love to have that conversation with you. That is an excellent question because we have this requirement, and we have been working very closely with the industry. And they have stood up a cyber security task force.

We have worked with national labs to generate two new regs that deal with that issue. They have adopted, the industry has adopted, those NUREGs and built an entire cyber security program management guideline around those that uses risk insights, that uses -- it's a very systematic self-assessment of all of the digital assets on your site prioritized by risk and other metrics. And then you build your protective strategy based on that information.

It's a long conversation, but it's pertinent because it's an ongoing dialogue that we're having right now. And it's not easy. It's not an easy issue. And this is huge for new reactors because all of these brand newfangled digital systems are being --

MEMBER MAYNARD: Yes. For the existing plants, this is one of the times when you're glad that you're making high in the technology.

MR. MORRIS: Yes. I'm almost too embarrassed to admit that, but it's true.

MS. SCHNITZLER: Okay. Appendix B on this list revises and updates the training and qualifications of security officers. And I want to point out appendix C, which details the requirements for security contingency plans.

In addition to security actions during security events, the contingency plan includes requirements for an integrated response plan, which details the procedures and plans and strategies to maintain or restore core cooling capabilities, containment, and spent fuel pool cooling capabilities, using existing or readily available resources that can be implemented with loss of large areas of the plant due to explosion or fire, kind of a bit mouth but --

MR. MORRIS: That's B(5)(b). That's what that is.

MS. SCHNITZLER: And that's basically B(5)(b).

MR. MORRIS: Now, it is worth pointing out here that most of that stuff, 95 percent of that, if not more, is operational. It's what do the operators do, what do the first responders, not security. The event already happened. Now it's what do you do about it to keep the core cool and shutdown and all of that.

So we are actually considering internally extracting that requirement from the security regulations and moving it to a more appropriate in my view location in Part 50, but that's an ongoing internal discussion.

MS. SCHNITZLER: But I wanted to make sure you knew that that was in that part.

VICE CHAIRMAN BONACA: Appreciate it because --

MS. SCHNITZLER: Right.

VICE CHAIRMAN BONACA: -- in the line, that is what it is.

MS. SCHNITZLER: 73.56 generically applies to the access authorization order, updates the rule language, and complements the changes in 55.

73.71 enhances the reporting requirements to the NRC for security issues.

And then the last two are two new ones. 73.18 and .19 are new regulations on the use of enhanced weapons, as Scott discussed. It expands the weapons capability for licensees in protection of their facilities.

It's currently proposed to be applicable to nuclear plants and to category 1 facilities and is part of the EPAct. The last part is 73.58, which we have discussed a little bit, too, new regulation that assures the security/safety interface at nuclear plants.

Next is in new reactors. We also initiated a rulemaking to require consideration of security requirements in the design stage for new reactors. This was proposed to the Commission as 73.62, "Security Assessment Requirements for Nuclear Power Reactor Designs" in September of '06.

In April of this year, the Commission

disapproved the proposed rule and directed the staff to place some aspects of that into a rulemaking for Part 52. They also requested that guidance for the new reactors proceed, and that is being done.

MEMBER APOSTOLAKIS: Did they say why?

MR. MORRIS: Yes. I can give a little more background on that. Basically what occurred is that as early as 2003-2004, the staff was writing papers to the Commission about, gee, it looks like new reactors might come back. And we said, "Well, gee, wouldn't it make sense to update the advanced reactor policy statement to include an expectation that securities measures be considered at the design stage?"

Because, I mean, right now the way you can look at security is it is an add-on. You build a reactor. You make sure it is safe, et cetera. And then you put a layer of guys with guns around it.

What we are saying is, why don't you make the thing hard to begin with? And then you don't need as many guys with guns. You make the things inherently more robust for security purposes.

VICE CHAIRMAN BONACA: You know, we supported that.

MR. MORRIS: The Commission agreed with

that. We wrote a paper. And they said, "Agree with that. Go ahead. Update the policy statement to include that thought. And, oh, by the way, generate a proposed rule."

So we did that, which we delivered in '06. And then, for a variety of reasons, it got disapproved; in part, because the Commission felt that some of the things that were being proposed in here would already be addressed by new reactor applicants because of all of the work that we had done in the DBT rule and these other rulemakings that we are talking about.

But one part that clearly fell outside of that was airplanes. And so they said, "Okay. You're right. We need to keep that piece." But they said, "Rather than make that a 73 rule, let's make that a Part 52 rule because we are really focused on new reactors. We want those new reactors to explicitly consider aircraft impact in their designs."

And so that is what happened.

MEMBER APOSTOLAKIS: And this is now proceeding? Is that the one --

MR. MORRIS: That is ongoing. That is actually a rulemaking being conducted by the Office of New Reactors and --

MEMBER WALLIS: All of these are external threats. How about the sophisticated insider who is cyber-knowledgeable? That is the kind of thing that might be more --

MR. MORRIS: Yes. We can have that discussion, I mean, but the design basis threat includes an insider.

MEMBER WALLIS: You can design the place so it is less easy for some guy to screw it up from inside, I would hope.

MR. MORRIS: An insider is a bad thing, absolutely, particularly an active insider. And so one of the ways that the agency has dealt with that -- first of all, it is an element of a design basis threat. So licensees have to have the means to deal with it.

MS. SCHNITZLER: And there are multiple programs and layers --

MR. MORRIS: Right.

MS. SCHNITZLER: -- that try to prevent that from occurring.

MEMBER WALLIS: Recognizing it is happening.

MS. SCHNITZLER: Right.

MR. MORRIS: Yes. That's very much an

active dialogue. And it's actually very much a piece of the proposed rulemaking we are doing. There is an insider mitigation program at all of these facilities, the elements of which include additional physical measures but also additional behavioral observation requirements, access authorization.

There are a variety of things that are done to try to -- but it is still a real concern. And we are trying to deal with that in the cyber security part of the rulemaking and guidance as well. But, again, we're --

MEMBER MAYNARD: I do think that is an important aspect that needs to be dealt with. I think at some point, though, we have to say, "When are we starting to get diminishing returns?" because I don't care what you do, what you put in place, I can always then come up with a new thing to consider.

And, you know, at some point we may need to make sure that we are still focusing on operating the power plant and taking care of what's --

MR. MORRIS: I have heard that argument many times, many times. And I don't disagree with it. So the question is, what is enough to demonstrate high assurance?

MEMBER MAYNARD: So I guess that gets back to --

VICE CHAIRMAN BONACA: That is a long time for requirements. I mean, we are talking about 20-25 years requirements that you cannot disable the plant to bring it from one location. There is no individual location from which an individual can disable the plant. And there is a possibility that an individual by himself can do that.

MR. MORRIS: And particularly when it comes to cyber, a lot of the redundancy and diversity requirements that are the general design criteria in part 50 actually help further that goal. But in the digital world, I mean, I also serve on the Digital I&C Steering Committee, which -- I don't know if you -- if we haven't met with you, we are going to soon.

In fact, we have a Commission meeting next week, where this is one of the topics that we are trying to iron out because some of these vendors are putting everything into one box. You can't trace wires. It's not analog. It's not relays. It's software.

MS. SCHNITZLER: Right. As you can imagine, all of this rulemaking, you know, promulgated a prolific amount of regulatory guidance. And so this is a list of the regulatory guidance under development that will be published at the end of this year in draft form. And it goes with the power reactor rulemaking.

MEMBER APOSTOLAKIS: Mario, are we reviewing those?

VICE CHAIRMAN BONACA: We are going to talk to the ones that we --

MR. MORRIS: There's a few of them that we are going to ask you to take a look at.

MS. SCHNITZLER: And the special note --

MR. MORRIS: You can always defer. You can always decline.

MEMBER APOSTOLAKIS: I know.

MS. SCHNITZLER: Yes.

MEMBER APOSTOLAKIS: But our Chairman here doesn't let us do it.

VICE CHAIRMAN BONACA: One we are already involved in is guidance for the --

MS. SCHNITZLER: Right. And there's a couple of them on here. You know, one is the contingency planning guidance.

MEMBER APOSTOLAKIS: I would like to see that one.

MS. SCHNITZLER: That would be one, the portion of it that has to do with large area fires, the guidance for cyber security addressing the requirements of 73.55(m). Those are two here that need your review and the guide for safety/security interface.

MR. MORRIS: Which was just published or is about to be published in draft form?

MS. SCHNITZLER: It is just about to be published.

MEMBER ARMIJO: Some of these guides; for example, the weapons, will that be open to the public?

MS. SCHNITZLER: Yes. We are really focusing as much as we can on making our guidance publicly available. The first two guides that are published in July are the safety/security interface and guidance on reportability. They are publicly available. And we are very closely looking at the other guidance to make sure we have interaction to the fullest extent that we can.

MR. MORRIS: Physical security probably won't be. A couple of these probably won't be.

MEMBER ARMIJO: This is the kind of information useful to somebody.

MS. SCHNITZLER: Right.

MR. MORRIS: Exactly.

MEMBER ARMIJO: I mean, why --

MR. MORRIS: Obviously if it is safeguards, it is not going to be out there. And there are other things that we look at. But we have also received an SRM from the Commission when they have approved this proposed rule to not only produce reg guides that are safeguards but also produce publicly available reg guides.

So I don't know whether that -- to date, I don't know whether that means I as supposed to redact them all and issue redacted versions or what. And so that is part of my struggle, but it is not my immediate struggle. I've got plenty of those. That is not one of them.

The point is the Commission is sensitive to the idea that we have hidden behind the curtain for a long time and appropriately so. But to the extent we can begin to engage and share in an open forum, particularly since this is rulemaking, you know, we need to do that.

MEMBER APOSTOLAKIS: Are the rules public?

MR. MORRIS: Absolutely, --

MS. SCHNITZLER: Yes.

MR. MORRIS: -- although the industry argued very hard to not make them public.

MEMBER ARMIJO: What was their logic?

MR. MORRIS: Well, their logic is the industry -- I mean, I don't want to put words in their mouth, but a paraphrase of it is the idea was they're looking for you probably heard regulatory stability. You've probably heard that before.

And security is an area where they feel quite vulnerable with respect to regulatory stability because threats change and technologies change and a lot of things are going on in the world.

So in order to have achieved the maximum degree of regulatory stability, they offered that the NRC should avail itself of the provisions in the Atomic Energy Act to conduct secret rulemakings, which would mean we would have to devise a whole out-of-the-public-eye rulemaking process, which we currently don't have but we are able to have by the statute but then to build that process and then codify all of these security requirements in rules because if we did that, it's a lot harder for the staff to change it.

MS. SCHNITZLER: It's written at a more specific level.

MR. MORRIS: Right. I mean, what Bonnie didn't tell you was, but maybe it was implicit, is that there is a fair amount of ambiguity in some of these regulations. Why? Exactly for the very thing that you just said, because if you say you have to have this, you have to have that, and it has to be this color and this thickness, you are just basically giving the bad guy a road map to how to beat you.

So there is a fair amount of ambiguity in the rule. The details are captured in the orders that we issued and in these safeguards reg guides. Well, --

MS. SCHNITZLER: There is it.

MR. MORRIS: The industry argues if the guides are where the real requirements are, well, you guys can change those. I mean, that doesn't require any -- but if it's in a rule, that's a lot harder for you to change those. That's true.

MEMBER MAYNARD: Yes. But, really, is that such a bad thing? I mean, again, you need to have some flexibility to be able to do some things.

MS. SCHNITZLER: I think so, too.

MEMBER MAYNARD: But also if you make it too flexible, you really are moving things around. It needs to be before changes are made that there is more consideration given than just "Gosh. You know, I think things are a little different."

MR. MORRIS: And you can imagine we have

a lot of spirited discussions with the industry over just this and with our Commission and with other senior management and other federal stakeholders, quite frankly.

And I do believe that ultimately we come out in the right place. We don't just willy-nilly issue it.

MS. SCHNITZLER: I think we are in a good spot. I think we have enough specificity in the rule to lay out the expectation but to give the site enough flexibility for their physical footprint or for their different budgeting venues to look at alternatives. So I am pretty comfortable we are in a fairly good middle of the road area with --

MEMBER MAYNARD: I think we need to maintain that balance.

MS. SCHNITZLER: Yes.

MEMBER MAYNARD: I don't think we should go either way too far.

MS. SCHNITZLER: This is a list of additional regulatory guidance that we are reviewing. I would only point out the last two reg guides. They are --

MR. MORRIS: NUREGs.

MS. SCHNITZLER: NUREGs. I'm sorry. And

they are guidance in support of new reactors. And I suspect that we may be asking you to review that also.

MR. MORRIS: The last one is of particular interest because it is basically a -- it's a menu is what it is. It's things you can do with the design of a new facility that improves its resilience or robustness if that's a word against a threat.

MS. SCHNITZLER: It improves the security posture.

MR. MORRIS: For example, it shows you all these technologies that are out there and construction techniques, et cetera, that make the facility more robust from a security posture standpoint.

MEMBER POWERS: Do you address underground studies?

MR. MORRIS: Berms, not necessarily underground.

MEMBER POWERS: Why is there resistance to underground citing?

MR. MORRIS: I don't know. I don't have the answer to that.

MEMBER POWERS: In the late '70s but before TMI, I know that a study was carried out where they were looking with regard to a safety and not a security. And what they looked at at the time was

"Okay. Here is how the plant is built above ground. Put it underground. Don't change anything about the plant, what you can do for underground citing." It came out a wash from safety. You know, it was --

MR. MORRIS: So, therefore, nobody wanted to dig a hole.

MEMBER POWERS: Nothing went beyond on that. And they certainly didn't look at optimizing how you just built a plant different if you built it underground.

But nobody looked at the security at the time. And the fact that it was a wash on safety suggests that they didn't run into any formidable technical difficulties in doing that.

MR. MORRIS: That certainly has appeal from a security standpoint. It's certainly hard to hit it with an airplane when it is underground or you limit the number of entry points if you are a bad guy.

MEMBER POWERS: Yes, there were two. There were only two entry points to it. And it would be relatively easy to defend both of those entry points because they were both --

MR. MORRIS: But I don't know. That's a good question. I don't know.

MEMBER POWERS: But the other thing that

comes up is that for the MO_x fuel fabrication facility, we are looking at basically a Butler building outside a fence. But next door to it is the DOE facility, which is the plutonium pit disassembly that is basically a bermed-in heavy wall structure. That makes the difference. It's the same plutonium on both sides of the fence.

MR. MORRIS: Yes.

MEMBER POWERS: In fact, there is more of it over in the process facility than there is at any one time in the pit disassembly facility.

MR. MORRIS: I won't speculate on that.

MS. SCHNITZLER: Okay. This next slide is probably the real reason for the meeting and what you would like to focus on. This slide kind of encapsulates all of the things we have discussed and have talked about, places where we think we are going to need ACRS reviews; as we have discussed, digital computer and communication, safety/security interface, the Bravo(5)(bravo), you know, large area fire, and then the NUREGs for new reactors.

VICE CHAIRMAN BONACA: Well, this is very useful. And I appreciate your coming and telling us about it because, I mean, I didn't know, for example, digital computer and communication networks were coming up. It's just an example.

MR. MORRIS: Yes. One of the biggest uses that we are trying to reconcile in that arena is the fairly prescriptive requirements in Part 50 for safety system controls and regulatory guidance that has been established. And what we are trying to do in our rulemaking for cyber security is reconcile on those two things.

VICE CHAIRMAN BONACA: Okay.

MR. MORRIS: That is an issue that we thought that these --

VICE CHAIRMAN BONACA: These areas are coming up for our review over the next 12 months.

MEMBER APOSTOLAKIS: That's a lot of work, isn't it?

MS. SCHNITZLER: Currently our big package rulemaking is due to the EDO on 1/2/08. Our guidance is in development. The draft guidance will be out Summer and Fall of -- it says 2007. Yes. And then ACRS reviews required for portions of that we're estimating to be Fall and Winter of 2007.

MR. MORRIS: But that's draft. I mean, those are draft documents.

MS. SCHNITZLER: Right.

MR. MORRIS: They aren't final documents

but yes.

MS. SCHNITZLER: Right.

VICE CHAIRMAN BONACA: Okay. Well, that's --

MS. SCHNITZLER: And that really concludes our presentation. If you have any other questions or --

MR. MORRIS: That's five and a half years worth of work in a nutshell.

(Laughter.)

MEMBER MAYNARD: I thought it was a very good summary, and I thought it was very useful.

MEMBER APOSTOLAKIS: Oh, yes. Very useful, very useful.

MEMBER POWERS: Can I just ask a specific question? I see on a lot of the sites these secure firing stations. I think their locations --

MR. MORRIS: The ranges? Do you mean the firing ranges?

MS. SCHNITZLER: I think he is talking about a BRE, a bullet-resistant enclosure.

MR. MORRIS: Oh, bullet-resistant enclosures.

MEMBER POWERS: Enclosure. Those of us who --

MS. SCHNITZLER: It looks very similar to --

MEMBER POWERS: -- have visiting attacking facilities in the past used to call those targets.

MR. MORRIS: It depends on the weapon you are using.

MS. SCHNITZLER: Right.

MR. MORRIS: They are bullet-resistant enclosures, which implies that the specific -- and I can't go into the detail, but the specific weapon that we attribute to the bad guy in the DBT can't beat that.

MEMBER POWERS: Yes, but nobody carries that small of a weapon anymore.

MR. MORRIS: Well, that is a discussion you will have to have with people with a lot higher pay grade than me.

MS. SCHNITZLER: Right. And don't think that that is the only part of the protective strategy there is.

MR. MORRIS: Yes. I mean, that's --

MS. SCHNITZLER: That is the other side.

MR. MORRIS: When we talked about the fact that the protective strategies at all of the sites were different, that is absolutely true. There are layers upon layers upon layers upon layers of defense. What you see is just one layer.

MS. SCHNITZLER: Just one small piece of it.

VICE CHAIRMAN BONACA: I think that it --

MEMBER MAYNARD: What you can't see, you have got to be careful about.

MS. SCHNITZLER: That's correct.

MR. MORRIS: That's right.

VICE CHAIRMAN BONACA: Whatever we do I think now falls into place with a picture of that. Thank you very much.

MS. SCHNITZLER: Excellent. Thank you.

CHAIRMAN SHACK: Well, it is time for a break.

(Whereupon, the foregoing matter went off the record at 2:15 p.m. and went back on the record at 2:32 p.m.)

5) REVISIONS TO DRAFT FINAL NUREG-1852, "DEMONSTRATING THE FEASIBILITY AND RELIABILITY OF OPERATOR MANUAL ACTIONS IN RESPONSE TO FIRE"

CHAIRMAN SHACK: We can come back into session. Our next topic is "Revisions to Draft Final NUREG-1852, 'Demonstrating the Feasibility and Reliability of Operator Manual Actions in Response to

Fire.'" And that, of course, is George.

5.1) REMARKS BY THE SUBCOMMITTEE CHAIRMAN

MEMBER APOSTOLAKIS: Okay. As the members recall, we reviewed this document last month. And we recommended that it be published after some changes. And the staff has, in fact, made changes to the document we saw.

I have already seen the changes. So we will have a briefing by the staff on the changes they made. And then we will send a letter to the Commission or to the EDO, actually, stating whether we agree with what they have done.

So, without any further ado, Mr. Ibarra?

5.2) BRIEFING BY AND DISCUSSIONS WITH REPRESENTATIVES OF THE NRC STAFF

MR. IBARRA: Good afternoon. My name is Jose Ibarra, and I am the Branch Chief of the Human Factors and Reliability Branch in the Office of Nuclear Regulatory Research.

We were here last month, like George said, to brief you on the public comments of how we change that NUREG, 1852, "Demonstrating the Feasibility and Reliability of Operator Manual Actions in Response to Fire." And we're here today to address your comments on the NUREG.

This NUREG has been a cooperative effort with the Office of Nuclear Reactor Regulation. And Alex Klein is here representing NRR today. The presentation will be done by Erasmia Lois from my staff.

DR. LOIS: Thank you very much.

MEMBER APOSTOLAKIS: So what are you bringing there with this black thing, something you don't want us to see? Is it just cosmetic?

DR. LOIS: Just cosmetic.

MEMBER APOSTOLAKIS: Okay.

PARTICIPANT: It's the style, George. It's the style.

MEMBER APOSTOLAKIS: That I would lose my --

DR. LOIS: So the purpose is to summarize the changes and the request to the ACRS for endorsement to publish the NUREG. And what I am going to do is I am going to briefly summarize the comments and then what we did to address the comments.

The first moment was to add to the NUREG a discussion adopting risk assessment and human reliability analysis tools to guide the judgment made when identifying the sources of uncertainties, especially when it comes to the determination of the time margin.

And I believe that the ACRS had in mind these tools and recommended specifically the ATHENA and the EPRI SHARP guidance provides good structure to do the deterministic analysis as well in order to come up before you get up to the numbers, the guidance provided for how do you really explore the various contexts, the human action passages that are performed and what did we take is a very good structured way to solve that in actuality perspective uses could benefit from that guidance for doing a better job in identifying the certainties as well as doing a more efficient job.

However, we did not do as much as the ACRS probably wanted. We just added a paragraph where we mentioned that these tools are available and can be used; however, not required. And the only thing that is needed to be done is to determine to show that the visibility and the reliability criteria have met.

I believe we did that because we didn't want to add to the confusion as to this or led to the NUREG being perceived as being very encompassing that requires a lot of analysis. It would need for the simplest action to provide tremendous justification. And if we reference ATHENA, the perception of being a very detailed analysis, then probably we could create more confusion. So we didn't do as much as the ACRS wanted. Sorry about that.

MEMBER APOSTOLAKIS: We still haven't written the letter.

(Laughter.)

MEMBER APOSTOLAKIS: I'm sorry.

CHAIRMAN SHACK: You might be sorry.

MEMBER APOSTOLAKIS: But I do think that you guys are a little timid. The use of risk-related clinics. What is risk-related about identifying some areas using SHARP or ATHENA? It's not risk. It's just identification of centers. If you want, it is a deterministic analysis, really.

The moment you put that risk-related, immediately people say "Oh, this is vampire-related. You know, we shouldn't touch it because this is deterministic."

(Laughter.)

MEMBER APOSTOLAKIS: Anyway, this is just a comment for the future. At least introduce the concept of scenario, but the scenario construction is really like anything else. We were doing scenario analysis in the deterministic world before. Maybe we didn't call them explicitly scenarios, but we did.

But I suspect there was a concern here of invoking risk-related methods. And, my God, you are not supposed to do that because this is deterministic.

I mean, I am not necessarily asking for an answer because I am very certain that this is what happened.

CHAIRMAN SHACK: It's a rhetorical comment.

MR. KLEIN: This is Alex Klein. If that's a comment, then in terms of a response, I don't know if one is necessary. However, what I do want to say to Dr. Apostolakis is that we acknowledge what your recommendation was in terms of putting the words into the NUREG.

We are not necessarily precluding the use of these tools by a licensee. They are free to use other tools that area available, like ATHENA, if they want to, as we have suggested in the wording here that was added to the NUREG.

So, you know, bottom line to us is those tools are available. They are free to use those if they wish to inform the application of this NUREG-1852 for criteria. And we would not preclude the use of that.

MEMBER APOSTOLAKIS: What I am trying to

say, Alex, because I noticed this throughout the meeting last month, when we are reviewing something or preparing something like this NUREG that is supposed to be not risk-informed, immediately there is a wall being raised that surrounds all the risk methods.

Anything that is being used in a PRA now is a no-no. And my point is that a lot of the stuff that is being done in the risk area is, in fact, deterministic, in the development of doing scenarios and doing other things. And this wall doesn't make sense.

And the idea, the spirit of the comment was to, in fact, help the licensees, not add burden. But that's okay.

DR. LOIS: And we recognize that you are absolutely right. And it wouldn't be easily done in this document unless we could add a chapter where we come in and we explain about the PRA tools that do a lot of the deterministic analysis and have developed a structured way to do the deterministic analysis, et cetera, et cetera.

That would need at least a chapter that would need to go back and forth to another review, but we take that as a --

MEMBER APOSTOLAKIS: In the future, I hope that we will see some.

DR. LOIS: Absolutely. This is a very good point which you are going --

MEMBER APOSTOLAKIS: Many times, you know.

DR. LOIS: I hope not on this document again.

MEMBER APOSTOLAKIS: Many times I have heard in the past. You know, you are making a suggestion, "Oh, but that is risk-informed. You know, we can't use it because this is not risk-informed." The moment you start introducing probabilities, then you become risk-informed.

MEMBER WALLIS: That's the wall. Is the wall the probability thing? Is that what creates --

MEMBER APOSTOLAKIS: I think, yes, when it comes -- no. The wall is between everything that the PRA, the methods PRA, uses and the so-called deterministic stuff. And my point is that a lot that is being done in the PRA world is, in fact, deterministic in some sense. The moment you introduce the probabilities, then, of course, it becomes different.

MEMBER WALLIS: But you have to be sure. You have to say the probability is one or zero. Then you are --

MEMBER APOSTOLAKIS: In this world, that is what you do. If it is three times, then it is okay.

CHAIRMAN SHACK: Close enough.

MEMBER APOSTOLAKIS: Close enough. Okay. Let's move on.

DR. LOIS: Okay. The second recommendation was to add a section that indicates that the level of analysis needed to justify meeting the criteria should be commensurate with the action proposed in a way that if it is a simple action, you may not need as much justification as it would be for a more complicated action.

And within that, by adding a paragraph in chapter 1 where we are stating exactly that. A simple action may not need as much justification. For complex actions, licensees may choose to comply with the rule. It doesn't mean they may not have to do extensive analysis, but they do have the option to submit an exemption request. And in those cases, they may need to do more detailed analysis for physical retainability.

And then in chapter 3, we --

CHAIRMAN SHACK: Excuse me, Erasmia.

DR. LOIS: Yes?

CHAIRMAN SHACK: Is this language literally added to the document?

DR. LOIS: Yes.

MEMBER WALLIS: It doesn't make sense. I don't understand the last language sentence.

MEMBER APOSTOLAKIS: Which sentence?

CHAIRMAN SHACK: "Detailed analyses of operator manual action on feasibility and reliability." I don't understand what that means. Do you mean the effects of manual action on feasibility or what? It doesn't make sense.

DR. LOIS: You are --

MEMBER APOSTOLAKIS: The last bullet? Is that the last bullet of the graph?

CHAIRMAN SHACK: The words "detailed analyses of operator manual action on feasibility and reliability" don't make sense to me.

DR. LOIS: I'm sorry? I don't --

MEMBER APOSTOLAKIS: The last bullet.

DR. LOIS: "Licensees have the option to submit an exemption or license amendment" --

CHAIRMAN SHACK: I understand that part.

DR. LOIS: -- "request using detailed analyses of the operator manual actions" --

CHAIRMAN SHACK: Of the effect of --

DR. LOIS: -- regarding "feasibility and reliability." Is it beyond --

MEMBER APOSTOLAKIS: That whole NUREG refers to how to do such an analysis. This is a bit out of context.

CHAIRMAN SHACK: It should be "Detailed analyses of the feasibility and reliability of operator manual action."

MEMBER WALLIS: That makes some sense. That makes some sense.

DR. LOIS: "Of the feasibility." Thank you. On that basis --

MEMBER APOSTOLAKIS: Or, as Erasmia said, "regarding the reliability."

DR. LOIS: "Regarding."

MEMBER APOSTOLAKIS: I think "of" is better.

MEMBER WALLIS: Regardless, you've got to change the order, too.

MEMBER APOSTOLAKIS: Yes.

DR. LOIS: Actually, it's "of."

MEMBER APOSTOLAKIS: Do you have the actual --

PARTICIPANT: "Feasibility and reliability."

MEMBER APOSTOLAKIS: -- language of the guide here?

DR. LOIS: I have "Operator manual action feasibility and reliability."

PARTICIPANT: "Feasibility and reliability."

MEMBER APOSTOLAKIS: "For detailed analysis of the feasibility and reliability of operator manual actions." Move the "feasibility and reliability."

MEMBER WALLIS: Now I understand what it means.

DR. LOIS: Okay.

MEMBER APOSTOLAKIS: Well, you always did but just --

MEMBER WALLIS: I didn't understand before. No, no, I didn't.

MEMBER APOSTOLAKIS: Okay.

DR. LOIS: We'll do that. Thank you.

In chapter 3, we clarified further what we mean here, what is a simple justification or analysis may be sufficient if it can be shown that a sufficiently long time exists, there are no unique aspects required, and that could run the extinguishment of the fire or the proposed manual actions are relatively straightforward. So we kind of clarify what we mean by "simple actions."

And then, on the other extreme, a rigorous analysis and review is likely to be needed when the time available is relatively short; the operator manual actions are not straightforward, may be more complicated; for example, on multiple actions or the same operator doing multiple tasks; or unique aspects of the fire, such as the extinguishment, is difficult. So you may need just one action to extinguish a fire, but it may be difficult to do it.

Any comments to make?

MEMBER ARMIJO: Extinguishment?

MEMBER APOSTOLAKIS: There is such a word, right?

DR. LOIS: There is. The third comment was to discuss the combination of skills and expertise that would be appropriate for an expert panel if used to estimate time margins and noted that potential limitations of the approach may exist.

What we did for that is we added a section, appendix B, where the time margin limitation through expert panel has been discussed. And we say that a multi-disciplinary team is recommended of independent specialists, recognized in at least one of the areas. We cite here some areas needed. And we clarify that the disciplines involved may vary depending on the particular topic being analyzed.

For example, the scenario may result in radiation deposit. Then you may need to have radiation deposit experts and health physicists to help out to identify the time margin.

And also we discussed the advantages and disadvantages. Advantages are that the participants' knowledge and expertise help determine in the margin, may be used to have reductions in the time and cost allocations compared to other evaluations for retainment and determining the time margins, and leverage on the credibility of the conclusions because of the panel's expertise.

However, the disadvantages are that minority views might be eliminated, potentially a dominant member might dominate the results, and evidence that the operators sometimes may be optimistic about the action implementation. And we cite references for guidance for various sources of bias.

With that, I complete my presentation.

MEMBER APOSTOLAKIS: Any questions?

(No response.)

MEMBER APOSTOLAKIS: Okay. Thank you very much for coming back and responding so quickly to our comments.

And I understand Mr. Paul Gunter from the public would like to address the Committee for 5-10 minutes. Mr. Gunter?

DR. LOIS: Thank you.

MEMBER APOSTOLAKIS: You are welcome.

MR. GUNTER: Thank you very much. I appreciate the opportunity.

First of all, I would like to make a correction. I am now employed with a group called Beyond Nuclear with the Nuclear Policy Research Institute, although I will be continuing on with Nuclear Information and Resource Service on some specific aspects and proceedings, such as the Oyster Creek relicensing application, which we are involved in.

I would like to raise some of the concerns. I apologize for not being at the June 6th meeting because of a competing commitment, but the public still has a number of broad concerns with regard to the operator manual action.

I think that chief among those concerns is that given the scope of the revelation of the operator manual actions that we see in the industry and the surprise with which it came to the agency, starting, I believe, with pilot fire protection functional inspections in 1999, the concern is that the operator manual actions are being posed to supplant passive physical fire protection features as designated in 3(g)(2).

And, frankly, we don't believe that that constitutes an equivalent measure of safety. And, despite the comments on staff in reply to the public comment, we still believe that it constitutes a significant a diminishing in defense-in-depth.

I think one of the principal reasons that we believe that it diminishes defense-in-depth, first of all, is how are you all going to capture the various uncertainties that can determine a fast-moving fire versus a slow-moving fire.

And what we have seen as well is a retreat by staff from the original criterion for the time commitment, where, you know, the two-times factor was introduced.

I know the ACRS had some concern about how that factor was introduced. And perhaps, if not, it was a hat trick to put some structure into this uncertainty.

But, again, what we have seen now and what is indicated -- again, I haven't read the -- I don't know that the revised NUREG is actually out for public review yet, but it is my understanding that there is a retreat from the time commitment with regard to the reliability factor in these operator manual actions.

And so when you look at NFPA 805 and it is a comparison between performance-based and deterministic-based, you know, they are explicit in there that there need to be engineering qualification that are the equivalent of the deterministic methods. And it's one thing to be able to test and qualify a fire barrier.

As problematic as that has been over the history of this industry, you can do it. There are industry measures for time-temperature curve.

You know, the public doesn't have confidence in human reliability in being tested, particularly since it cannot be tested under actual conditions that could be encountered during a fire.

So we have some real concerns, particularly with regard to what we believe to be the scope of the changes that we are about to make. As a matter of fact, we believe it to be a U-turn from the promulgation of appendix R and 10 CFR 50.48 as a result of the Browns Ferry fire.

You know, I think some of the -- one clear indicator of that U-turn is the fact that the staff, much to our dismay, brought Browns Ferry unit I back online with at least -- I mean, the number is not yet determined but at least 100 operator manual actions that came in under enforcement discretion.

So the staff did not have any industry. TVA did not have confidence in demonstrating any equivalency for these operator manual actions so that they could actually meet the exemption requirement. But they were brought in under enforcement discretion.

So where is the public confidence in that measure? How can we have public confidence when the fire that promulgated the regulation receives enforcement discretion from the agency?

Browns Ferry is not an isolated case. Shearon Harris, which is currently under review by the Government Accountability Office through Congressman Price, also has widespread operator manual action.

And so it remains our concern, first of all, that the scope of these operator manual actions I don't think has been bounded by staff. They weren't able to provide you with effective numbers on how many operator manual actions are actually out there.

I think that is still an iceberg that is waiting to be revealed. And, frankly, we are concerned about the fact that this action is being taken prior to actually bounding the scope of the problem.

And secondly is that if, in fact, it is supplanting the passive physical fire protection features and there is this question of equivalency but there is also the concern that staff has, for example, the bulk of the operator manual actions as we read it come from the thermal lag fire barrier violations.

Now, staff had six years, from 1992 to 1998, to review, to do safety reviews, with each of the licensees on their thermal lag corrective action programs.

Those corrective action programs were developed. In 1998, all but 17 operators in 24 units had corrective action programs. So in 1998, the NRC issued confirmatory action orders that for those 24 units to bring your plants into compliance with 3(g)(1) or 3(g)(2) -- and you could use 3(g)(3).

What happened, though, was that the operator manual actions were introduced without staff oversight, without the review, without the exemption process.

And we believe and continue to believe in willful noncompliance. And I think the word "willful" here is it's a very strong word. But, yet, we see that in subsequent evaluations, even some of the orders, as best as we've been able to investigate to date, the licensees are out of compliance with orders. I am not here to name names, but we can certainly disclose those. And we are talking those over with the GAO.

So there is the issue of enforcement on top of the broad uncertainties associated with these operator manual actions. So, you know, I sincerely think that we are at a very momentous decision here where, in fact, we could be returning to the day before the Browns Ferry fire.

And it would be a significant setback, particularly given all of the actions that the staff has put into this issue to date, not only with thermal lag but now we have got HEMIC, we have got MT, FS-195. You know, when does that list end? And how far and how deep into the passive structures for fire protection, which we believe are the front line of fire protection, are we going to remove or cut into that front line and supplant it with what we believe to be the last ditch efforts of operator manual actions?

I will conclude at that point.

MEMBER POWERS: Let me ask you one question. You mentioned the problematic nature of qualifying a fire barrier and mentioned the industry standards.

A frequent criticism of that industrial standard, ASTME fire standard, is that the heat flux loading unit puts on. It is not representative of anything that could arise in a nuclear power plant. Do you have any comments on that?

MR. GUNTER: Well, I believe that, again, I will address it with one of the comments that we made in reply to the NUREG in that fire protection is security infrastructure.

And so I believe that the most conservative standards for testing fire protection apply in terms of providing conservatisms to the security infrastructure of these facilities because of the risk and the consequence associated with failure of post-fire safe shutdown.

So I think the most conservative standards do apply, particularly when addressing security infrastructure. But, then again, there are the uncertainties of being able to introduce transient combustibles. You know, that is a hard one to model. And you can't necessarily rely on quantifying combustibles that are in a room when something else, even though it's not jet fuel, could come into that room.

So, again, I think it's appropriate to apply the most conservative fire test standards. And, again, that's what ASTME 119 has derived. And I think that that should be honored and that should be the standard.

MEMBER POWERS: It's not entirely clear that it is especially conservative when it comes to hot shorts because it's very hot.

MR. GUNTER: Right. Thank you.

MEMBER APOSTOLAKIS: Has the Commission approved the use of operator manual actions as an alternative to physical barriers?

MR. KLEIN: The Commission withdrew the proposed rulemaking back in March of 2006 that would have allowed as an alternative the use of operator manual action in lieu of a fire barrier in conjunction with detection and suppression.

The staff had proposed in that rulemaking an alternative under 3(g)(2) to allow operator manual actions in conjunction with detection and suppression to address defense-in-depth.

So in terms of the characterization that the staff has made a U-turn on appendix R or has diminished defense-in-depth we disagree. We have made no changes to the appendix R rule. We are not proposing any changes to the appendix R rule with this issuance of the NUREG assuming that we get a favorable response from ACRS.

The use of this NUREG-1852 will we believe for the first time put in one place a consistent set of criteria for the staff to use to evaluate the application of operator manual actions if a licensee comes in to us under a licensing action, a future licensing action.

MR. GUNTER: Could I reply?

MEMBER APOSTOLAKIS: Absolutely.

MR. GUNTER: I have to respectfully disagree with Alex. The use of suppression detection in 3(g)(2) is used in conjunction with fire barriers, in that case with a one-hour fire barrier. What we are talking about are inoperable barriers now that -- the operator manual action or in lieu of lack of cable separation.

So I think that the question then becomes how reliable and how much confidence we can have in human reliability to accomplish an operator manual action, as opposed to passive physical fire protection features, such as 20 feet minimum separation and qualified fire barrier, albeit one hour, but it's still qualified.

That is really our concern. It is sort of mixing apples and oranges when you are talking about human reliability and qualifying passive physical fire protection features.

MR. KLEIN: We are not suggesting that -- and I don't want to get into a debate here because the proposed rulemaking was withdrawn. We understand that there is no equivalency between a fire barrier and an operator manual action.

I believe that our proposed rulemaking, the statement of consideration has a fairly lengthy discussion on what the staff's position was if we had moved forward with a final rule.

We did not do so. That is why I made the comment that we did not make a U-turn in appendix R. We are not making any changes to the regulations. And neither are we proposing to make any changes to the regulations with this NUREG-1852.

MEMBER APOSTOLAKIS: Okay. The Commission disapproved the proposed rule.

MR. KLEIN: No, it did not. We recommended, the staff recommended, that the Commission --

MEMBER APOSTOLAKIS: Right.

MR. KLEIN: -- withdraw the proposed rulemaking because it did not meet our goal of efficiency and effectiveness --

MEMBER APOSTOLAKIS: Right.

MR. KLEIN: -- because of the fact that the licensees in their response to the proposed rulemaking had indicated to us that there would be many exemptions submitted.

MEMBER APOSTOLAKIS: The question is, has the Commission said that it's okay for a licensee to come and argue that operator actions can be used in arguing for an exemption from appendix R? The Commission has blessed that?

MR. KLEIN: Licensees are free to submit an exemption request on their Part 50.12.

MEMBER APOSTOLAKIS: Right.

MR. KLEIN: Yes. And I will add to it in a second. We issued a RIS back in 2006, Regulatory Issue Summary 2006-10, which clearly explains the staff's regulatory position on the use of operator manual actions and the fact that if a licensee wishes to use an operator manual action in lieu of the protection requirements under 3(g)(2), that licensee must come in for an exemption request to the staff to receive prior approval to take credit for that operator manual action.

And Phil Qualls would like to --

MR. QUALLS: Yes. My name is Phil Qualls. I just wanted to add just a little bit.

Historically there have been exceptions approved for operator manual actions at one time. I was really the first person here in NRR to stir this issue up. I did training and got NE upset. And I'm the one that sent the letter response to NE and went to CRGR the first time.

There have been historically multiple exemptions approved for operator manual actions in lieu of meeting 3(g)(2). I counted. We have a database that ends in -- if we funding the contract, it terminates in like 1992, but I counted like 50 or something at one time. I didn't keep a record of it, but it was on the order of 50.

The problem I had because when I was researching the first time we were coming up with criteria and the like is what were the bases for approving them. There's nothing.

Now, the question isn't, is a manual action equivalent to a barrier? It isn't, in no way. Not once did we really say a manual action is equivalent to a barrier, but it's like the standard. It's like if you go back to appendix R, why did they set a three-four rated fire barrier where you need a standard that is adequate for our safety concern? Okay.

Now, not all three-hour fire barriers are really adequate for the fire hazard. There is diesel fuel, fuel oil fires, and such that will exceed the ASTME test boundaries. Okay? So the fire barrier won't match that, but do you set a standard that is adequate?

So the question we looked at with these manual actions is, what kind of standard will serve for an exemption so that we can review consistently and ensure that it meets an adequate safety level?

It's not equivalent to a barrier. A one-hour barrier is adequate. Okay? The manual action is not equivalent to a barrier, but is it in its own way an adequate level to maintain safety? And, actually, having inspected a lot of these in the field, we need some standard out there really bad.

And there are multiple examples -- I don't want to get into anecdotal stories of what I found inspection, but there are some that are just unperformable. I mean, there were some pretty bad examples that we found during inspections.

And that's one of the reasons we came up with the original criteria, is we really need some standard because we do get exemptions and we have historically got exemptions. And trying to research the bases for approval for those exemptions there is nothing there.

MR. GUNTER: I completely agree with Phil on this. I want to be clear that the public interest community is not opposed to qualifying operator manual action.

What our concern is, it's represented, for example, by Shearon Harris, where the operator -- you know, basically where fire barriers were put in was where they couldn't substitute an operator manual action. That is from NRC documents, as we discovered.

It is opening that floodgate that is our concern now, particularly given the broad range of inoperable fire barriers that are out there, the concern with regard towards the lack of cable separation.

And this is all still being mapped out as to how extensive the problem is. It is this floodgate that we are concerned about, that, in fact, we are talking about an industry that as we see it has stonewalled the staff, has basically faced down enforcement, and is now in the position to pose supplanting physical fire protection features with operator manual action.

MR. QUALLS: And, actually -- this is Phil Qualls again -- Paul, I agree with you.

I will relate one plant, one inspection that I wasn't on the team, but I was heavily involved with it here. And that was ANO inspection and the findings and the follow-up and all the panels and all the other stuff that we did.

When I looked at what ANO was doing -- and, now, they got a white finding and a violation and they are in the middle of corrective actions at this point. They were doing -- if you look at it, they were really shutting down the way Browns Ferry would have shut down in 1974, before the fire, relying totally on manual actions, waiting for something to occur and the operators to respond.

And we agree completely that is what we are trying to prevent with the standard. That is why we are trying to get -- we are enforcing the rule.

That is why we are making licensees come in for exemption, so they get staff review and approval and get reviewed to some high-level standard. And that's our goal, too, and we don't disagree with you on that point.

MEMBER APOSTOLAKIS: Any other issues?

(No response.)

MR. GUNTER: Thank you.

MEMBER APOSTOLAKIS: Thank you very much.

Well, Mr. Chairman, back to you.

CHAIRMAN SHACK: We are ahead of schedule. Let's take a short break until 3:30. And then we'll come back and start on our preparation of reports.

MEMBER APOSTOLAKIS: You don't have to start at 3:45, right?

MEMBER CORRADINI: He gets to move us forward.

CHAIRMAN SHACK: We don't need the court reporter anymore.

(Whereupon, the foregoing matter was recessed at 3:12 p.m., to be reconvened on Thursday, July 12, 2007, at 8:30 a.m.)

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

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.

Charles Morrison

Charles Morrison
Official Reporter
Neal R. Gross & Co., Inc.

NUREG-1852
Demonstrating the Feasibility and Reliability of Operator Manual Actions In Response to Fire

Erasmia Lois, PhD
Senior Risk and Reliability Engineer
Division of Risk Assessment and Special Projects
Office of Nuclear Regulatory Research

Presentation to
Advisory Committee on Reactor Safeguards
July 11, 2007

Purpose of the Briefing

- Summarize changes made to NUREG-1852 to address ACRS comments during the June 6, 2007 meeting
- Request ACRS endorsement to publish the NUREG

ACRS Comment #1

- Discuss adopting risk assessment and human reliability analysis tools to structure the judgment made when identifying the sources of uncertainties that could affect time margin estimates

3

Changes made to NUREG-1852 to Address Comment #1

- Added text stating (section 2.2) that this report provides a deterministic approach; however
  - Risk assessment and particularly human reliability techniques may be useful for identifying the range of fire scenarios and related contexts and the possible operator manual actions that might be used.
  - The use of such risk-related techniques is not required.
  - Ultimately, the operator manual actions should meet the applicable deterministic criteria for feasibility and reliability.

4

ACRS Comment #2

- Add a section in the beginning indicating that the level of analyses needed to justify meeting the criteria should be commensurate to the action proposed to be implemented

5

Changes made to NUREG-1852 to Address Comment #2

- Added a paragraph in Chapter 1 stating
  - It is expected that for many cases, where extra time is clearly available and the actions are relatively simple, evaluating the criteria will be straightforward, requiring only simple justification and analysis
  - For complex cases, licensees alternatively may choose to comply with the requirements of Appendix R by performing appropriate design changes.
  - For these cases, licensees have the option to submit an exemption or license amendment request using detailed analyses of operator manual action on feasibility and reliability

6

Changes made to NUREG-1852 to Address Comment #2 (cont)

- Added additional text in Chapter 3 noting that not all of the criteria will usually require significant analysis or even be applicable
  - Simple justification or analysis is sufficient if it can be shown that
    - sufficiently long time is available (e.g. several hours), and
    - there are no "unique" aspects of the fire that could prolong its extinguishment unduly, and
    - the proposed operator manual actions are relatively straightforward

7

Changes made to NUREG-1852 to Address Comment #2 (cont)

- At the other extreme, a rigorous analysis and review is likely to be needed to account for all the criteria and how well each is met, if
  - the time available is relatively short (e.g., tens of minutes, at most) or
  - the operator manual actions are not straightforward or are somewhat complex (e.g., involving multiple operators or the same operator performing multiple actions), or
  - there are "unique" aspects to the fire making rapid extinguishment difficult

8

ACRS Comment #3

- Discuss the combination of skills and expertise that would be appropriate for an expert panel if used to estimate time margins
- Discuss potential limitations of the approach

Changes made to NUREG-1852 to Address Comment #3

- In Appendix B added Section B.5 summarizing the characteristics and types of expertise that would be appropriate for a panel
  - A multi-disciplinary team approach is recommended composed of
    - Independent specialists, recognized in at least one of the areas/specialties addressed
    - In general, include human reliability analysis, human factors, fire protection, operations, instrumentation and control engineering, training, procedure development, PRA, and other expertise as indicated by the fire scenarios and actions being examined
    - However, the disciplines involved may vary depending on the particular topic being analyzed

Changes made to NUREG-1852 to Address Comment #3 (cont)

- Section B.5 also discusses advantages and disadvantages
  - Advantages
    - The participants' knowledge and expertise in the subject area
    - Can result in significant reductions in time and cost allocations compared to other evaluation techniques
    - Leverage the credibility of conclusions because of the panel members' expertise
  - Disadvantages
    - Elimination of minority view points because of consensus-based conclusions
    - The potential for the view of a "dominant" member to be overly influential in the decision making process.
    - Evidence that operators can sometimes be optimistic about action implementation times and such bias needs to be controlled
  - The section cites references for guidance controlling for various sources of bias.

11

U.S.NRC
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Protecting People and the Environment

Nuclear Power Plant Security

ACRS Presentation

July 11, 2007

U.S.NRC
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Discussion Topics

- Post-9/11 Security Actions
- Energy Policy Act (EPAct)
- Security Rulemaking Objectives
- Regulatory Guidance
- ACRS Reviews
- Future for Security

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NRC Regulatory Approach to Security

- Requirements for Nuclear Power Plant Security are established in 10 CFR Part 73
- Regulations adopt Design Basis Threat (DBT) Approach
  - DBT establishes performance requirements
  - The DBT is informed by threat information; reviewed periodically, and updated as necessary
  - *"Largest reasonable threat against which a regulated private security force should be expected to defend under existing law"*

Post-9/11 Security Actions

- Issued 5 Security-related Orders (2002-2003)
  - Interim Compensatory Measures
  - Overtime for Security Personnel
  - Training and Qualifications for Security Personnel
  - Access Authorization
  - Revision of the Design Basis Threat

Post-9/11 Security Actions (cont.)

- Issued Security Advisories
- Issued Guidance Documents
- Enhanced coordination with Federal Agencies
  - Department of Homeland Security (DHS), NORAD, & FAA
- Conducted Force-On-Force evaluations
- Developed lessons learned from implementation and inspection of Orders, Force-On-Force, SFAQ's

Energy Policy Act - 2005

- Enacted August 7, 2005
- Title VI focuses on nuclear security
- Several security provisions for NRC consideration
- Specific provisions for DHS/NRC interface on siting of new nuclear plants

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Protecting People and the Environment

Energy Policy Act (cont.)

- Initiate security rulemaking with the following considerations:
  - Events of September 11, 2001
  - Assessment of a range of threats and multiple methods of implementation
  - Adequacy of planning for the protection of public health and safety in the event of a terrorist attack (force-on-force exercises)
  - Potential for fires, especially fires of long duration
  - Expanding the weapons capability of licensees in protection of facilities

Security Rulemaking Objectives

- Make generically applicable the requirements imposed by Orders
- Add new requirements that resulted from insights gained during and following implementation of the Orders
- Incorporate, as applicable, the EPAct of 2005

Security Rulemaking Objectives (cont.)

- Add security requirements for MOX fuel
- Enhance notification to the NRC for certain security events
- Address PRM 50-80 requesting regulations that would ensure security/safety interface remains intact
- Revise and enhance Access Authorization requirements

Security Rulemaking

- 73.1 Design Basis Threat
  - Proposed rule published 11/06
  - Rule covers radiological sabotage and theft/diversion of special nuclear material
  - Key changes include:
    - multiple, coordinated groups of attackers
    - suicide attacks
    - and cyber threats
  - Final rule published 3/07

Security Rulemaking (cont.)

- Part 73 Power Reactor Rulemaking (proposed rule published 10/06)
  - 73.18 & 19 Enhanced Weapons (currently proposed to be applicable to nuclear plants and category I facilities)
  - 73.55 Physical Security for Power Reactors
  - 73.56 Personnel Access Authorization Requirements for Nuclear Power Plants
  - 73.58 Safety/Security Interface Requirements for Nuclear Power Plants
  - 73.71 Reporting of Safeguards Events
  - Appendix B to Part 73- General Criteria for Security Personnel
  - Appendix C to Part 73 – Licensee Safeguards Contingency Plans

Security & New Reactors

- Incorporating Security into Designs of New Reactors
  - 73.62 Security Assessment Requirements for Nuclear Power Reactor Designs
    - Proposed rule to Commission 9/06
    - Commission disapproved rulemaking 4/07 (SRM-SECY-06-0204)
    - Staff directed to place some aspects of proposed rule in Part 52 rulemaking
  - Guidance for new reactors to proceed

Regulatory Guidance

- Draft Regulatory Guides currently under development or revision. (To be published by the end of 2007)
  - New guide for Physical Security (73.55)
  - New guide for Training and Qualification (Appendix B)
  - New guide for Contingency Planning (Appendix C)
  - New guide for Access Authorization (73.56)
  - New guide for Safety/Security Interface (73.58)
  - New guide for Cyber Security (73.55(m))
  - New guide for Enhanced Weapons (73.18 and 73.19)
  - Revised RG 5.62 Reporting of Safeguards Events (73.71 and Appendix G)

Regulatory Guidance

- Other existing and new regulatory guidance under development
- Drafts expected in late FY-08 and FY-09:
  - RG5.7, Entry/Exit Control for PA, VA, and MAA
  - RG5.12, General Use of Locks in Protection and Control of Facilities and Special Nuclear Material
  - RG5.44, Perimeter Intrusion Alarm Systems
  - RG5.65, VA Access Controls, Protection of Physical Security Equipment, and Key and Lock Controls
  - RG5.68, Protection Against Malevolent Use of Vehicles at Nuclear Power Plants
  - NUREG/CR-XXXX, Security Assessments for Nuclear Power Plant Design Certification and Combined License Application
  - NUREG/CR-1345 Rev. 1, Nuclear Power Plant Design Concepts for Sabotage Protection

ACRS Reviews

- 73.55(m) Digital Computer and Communication Networks
- 73.58 Safety/Security Interface Requirements for Nuclear Power Plants
  - DG 5021 Safety/Security Interface
- Appendix C to Part 73 – Licensee Safeguards Contingency Plans (site response to large area fires)
  - DG 5016 Contingency Plans
- Other Security-Related Documents
  - NUREG/CR-XXXX, Security Assessments for Nuclear Power Plant Design Certification and Combined License Application
  - NUREG/CR-1345 Rev. 1, Nuclear Power Plant Design Concepts for Sabotage Protection

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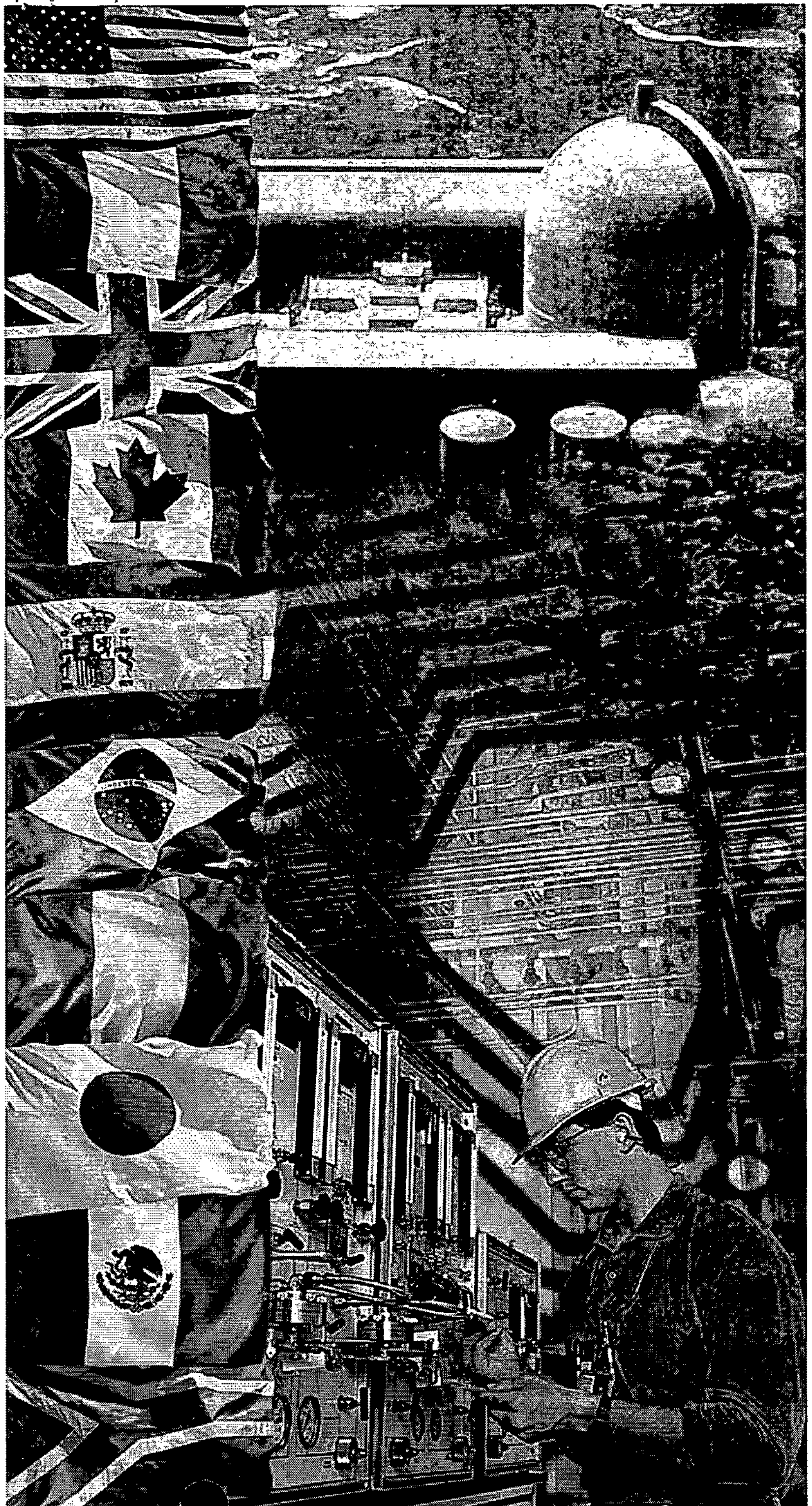
Summary

- Security Rulemaking proceeding (due to EDO 1/2/08)
- Supporting Regulatory Guidance in development (summer, fall, 2007)
- ACRS reviews required for portions of rulemaking (fall, winter 2007)



ELECTRIC POWER RESEARCH INSTITUTE

Pressurizer Nozzle Dissimilar Metal Weld Advanced Finite Element Analyses

ACRS Main Committee
July 11, 2007

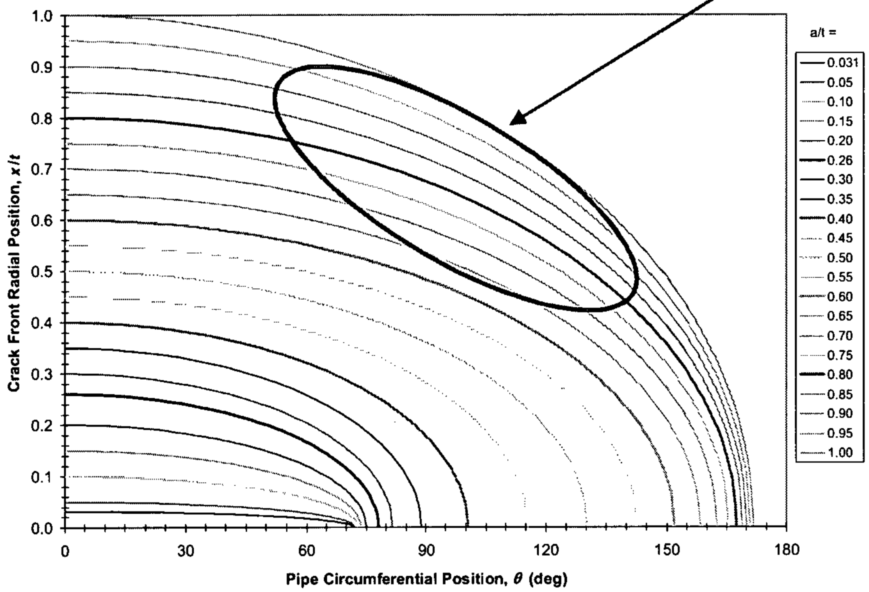
Amir Shahkarami
Senior Vice President
Engineering & Technical Services
Exelon Nuclear

Advanced FEA Project Objective

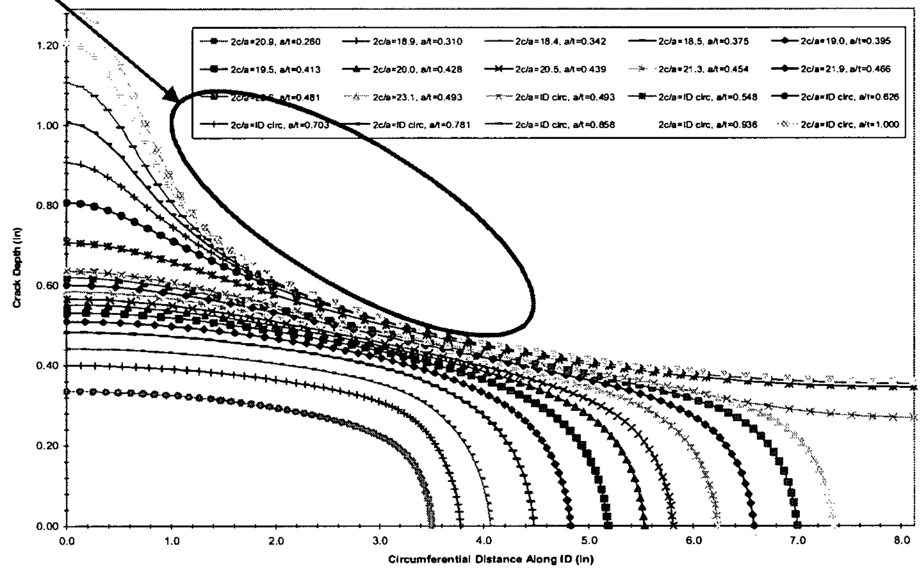
- Evaluate the viability of through-wall leakage prior to rupture for the pressurizer nozzle dissimilar metal (DM) welds in the group of 9 PWRs scheduled to performed PDI inspection / mitigation during the spring 2008 outage season given the potential concern for growing circumferential stress corrosion cracks

Project Goal

Semi-ellipse assumption over predicted extent of cracked material in this zone vs. the arbitrary shape methodology for the Wolf Creek nozzle benchmark run



Semi-Ellipse Crack Shape Progression



Arbitrary Crack Shape Progression

Growth at each point on the crack front as a function of the stress intensity factor calculated at that point

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Project Oversight

- Project Team
  - Dominion Engineering (DEI)
  - Quest Reliability – (FEACrack Software Developer)
- Expert Panel
  - Established to provide review, input, and oversight of the technical issues and approaches
  - Members well known in this industry were chosen
    - Ted Anderson, Quest Reliability, LLC
    - Warren Bamford, Westinghouse
    - Doug Killian, AREVA
    - Ken Yoon, AREVA
    - Pete Riccardella, Structural Integrity Associates
    - David Harris, Structural Integrity Associates
      - included specifically for his lack of recent involvement in Alloy 600 fracture mechanics applications to bring a fresh perspective
- Interacted with NRC Counterparts in ~7 NRC public meetings

Key Project Activities

- Software capability development within FEACrack
- Critical crack size calculations to define the end point for the crack growth calculation
- Crack growth calculations for custom crack shape
- Leak rate calculations - PICEP and SQUIRT models
- Develop and apply a sensitivity matrix of welding residual stress (WRS) profiles, including weld repairs
- Develop and execute an analysis parametric sensitivity case matrix
- Software verification and benchmarking
- Validation
- Expert panel input and review throughout the project

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Evaluation Case Matrix

Assess 51 welds in 9 spring 2008 plants

- Parameters
  - Plant Specific Geometries
  - Plant Specific Piping Loads
  - Weld Residual Stresses
  - Crack Growth Rate Stress Intensity Factor Dependence
  - Initial flaw geometry
  - Effect of Multiple Crack Initiation Sites

Evaluation Case Matrix

Plant Specific Geometries

- **S&R nozzles**
  - 35 safety and relief (S&R) nozzles (1 plant has only three S&R nozzles)
    - Represented by 5 geometric configurations
- **Spray nozzles**
  - 8 spray nozzles (1 examined by PDI process in 2005)
    - Represented by 4 geometric configurations
- **Surge nozzles**
  - 8 surge nozzles (1 already overlayed)
    - Represented by 2 geometric configurations

Evaluation Case Matrix

Plant Specific Piping Loads

- Cover full range of piping loads for 51 subject welds:
  - All plants 2235 psig pressure
  - Range of axial membrane stress loading, P_m
  - Range of bending stress loading, P_b
  - Crack growth loads include dead weight and normal thermal pipe expansion loads in addition to internal and crack face pressure
  - Critical crack size calculations included normal operating thermal loads in addition to internal and crack face pressure and dead weight loads

Evaluation Case Matrix

Weld Residual Stresses

- Input obtained from design drawings & shop travelers
- Fabrication Steps affecting weld residual stress (WRS)
  - Fill-In Weld under thermal sleeve (Surge)
  - Fillet Welds (Safety/Relief)
  - Stainless steel field weld to pipe
- Repairs
  - Deep ID Repairs
- Either thermal strain applied to simulate WRS profile or WRS FEA results directly input to crack growth model

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Evaluation Case Matrix

Crack Growth Rate Equation

- Sensitivity cases examine the effect of main uncertainties in the MRP-115 Crack Growth Rate (CGR) equation:
  - Uncertainty in the K_I power-law exponent (nominal 1.6) addressed by crack growth sensitivity cases assuming 5th and 95th percentile exponent values from MRP-115 statistical fit to laboratory CGR data
    - Power-law constant adjusted for these sensitivity cases to maintain 75th percentile value used for MRP-115 deterministic equation
  - Uncertainty in power-law constant itself addressed simply by scaling factor on time
    - 95th percentile constant is 1.77 times 75th percentile constant value
- No credit taken for a PWSCC crack growth K_I threshold

Evaluation Case Matrix

Initial Flaw Geometry

- Sensitivity cases investigate the effect of initial flaw geometry
  - Initial depth
  - Initial aspect ratio (2c/a) or 360° uniform depth surface flaw
  - Initial shape factor (e.g., low shape factor to semi-ellipse to uniform depth)
- Sensitivity cases indicate that crack profile upon through-wall penetration (or upon crack arrest) is insensitive to initial flaw shape for a given aspect ratio and depth.

Evaluation Case Matrix

Effect of Multiple Crack Initiation Sites

- Sensitivity cases investigate the effect of multiple crack initiation (e.g., Wolf Creek surge nozzle NDE results)
  - Enveloping of multiple initial flaws with one modeled flaw
  - Modeling of a part-depth 360° flaw
  - Growing multiple individual flaws and then combining on a single weld cross section for stability calculation

Evaluation Case Matrix Description

- Up to three WRS profiles applied to each case
  - Geometry and load base cases (1-20)
    - Axisymmetric WRS
    - Moment load varied up to maximum reported for specific configuration
  - ID repair base cases (21-26)
    - Non-axisymmetric WRS based on ID repair WRS FEA
  - Further bending moment sensitivity cases (27-30)
  - Sensitivity cases to investigate potential uncertainty in as-built dimensions (31-32)
    - Hypothetical ±10% variation in weld thickness
  - Axial membrane load sensitivity cases (33-34)
    - Relatively narrow range in membrane load for each geometry
  - Effect of length over which thermal strain simulating WRS is applied (35)

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Evaluation Case Matrix Description (cont'd)

- Simulation of elastic-plastic redistribution of stress at ID (36)
- Effect of initial crack shape and depth (37-41)
- Effect of stress intensity factor dependence of crack growth rate equation (42-47)
  - 5^{th} percentile exponent of 1.0 or 95^{th} percentile exponent of 2.2 assumed
- Effect of pressure drop along leaking crack (48)
  - Other cases assume full primary pressure applies to leaking crack face
- Effect of relaxation of normal operating thermal load (49-51)
  - For through-wall portion of crack growth progression, the normal thermal load has been eliminated for these sensitivity cases (for crack growth, leak rate, and critical crack size calculations)
- Effect of nozzle-to-safe-end crack growth model vs. standard cylindrical crack growth model (52-53)
  - Investigate effect of detailed geometry
- Supplementary cases specific to effect of multiple flaws on limiting surge nozzles (S1-S8)

Calculating Critical Crack Size

Approach

- The flow strength for net section collapse (NSC) based on the safe end material tensile properties
- NSC equations developed by Rahman and Wilkowski were used to calculate critical crack size for an arbitrary crack shape
  - Spreadsheet calculation was verified against Arbitrary Net Section Collapse (ANSC) software developed by Structural Integrity Associates
- Full thermal stress used to calculate the critical crack size
  - Full scale SS and Alloy 600 pipe tests and piping system FEA compliance studies support reduced thermal loads prior to collapse
- Applied Z-factor to reduce supportable moment to consider effect of EPFM failure mechanism
  - Full scale SS and Alloy 600 pipe tests support limit load failure mechanism
  - Comparison of J-R curve fracture toughness demonstrates Alloy 182 weld metal is similar to the pipe test materials
- Critical load for various calculated crack growth progressions checked against reported operating load to determine load margin factor vs. time

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Calculated Crack Leak Rate

- Leak rate calculations using two standard industry codes
  - PICEP and SQUIRT
- Flow rate through the crack based on PWSCC morphology
- Leak rate calculations based on crack opening displacement (COD) from FEA rather than standard COD expressions for simplified loading assumption

Evaluation Criteria

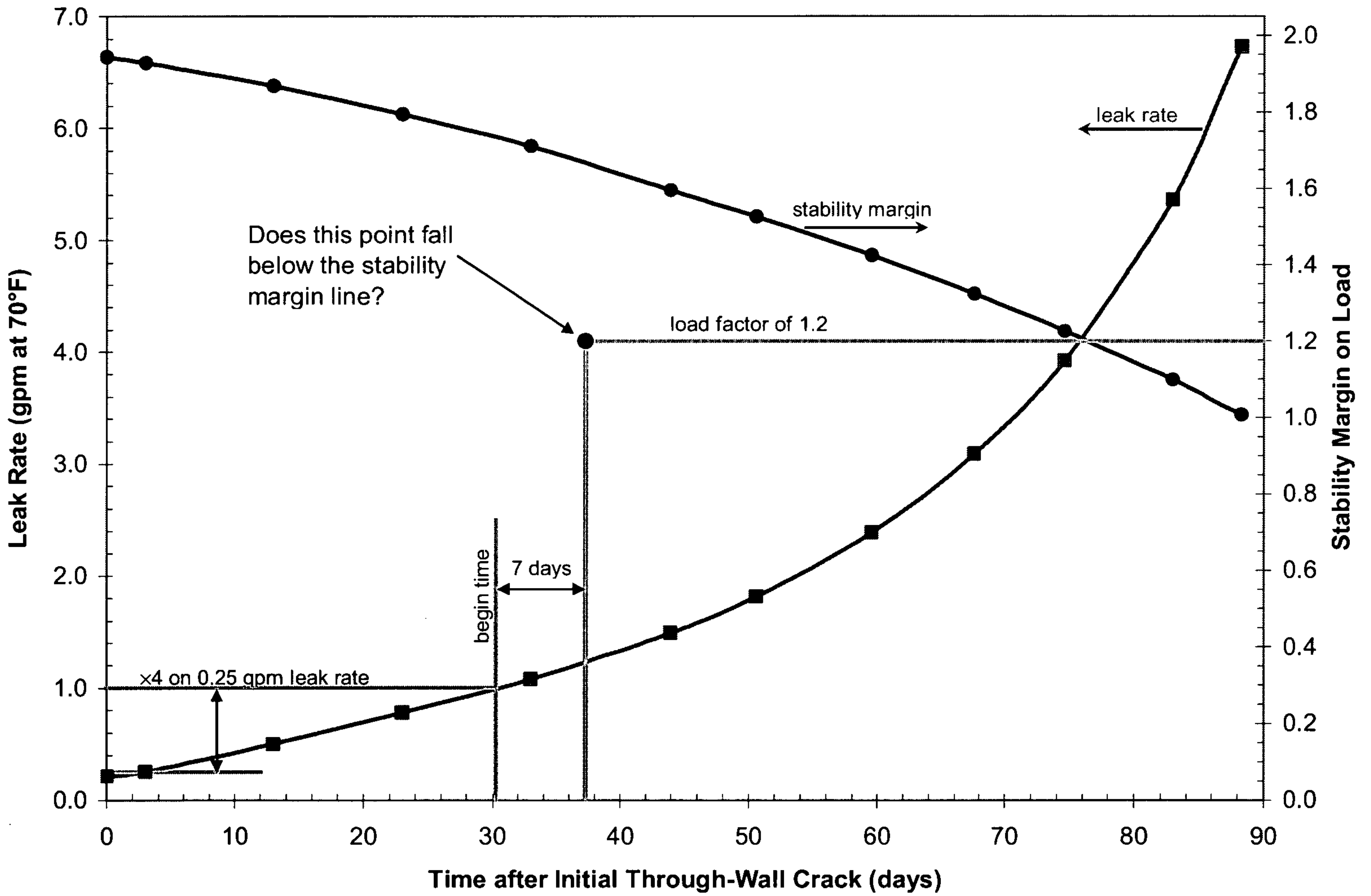

Illustration of Approach for Hypothetical Leakage and Stability Data

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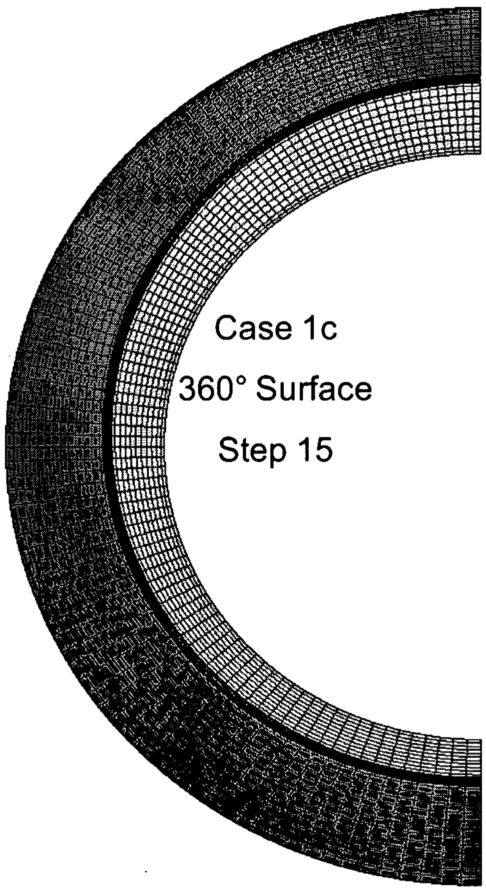
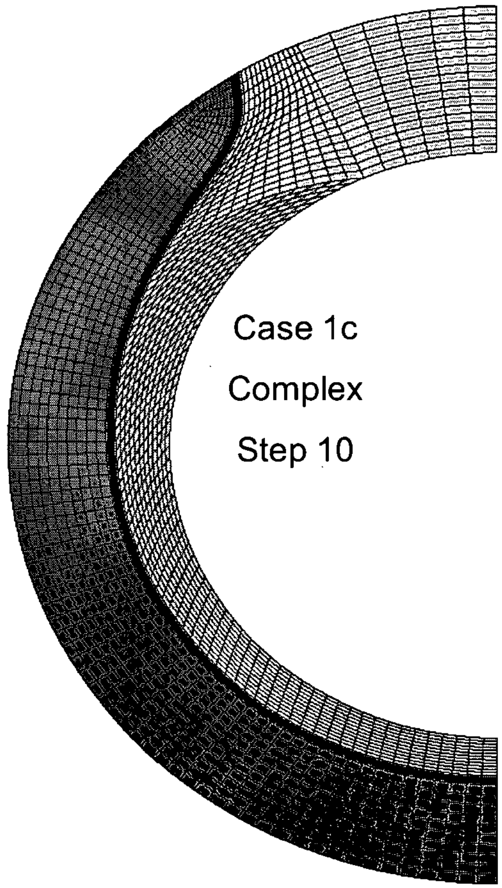
Example FEACrack Meshes



Safety and Relief Case

from 360° 10%TW surface crack

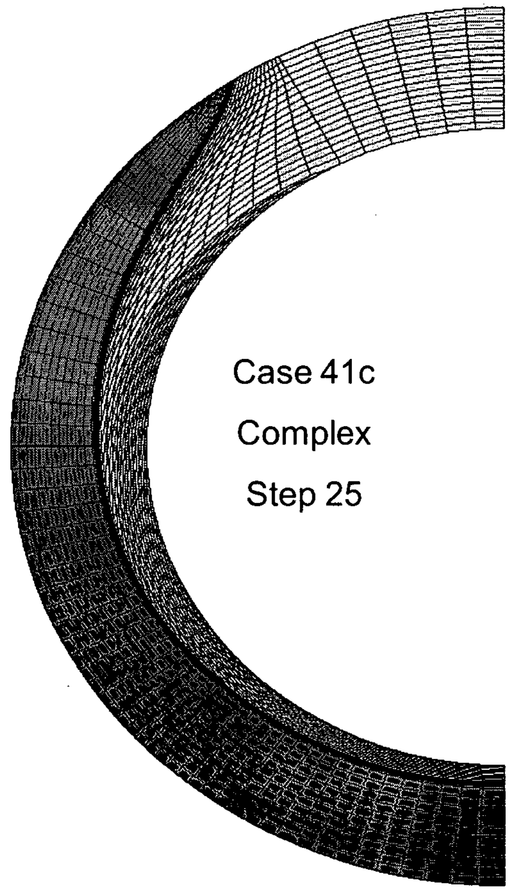
Axisymmetric WRS



Safety and Relief Case

from 360° 10%TW surface crack

Axisymmetric WRS

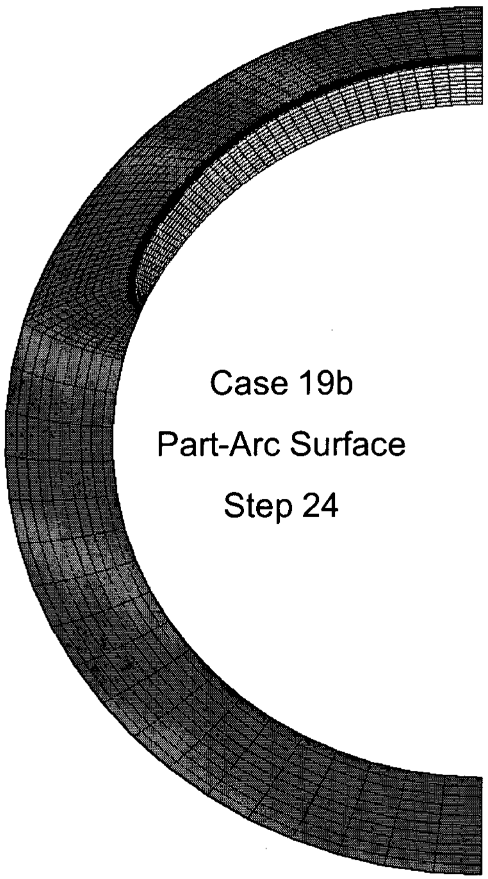


Safety and Relief Case

from 21:1, 40%TW surface crack

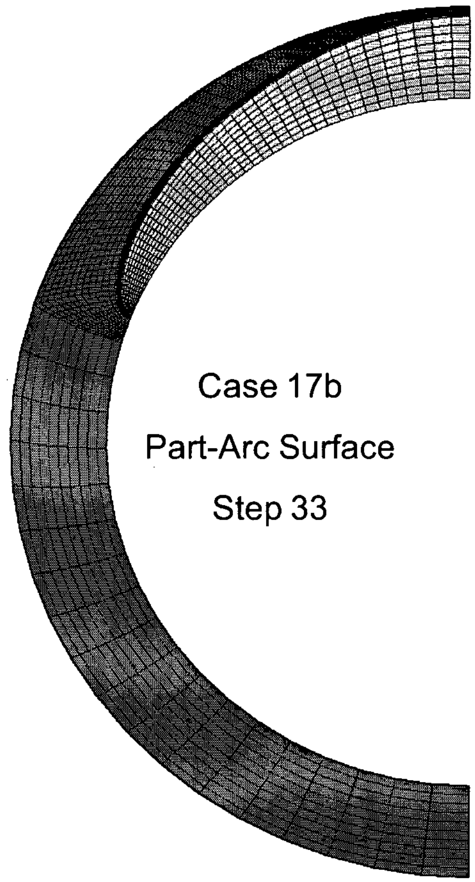
Axisymmetric WRS

Example FEACrack Meshes (cont'd)



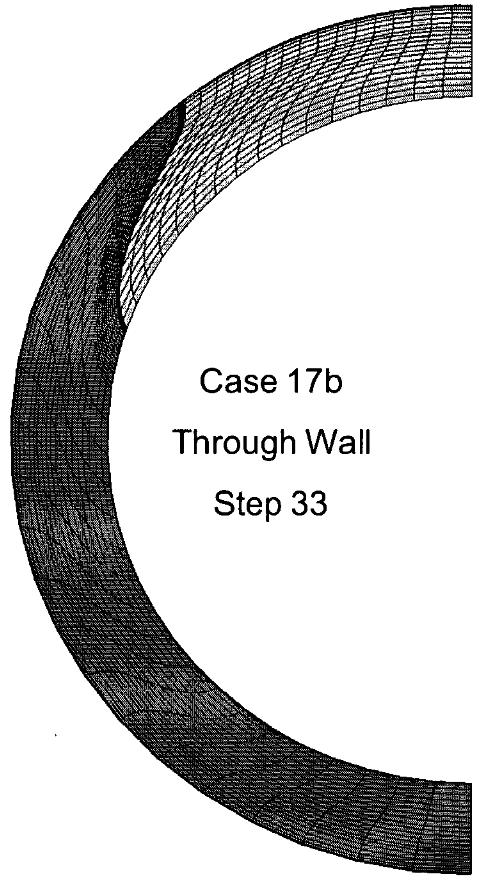
Surge Case

w/ SS Weld, Axisymmetric WRS



Surge Case

w/o SS Weld, Axisymmetric WRS



Surge Case

w/o SS Weld, Axisymmetric WRS

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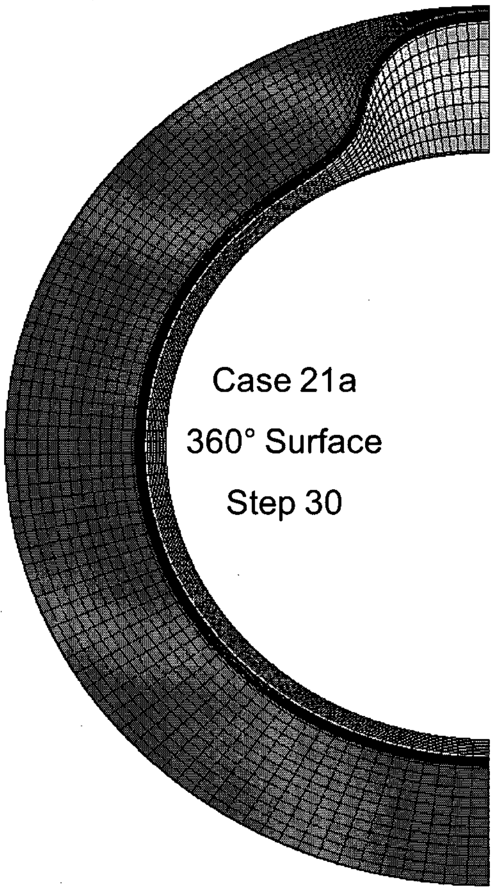
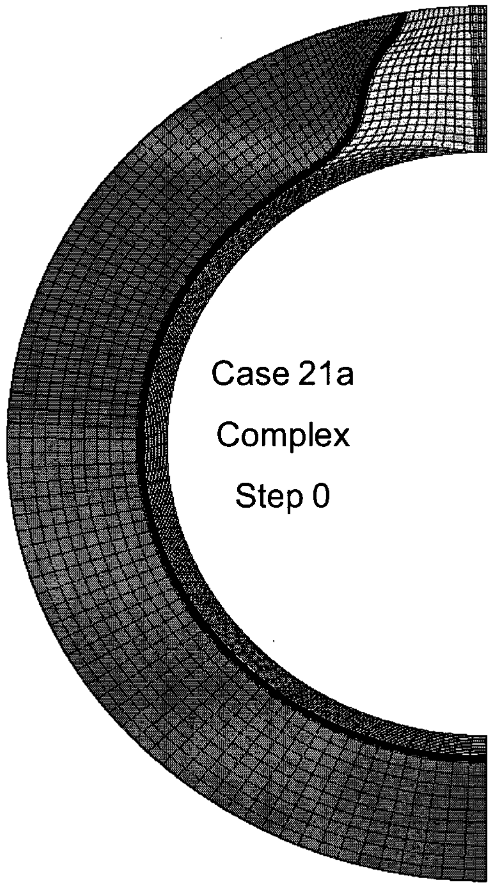
Example FEACrack Meshes (cont'd)



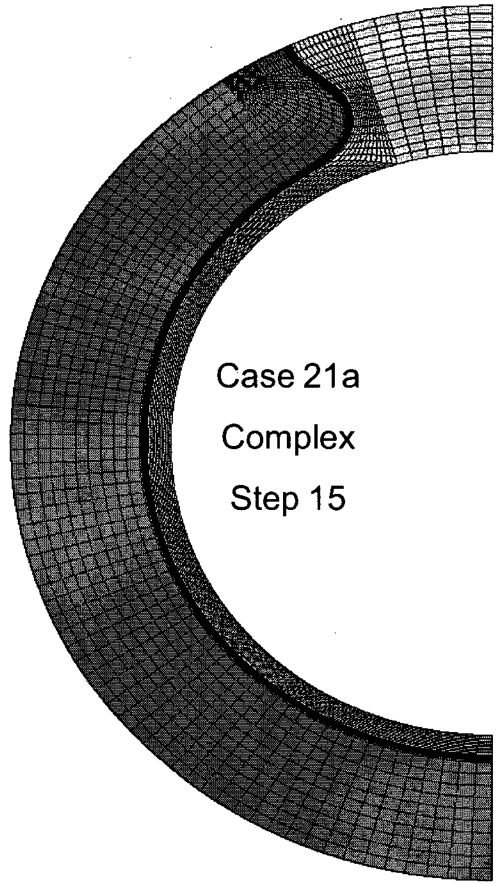
20° ID Repair Case

w/o SS Weld



20° ID Repair Case

w/o SS Weld



20° ID Repair Case

w/o SS Weld

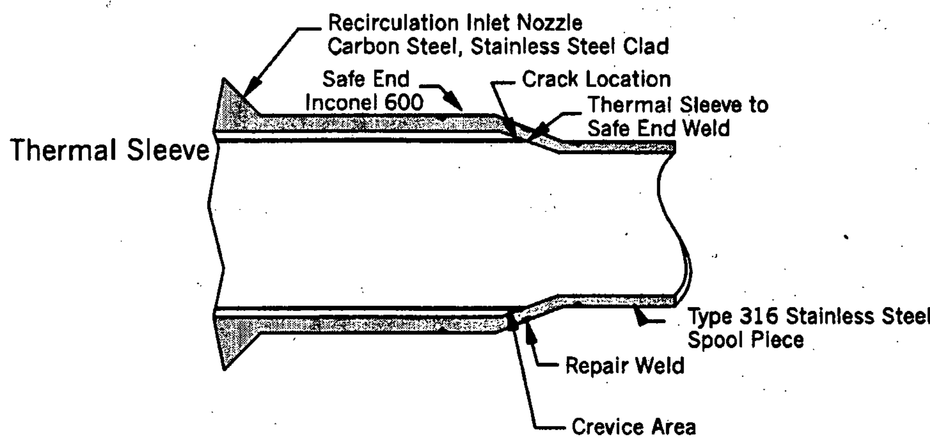
Preliminary Results

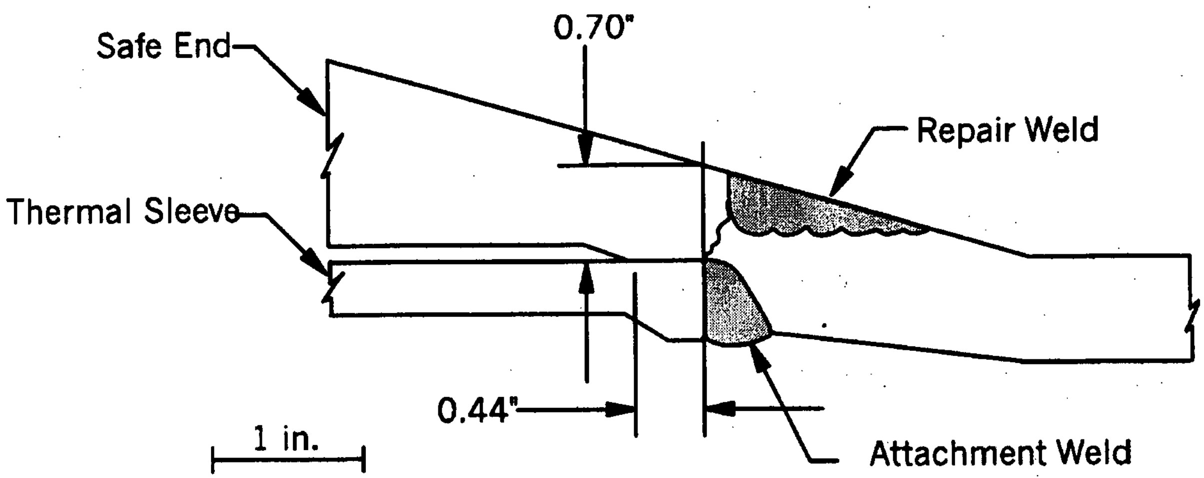
- All 103 completed cases in the main sensitivity matrix showed either
  - stable crack arrest (59 cases), or
  - crack leakage and crack stability results satisfying the evaluation criteria (44 cases)
  - generally considerable margins beyond evaluation criteria
- 9 supplemental cases further investigated effect of multiple flaws on limiting surge nozzle cases
  - Conservative application of the three indications found in the Wolf Creek surge nozzle weld to limiting surge nozzles (fill-in weld and relatively high moment load) gives results meeting the evaluation criteria with additional margin
  - On this basis, it is concluded that the concern for multiple flaws in the limiting surge nozzles is adequately addressed by cases that satisfy the evaluation criteria with additional margin

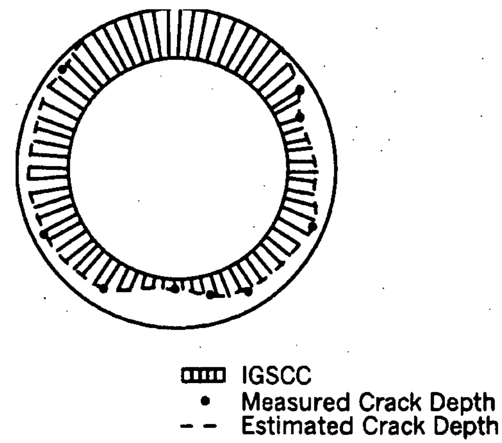
Validation

Duane Arnold Circumferential Crack

- The Duane Arnold crack was applied as a validation case
  - *From MRP-113:* Crack initiation and growth were attributed to the presence of a fully circumferential crevice that led to development of an acidic environment because of the oxygen in the normal BWR water chemistry, combined with high residual and applied stresses as a result of the geometry and nearby welds. The water chemistry conditions that contributed to cracking at Duane Arnold do not exist for the case of Alloy 82/182 butt welds in PWR plants.







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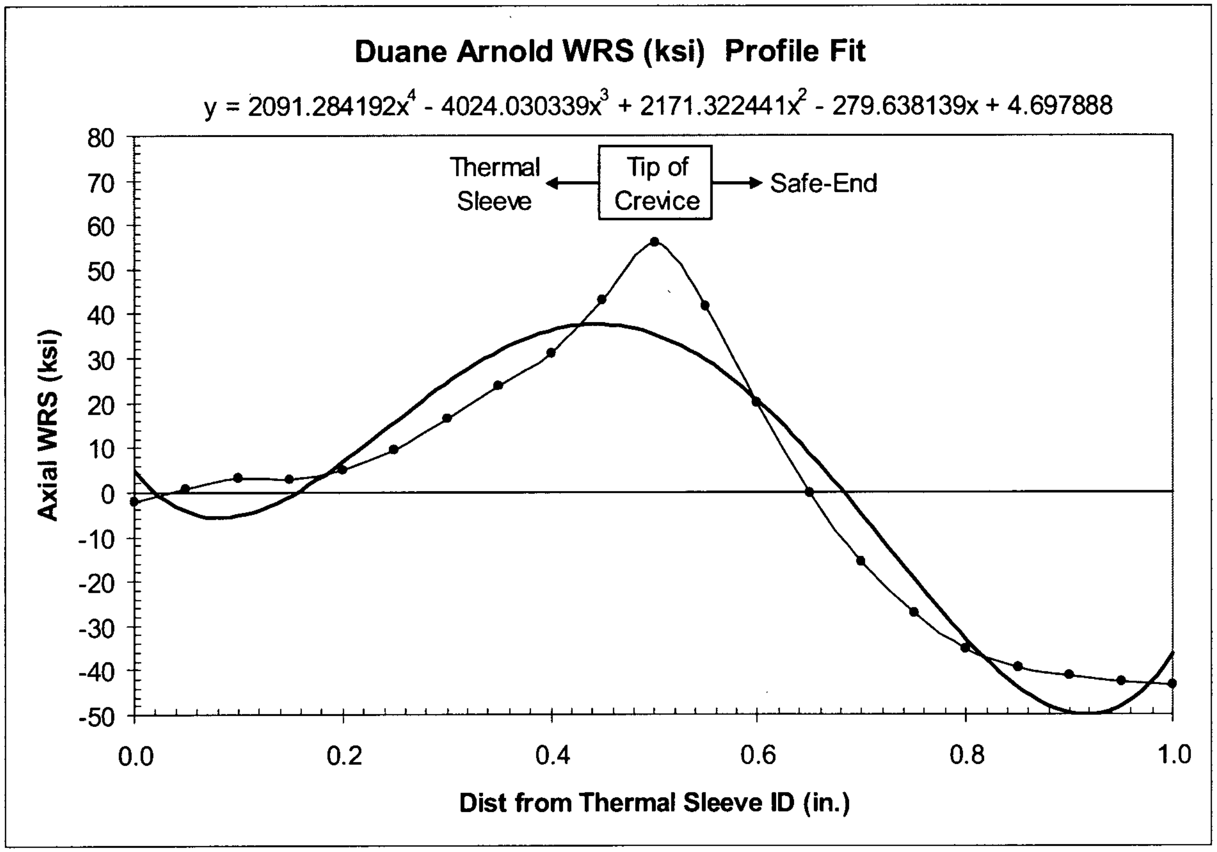
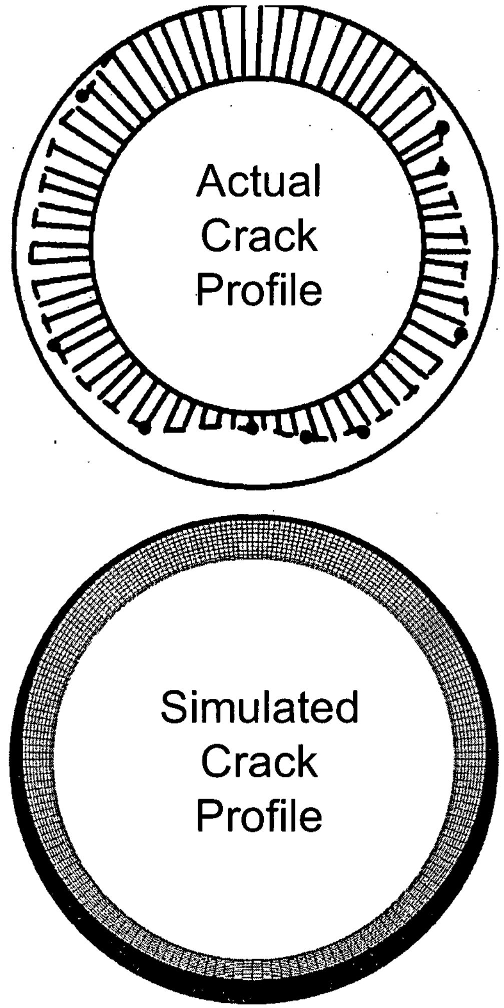
Validation (cont'd)

Duane Arnold Circumferential Crack





From 30% TW 360° Surface Flaw

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Preliminary Conclusions

- Assumption of semi-elliptical flaw shape shown to result in large unnecessary overconservatism
- All 51 subject welds are adequately covered by crack growth sensitivity cases that satisfy the evaluation criteria
- Results show tendency of circumferential surface cracks to show stable arrest
  - Axisymmetric welding residual stress profile must self-balance
  - Consistent with Wolf Creek experience given unlikeliness that four indications found in narrow depth band were growing rapidly at that time
- Sensitivity cases indicate a large beneficial effect of relaxation of secondary loads upon through-wall penetration
  - Detailed evaluations tend to support such a relaxation effect
  - Not credited in main cases

Advanced Finite Element Analyses of Pressurizer Nozzle Weld Flaws

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Protecting People and the Environment

Ted Sullivan & Al Csontos, Ph.D

July 11, 2007

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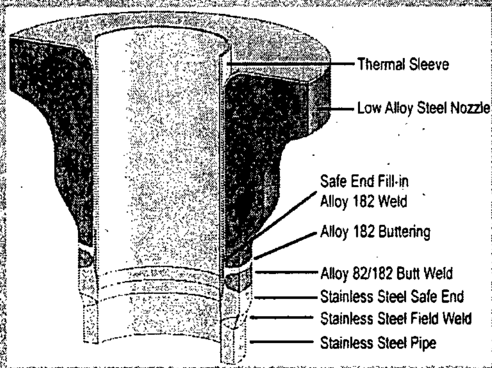
PWSCC in Alloy 82/182 Dissimilar Metal Butt Welds

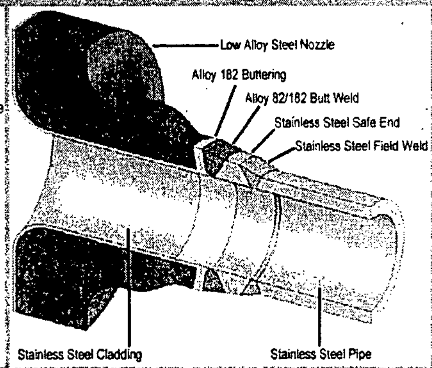
- Operational experience at Wolf Creek:
  - 5 circumferential indications found:
    - 1 in relief nozzle-to-safe end weld (7.7" ~26% through wall [TW])
    - 3 in pressurizer surge line nozzle-to-safe end weld (4" ~31% TW, 2.2" ~25% TW, & 0.8" @ ID surface)
    - 1 in safety nozzle-to-safe end weld (2.5" ~23% TW)
- NRC concerns:
  - **First case of multiple, long, circumferential flaws**
  - While axial flaws lead to leaks, circumferential flaws may lead to pipe rupture

Westinghouse Pressurizer Dissimilar Metal Butt Welds

Surge Nozzle-to-Safe End Dissimilar Metal Weld



Safety/Relief Nozzle-to-Safe End Dissimilar Metal Weld



NRC Wolf Creek Scoping Analysis: November 2006

- NRC staff in RES conducted a Scoping Study
- Purpose:
  - Evaluate the component integrity of the pressurizer nozzle welds using ASME Section XI flaw evaluation methodology
  - Calculate leakage rates from potential TW cracks
- Objectives of this study were to determine:
  - Time for the flaw to grow from current size to leakage
  - Time from leakage to rupture
  - Leakage rates from emerging TW flaws
- Outcomes:
  - Should inspections/mitigations be accelerated?
  - Are current leak detection thresholds adequate?

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NRC Wolf Creek Scoping Analysis: Results

- Surge nozzle results:
  - Leakage predicted to occur 1-2.2 years after discovery
  - All cases show at least 6 months b/w leakage and rupture
- Relief nozzle results:
  - Leakage predicted to occur 1.9-2.6 years after discovery
  - 20/24 cases show leakage and rupture occur simultaneously
    - Surface cracks unstable before growing throughwall
- Safety nozzle results:
  - Leakage predicted to occur 2.6-8.0 years after discovery
  - 8/24 cases show leakage and rupture occur simultaneously

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Regulatory Summary

- NRC staff concluded that inspections/mitigations need to be accelerated for some plants
- NRC staff concluded that enhanced reactor coolant system leakage monitoring frequency, action levels & actions needed to be put in place
- NRC issued Confirmatory Action Letters to:
  - Ensure enhanced leakage monitoring in place
  - Complete inspection or mitigation by the end of 2007
  - However, if industry's proposed advanced finite element analyses (FEA) provide reasonable assurance of safety, plants with outages planned in 2008 may avoid their 2007 outages

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Advanced FEA Project: Background

- Purpose:
  - Evaluate the component integrity of the pressurizer nozzle welds with new advanced FEA software for circumferential flaws that removes artificial conservatisms found in NRC Wolf Creek Scoping Analysis and ASME Section XI Code.
    - artificial constraint of the semi-elliptical crack shape
    - allow the crack to grow in a more realistic manner as a function of the stress intensity factor
- Objective:
  - Evaluate viability of through-wall leakage prior to rupture for the pressurizer nozzle-to-safe end dissimilar metal welds for the 9 PWRs that had planned to perform inspection/mitigation during the spring 2008 outage season

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Advanced Finite Element Analyses of Pressurizer Nozzle Weld Flaws: NRC Confirmatory Program

Ted Sullivan & Al Csontos, Ph.D

July 11, 2007

Advanced FEA Project: NRC Confirmatory Program

- NRC confirmatory program developed to benchmark, verify, and evaluate industry's analyses and results
- NRC staff interacting with the industry to provide timely input on the project analytical approach, modeling methodologies, and sensitivity study
- NRC provided comments by letter dated March 5th
- NRC staff reached agreement with the industry representatives on the analytical approach, modeling methodologies, and the matrix of sensitivity cases used in their analyses

Advanced FEA Project: NRC Confirmatory Program

- Industry & NRC independently developed:
  - Separate fracture mechanics based advanced FEA models that evaluate crack growth at each point on the crack front as a function of the stress intensity factor at that point
  - Separate axisymmetric WRS models for the various nozzle types, geometries, and fabrication processes
- Industry & NRC benchmarked:
  - Calculated K-solutions for arbitrary cracks to prove the advanced FEA models produced comparable K-solutions
  - Axisymmetric WRS models for the various nozzles
- K-solutions and WRSs benchmarking showed good agreement between industry's and NRC's models

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Advanced FEA Project: NRC Confirmatory Program

- NRC reviewed the fabrication drawings for the 9 PWRs scheduled to perform inspections/mitigations in the spring 2008 outage season
- Typical fabrication steps were shown to affect WRS:
  - Backchipping and last past 360° ID welds at certain Westinghouse plants produced tensile ID axial stresses
  - SS safe end welds generally reduced the ID tensile stresses when modeled with the last pass 360° weld
- Industry and NRC WRS models are being validated using an EU round robin study on dissimilar metal butt weld WRS modeling and measurements

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Advanced FEA Project: NRC Confirmatory Program

- Advanced FEA project evaluated in two parts
- Phase I Wolf Creek relief nozzle reevaluation:
  - Reevaluate scoping analysis results with new model
  - Good agreement between industry & NRC model results
  - Unlike the NRC Wolf Creek scoping study results, margins were predicted for the time between leak and rupture
- Phase II parametric sensitivity study:
  - Evaluate margin between detectable leakage and rupture through a matrix of sensitivity cases with plant specific nozzle geometries, loads, & WRS
  - Industry evaluating 117 sensitivity cases
  - NRC confirming ~25 sensitivity cases

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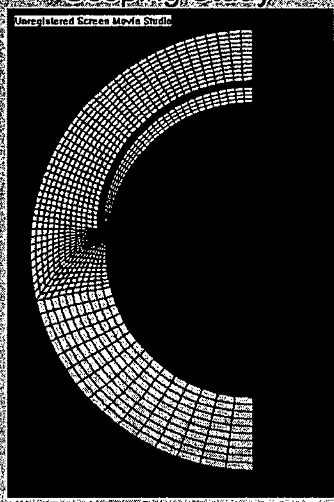
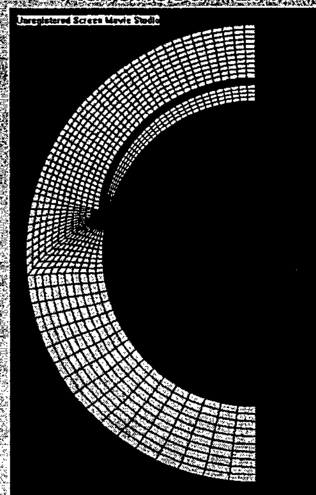
Advanced FEA Project: NRC Phase I Results

Scoping Study



Advanced FEA



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Advanced FEA Project: NRC Phase II Results

- Evaluated 4 safety/relief, 3 spray, & 3 surge nozzle cases from the industry's base cases with modifications
- To date, NRC has evaluated 20 cases not including the Phase 1 reevaluation of the 2006 NRC scoping analysis
- NRC may evaluate further cases depending upon the industry's results in their draft report
- For the limited cases evaluated, Phase II results show generally good agreement between the industry & NRC advanced FEA model results

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Project Completion

- Industry provided and is scheduled to provide:
  - Results for the majority of the 117 cases on July 7
  - Draft project report to the NRC on July 10
  - Final project report to the NRC on July 31
- Public meetings scheduled for NRC staff to ask questions on report and to provide comments on draft report
- Public meeting scheduled for early August
- NRC staff to prepare safety assessment by August 31
- Safety assessment to be issued to affected plants with NRC conclusions regarding inspection timing
  - Will address whether or not commitments in CALs for inspection in 2007 can be relaxed for plants with scheduled outages in 2008

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Summary

- NRC confirmatory program developed to benchmark, verify, and evaluate industry's analyses and results
- Phase I results show good agreement between the industry & NRC advanced FEA model results
- In contrast to the NRC scoping study, margins were predicted between leak and rupture for the relief line
- For the limited cases evaluated, Phase II results show generally good agreement between the industry & NRC advanced FEA model results
- NRC staff review of Phase II results underway
- NRC staff has not yet reached any conclusions

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ITAAC Closure Verification Using Sample-Based Inspection Process

Presented At: 544th ACRS Meeting

Richard Rasmussen, Branch Chief, CCIB
Richard Laura, Acting Team Leader, CCIB

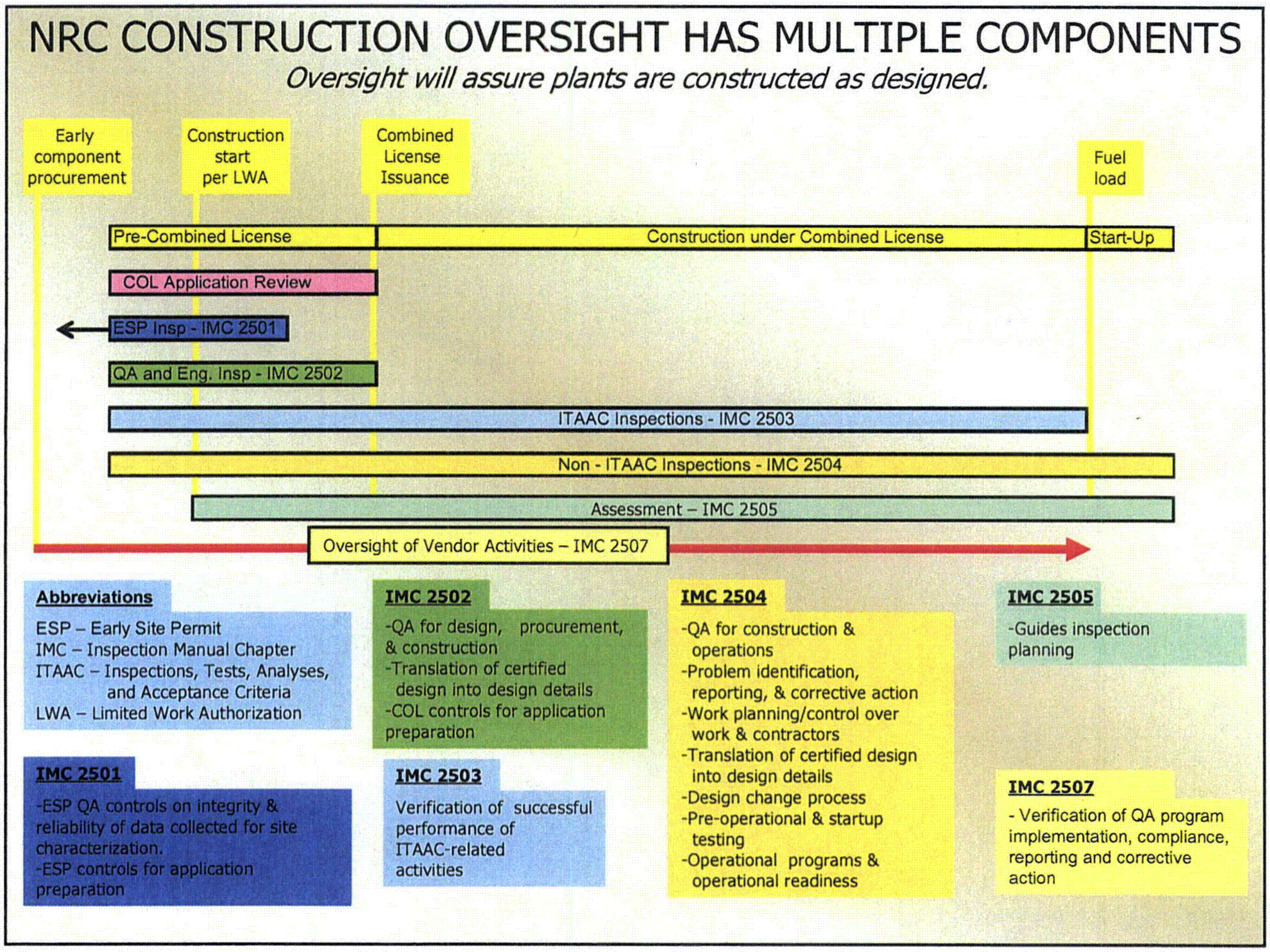
July 11, 2007

Briefing Objective

- Describe the staff approach to inspect and verify closure of ITAAC using a prioritizing and sampling approach.
- Describe why prioritization was chosen as an alternative to statistical acceptance sampling.
- Describe how the formal decision method formulates and ranks decision options (Weil and Apostolakis 2001).

Briefing Overview

- Background – Inspection of ITAAC is a subset of the overall NRC oversight
- Regulatory basis for ITAAC
- Grouping ITAAC
- Inspection prioritization process
- Results
- Conclusion


NRC CONSTRUCTION OVERSIGHT HAS MULTIPLE COMPONENTS
Oversight will assure plants are constructed as designed.
Early component procurement
Construction start per LWA
Combined License Issuance
Fuel load
Pre-Combined License
Construction under Combined License
Start-Up
COL Application Review
ESP Insp - IMC 2501
QA and Eng. Insp - IMC 2502
ITAAC Inspections - IMC 2503
Non - ITAAC Inspections - IMC 2504
Assessment – IMC 2505
Oversight of Vendor Activities – IMC 2507
Abbreviations
ESP – Early Site Permit
IMC – Inspection Manual Chapter
ITAAC – Inspections, Tests, Analyses, and Acceptance Criteria
LWA – Limited Work Authorization
IMC 2502
-QA for design, procurement, & construction
-Translation of certified design into design details
-COL controls for application preparation
IMC 2504
-QA for construction & operations
-Problem identification, reporting, & corrective action
-Work planning/control over work & contractors
-Translation of certified design into design details
-Design change process
-Pre-operational & startup testing
-Operational programs & operational readiness
IMC 2505
-Guides inspection planning
IMC 2501
-ESP QA controls on integrity & reliability of data collected for site characterization.
-ESP controls for application preparation
IMC 2503
Verification of successful performance of ITAAC-related activities
IMC 2507
- Verification of QA program implementation, compliance, reporting and corrective action

ITAAC Basis

- Inspection, tests, analysis and acceptance criteria
- Provide reasonable assurance that the facility has been constructed and will be operated in conformity with the license, the provisions of the Atomic Energy Act, and the Commission's rules and regulations (10 CFR 52.97(b)(1))
- Required to be submitted in the design certification and license applications
- Reviewed and approved by NRC in conjunction with approval of a certified design or issuance of a COL

ITAAC Examples

Design Commitment	Inspection Test Analysis	Acceptance Criteria
The RCPs have a rotating inertia to provide RCS flow coastdown on loss of power to the pumps.	Inspection of the as-built RCP vendor data will be performed.	The calculated rotating inertia of 16,500 lb-ft^2.
Pressure boundary welds in components identified in Table 2.1.3-1 as ASME Code Section III meet ASME Code Section III requirements.	Inspection of the as-built pressure boundary welds will be performed in accordance with ASME Code Section III.	A report exists and concludes that ASME Code Section III requirements are met for NDE of pressure boundary welds.

ITAAC Timeline

- 05/09/05: NRC contracted ISL to recommend sampling process for inspecting ITAAC
- 09/30/05: ISL issued Technical Report on the Prioritization of Inspection Resources for Inspections, Tests, Analyses and Acceptance Criteria (ITAAC)
- 04/25/06: Issued IMC 2503, Inspections of ITAAC
- 06/01/06: Briefed ACRS
- 01/23/07: Public Meeting
- 03/08/07: SECY-07-0047 (ITAAC closure)
- 05/16/07: SRM on SECY 07-0047
- 06/14/07: ITAAC Closure Verification Working Group

ITAAC Implementation

- Licensees perform 100% of ITAAC verification during construction
- Licensee submits closure letter to the NRC
- NRC verifies closure of all ITAAC through documentation review
- NRC inspects a sample of ITAAC-related activities to verify proper ITAAC closure
- NRC documents ITAAC closure verification in the Federal Register
- Commission ensures ITAAC are performed and prior to operation shall find that the acceptance criteria are met

Grouping ITAAC - Matrix

- Each certified reactor design has its own set of ITAAC including: piping, valves, welds, pumps, pipe supports, power supplies, cables, seismic qualification, etc. The total number of ITAAC range from 500 to 1000.
- For the AP-1000 and ABWR designs, the NRC staff evaluated all ITAAC and developed a *Matrix* organized by ITAAC common areas and programs applicable to those common areas. (Slide 11)

Grouping ITAAC

- 19 matrix rows – processes
- 6 matrix columns - programs
- The intersection of each row and column are called ITAAC *families* which have common characteristics and use the same IP.
- Observing performance of ITAAC activity within a family will provide insights that are applicable to the remainder of the family.

THE AP1000 ITAAC MATRIX

	A)As-Built Inspection	B)Welding	C)Construction Testing	D) Operational Testing	E)Qualification Criteria	F)Design/Fabrication Requirements
01)Foundations & Buildings	14				1	4
02)Structural Concrete			1			
03)Piping	10	10	10	4		17
04)Pipe Supports & Restraints						8
05)RPV & Internals	7	2	1	2	1	4
06)Mechanical Components	28	5	6	22	4	22
07)Valves	8	4	6	27	12	20
08)Electrical Components & Systems	15		5	24	8	8
09)Electrical Cable	10		1			11
10)I&C Components & Systems	61		35	63	16	9
11)Containment Integrity & Penetrations	6			1	1	1
12)HVAC	11	3	3	14	2	10
13)Equipment Handling & Fuel Racks	6			5	3	3
14)Complex Systems w/ Multiple Components	25			4	4	6
15)Fire Protection	7		1	2		
16)Engineering	5				2	10
17)Security	3				1	
18)Emergency Planning						
19) Radiation Protection	5				1	1

Rank-Ordering of ITAAC

- Rank-ordering of ITAAC inspection was based on *attributes and associated ITAAC impact* that make one ITAAC more or less important to inspect based on optimizing resources to minimize the possibility of a significant flaw going undetected.

- Step 1: Five *attributes* were developed: safety significance, propensity for making errors (includes higher complexity or inherently difficult tasks), construction and testing experience, opportunity to verify by other means, and licensee oversight.
- Step 2: Expert panels assigned relative weights for attributes using AHP. Then, utility values were assigned for each attribute.
- Step 3: Expert panels determined utility factors for each attribute for each ITAAC.
- Step 4: The results were fed into an algorithm which produced a listing of ITAAC "value of inspection" results.

ITAAC Attributes

- Propensity of Making Errors – The degree of propensity to making errors during fabrication, installation or testing. This may depend on complexity or inherent difficulty of the activity.
- Construction and Testing Experience – Relates to possible first-of-a-kind activity, or performed by company with little nuclear experience.
- Opportunity to Verify by Other Means – The degree that the activity can be verified by observing other functional, pre-operational or performance tests.
- Licensee Oversight Attention – The effectiveness and extensiveness of licensee's oversight attention and QA efforts, including their contractors and suppliers.
- Safety Significance – The safety significance assigned to the system, component, or structure included in the ITAAC.

Utility Theory

- Utility theory approach – prioritized ITAAC by inspection value (slide 15).
- Utility is a figure of merit for a decision option that quantitatively shows how much the decision-maker's values and preferences will be addressed by implementing that option.

ITAAC Rating Data Examples

AP1000 ITAAC	Error Prop.		C & T Exper.		Verify by other means		Lic. Over-sight	Safety Signif.	ITAAC Rank
	B	V	B	V	B	V	B	B	
2.2.3.9a.i	2	2	3	1	4	1	3	4	0.432
3.3.2a.i	3	2	4	1	5	2	3	5	0.658

ITAAC 2.2.3.9a.i - The calculated flow resistance for each in-containment refueling water storage tank drain line is satisfactory.

ITAAC 3.3.2a.i - The as-built nuclear island structures, including critical sections, conform to design and will withstand design basis loads without loss of structural integrity.

AP1000 ITAAC Assigned to IP65001.06

Family 06A

As-Built Mechanical Components

ITAAC	Rank
2.2.02.07a.iii	0.160
2.2.02.07c	0.307
2.2.02.07f.ii	0.160
2.2.02.08a	0.160
2.2.03.08b.02	0.419
2.2.03.08c.ix	0.419
2.2.03.08c.v	0.419
2.2.03.08c.vi	0.419
2.2.03.08c.vii	0.419
2.2.03.08c.viii	0.419
2.2.03.08c.xi	0.419
2.2.03.08c.xiii	0.289
2.2.03.08d	0.289
2.3.02.08a.ii	0.124
2.3.03.03a	0.124
2.3.03.03b	0.124
2.3.03.03d	0.124
2.3.06.05a.i	0.124
2.3.07.07b.i	0.124
2.3.07.07b.ii	0.124
2.3.09.01	0.124
2.3.09.03.i	0.124
2.3.09.03.iv	0.124
2.3.10.05a.i	0.089
2.3.11.02.i	0.089
2.3.12.01	0.089
2.3.14.03	0.089
2.5.05.02.i	0.124

Family 06B

Welding Mechanical Components

ITAAC	Rank
2.1.02.03a	0.520
2.2.01.03a	0.520
2.2.03.03a	0.520
2.3.02.03a	0.225
2.3.06.03a	0.261

Family 06C

Construction Testing Mechanical Components

ITAAC	Rank
2.1.02.04a	0.289
2.1.02.08c	0.367
2.2.01.04a.i	0.419
2.2.03.04a	0.289
2.3.02.04a	0.089
2.3.06.04a	0.124

Family 06D

Operational Testing Mechanical Components

ITAAC	Rank
2.1.02.08b	0.497
2.2.02.07a.i	0.381
2.2.02.07b.i	0.400
2.2.02.07d	0.381
2.2.02.07e.ii	0.178
2.2.02.07f.i	0.178
2.2.03.08b.01	0.596
2.2.03.08c.i	0.589

Family 06D

Operational Testing Mechanical Components

ITAAC	Rank
2.2.03.08c.ii	0.562
2.3.02.08a.i	0.142
2.3.02.08a.iii	0.142
2.3.02.08b	0.089
2.3.02.12b	0.124
2.3.03.03c	0.142
2.3.06.09b.ii	0.178
2.3.06.09c	0.178
2.3.06.09d	0.178
2.3.07.08.ii	0.142
2.3.08.02.i	0.178
2.3.08.02.i	0.178
2.3.09.03.ii	0.219
3.3.10.i	0.497
3.3.10.ii	0.529

Family 06E

Qualification Criteria Mechanical Components

ITAAC	Rank
2.3.06.05a.ii	0.295
2.3.10.05a.ii	0.260
2.3.11.02.ii	0.260
2.5.05.02.ii	0.295

Family 06F

Design/Fab Requirements Mechanical Components

ITAAC	Rank
2.1.02.02a	0.532

Family 06F

Design/Fab Requirements Mechanical Components

ITAAC	Rank
2.2.01.02a	0.532
2.2.01.04a.ii	0.622
2.2.02.05c	0.300
2.2.02.07a.ii	0.381
2.2.02.07b.ii	0.402
2.2.02.07b.iii	0.402
2.2.03.02a	0.532
2.2.04.08b.ii	0.160
2.3.01.03.i	0.269
2.3.02.02a	0.237
2.3.03.02	0.277
2.3.03.02	0.277
2.3.06.02a	0.273
2.3.06.05a.iii	0.301
2.3.06.09b.i	0.287
2.3.07.08.i	0.252
2.3.08.02.ii	0.287
2.3.10.05a.iii	0.265
2.3.10.05a.iii	0.265
2.3.11.02.iii	0.235
2.3.11.02.iii	0.235
2.3.11.03a	0.124
2.3.12.02	0.089
2.5.05.02.iii	0.301

Portfolio Perspective or Coverage Check for all ITAAC

- For the baseline inspection program, a threshold of .4 was selected based on engineering judgment, to provide an adequate sampling of overall ITAAC activities.
- To ensure that all ITAAC families are inspected, matrix families with no ITAAC greater than the .4 threshold are inspected by selecting one ITAAC.
- Flexibility for NRC Region 2 to modify inspections, on a limited basis, to ensure the sample is representative of the total population.

Results

- For the AP-1000, 233/672 ITAAC were selected which is 35%.
- For the ABWR, 383/881 were selected which is 44%.
- Reviews are in process to determine resource levels needed to complete the baseline inspection program.
- Licensee performance is monitored as part of the assessment process and NRC can expand the selection of ITAAC samples based on poor performance.

Conclusion/Questions

- The baseline inspection program consists of ITAAC selected for direct NRC inspection using a defined prioritization process.
- The prioritization process optimizes NRC resources.
- Completion of this program will provide reasonable assurance that a significant construction or design translation error does not go undetected.