AFTERNOON SESSION

(1:30 p.m.)

CHAIRMAN APOSTOLAKIS: Our next topic is the need to revise 10 CFR, Part 54, requirements for renewal of operating licenses for nuclear power plants. Dr. Mario Bonaca is the leader.

DR. BONACA: All right. Good afternoon after lunch.

All right. On August 1999, the Commission requested the staff to provide internal analysis and recommendation to the Commission on whether it would be appropriate to resolve generic technical issues raised by the industry in many cases through rulemaking, and we are at the point where the staff has concluded its own evaluation, and we're going to hear from them today.

So I'll turn over the meeting to Mr. Grimes.

MR. GRIMES: Thank you, DR. Bonaca.

My name is Chris Grimes. I'm the Chief of the License Renewal and Standardization Branch.

And rather than repeat the purpose of the meeting too many times because the staff presentation is going to make the purpose of the meeting clear and our message, hopefully, will be clear to you, and we request that the committee support our view at the conclusion of this presentation, that there's no need to revise the license renewal rule at this time.

And with that I will turn over the presentation to Dr. Sam Lee. Sam was the team leader who headed up the development of the regulatory guidance and standard review plan for license renewal, and he's going to explain the extent to which we've explored the possibility of rulemaking.

Sam.

DR. LEE: Yeah, my name is Sam Lee. I'm from the License Renewal and Standardization Branch, NRR. And with me here today I have Greg Galletti, Brian Thomas, and Steve Koenick coming up here from the NRR staff so that they will be here in case your questions they can answer.

About two years ago in response to SECY 99-148, the Commission directed the staff to prepare the improved license renewal guidance document that used the generic lessons learned, the core report, the standard review plan, and the reg. guide for license renewal.

In the same SRM, the Commission also directed the staff to prepare a recommendation on whether the license renewal rules should be revised.

And we have held a public meeting to get comments on whether there's a need to review the rule, and we plan on providing our recommendation to the Commission by the end of August.

The ACRS has previously provided their comment in a letter responding to the improved generic guidance documents, and the ACRS indicated that the staff should encourage applicants to provide scoping process results in the application, and that would have the review process and to make the information more transparent.

The staff agrees with this committee. The initial license for new applicants have provided this information for staff review, and also the standard review plan and industry guidance NEI 95-10 indicate that such information should be provided. The staff recommendation is that we will continue to work with industry to clarify the guidance document that address these comment.

MR. GRIMES: Excuse me, Sam.

I would like to point out that we're making a distinction here between acting on a recommendation to provide the information in a voluntary way as opposed to codifying a requirement for the results of the scoping process in more detail as a requirement in the rule.

So all of these comments relate to possible changes to the rule.

DR. LEE: Okay. The Union of Concerned Scientists originally planned to attend the public meeting. However, they were not able to. So they provided comment and a letter, and they have three comments.

The first comment, and the Union of Concerned Scientists, UCS, indicated that the license renewal rules should be revised to add the rad waste system into the scope of license renewal because the failure of such systems can cause excessive release of radioactivity into the environment.

The UCS had previously provided this as a rulemaking petition to establish regulating this separately under the petition process.

The second comment is that the UCS cited cases where the equipment had failed because of aging and caused plant shutdown since last year. Since the beginning of last year they cited about eight cases. So their comment is that we should define the minimum standards for an effective aging management program.

We have looked at the eight cases that were cited by UCS. Only one case that relates to the

Indian Point 2 steam generator degradation, related to passive component, and that's already been addressed in the Gall report.

The other cases relate to active components, such as transformers, sonar (phonetic) valves and breakers. Active components are addressed by the current regulatory process, and they are not subject to the additional requirements of license renewal.

And regarding the effective aging management programs, the guidance documents, the improved guidance documents evaluates programs using ten program elements, such as the scope of the program, the problem with this monitor acceptance criteria, corrective action, operating experience.

The staff recommendation is that we'll clarify the guidance document to address this problem, and in particular, relate to the element of operating experience.

The last comment is that the staff is accepting applicant commitments to perform one time inspections many years from now, to confirm that either aging is not occurring or it's occurring at such a slow rate that you do not need an aging management program.

UCS comment is that should the one time inspection be real aging degradation, the licensee at that time of renewal license would cite back the protection if the program need to be changed.

The staff believes that if aging degradation is detected by one time inspections, the plant's QA program would identify the appropriate corrective action, and should the staff consider changing previously approved aging management programs, back-fit is the appropriate regulatory process to evaluate the needed changes.

And again, we will consider clarifying the guidance document to address the one time inspection comment.

Okay. The industry through NEI provided the comment and letter, and NEI indicated that rulemaking is not necessary at this time, similar to what Chris had indicated earlier, and NEI is going to make a separate presentation after the staff.

Our conclusion, the staff recommendation. Based on the experience of renewing license renewal applications and developing the improved license renewal guidance document, the staff believes that rulemaking is not necessary at this time.

The improved license renewal guidance

documents are living documents, and we plan on clarifying and updating them to address these comments and also additional experience from future license renewal reviews and the ongoing NEI demonstration project in which industry is using these documents to prepare sample application sections.

And the staff will continue to monitor the license renewal process and experience and other rulemaking activities done by license renewal.

That concludes our presentation.

DR. BONACA: On slide number four under the first comment by UCS, your recommendation was to address rad waste systems under rulemaking petition process. Could you expand on that?

MR. KOENICK: Yes. What we do is in accordance with some interim guidance that NRR issued in February, we have a petition for rulemaking process. As part of this process, this is also consistent with NUREG ER-53, which is NRC regulations handbook, and what we do is we have a working group with disciplines represented, and we come up with a recommendation that goes through a Petition Review Board, and then we document our resolution, and then follow up with the necessary actions.

DR. BONACA: This is not inconsistent then with your recommendation of not changing the rule right now?

MR. KOENICK: Well, the petition is pre-dispositional now.

MR. GRIMES: This is Chris Grimes.

I'd like to point out that if the petition review process should conclude that the rule should be reviewed to address rad waste systems, and that would go to the Commission then for approval of the rulemaking plan, and if that should occur as Dr. Lee pointed out, that would be an opportunity to change the rule and perhaps do some of these other things that we've recommended clarifying in the guidance.

But right now we are not taking on that, the decision for the petition. That's going through NRR's process.

DR. BONACA: Okay. Thank you.

DR. UHRIG: I have a question. Could you comment on how monitoring rulemaking activities will provide opportunities to improve the license renewal process? This is the last statement on page 6.

DR. LEE: I guess some of the rulemaking activities, for example, okay, like ongoing there's a proposed rulemaking on POP 2 (phonetic), on the formal hearing process, to quote the informal hearing process, and if that would happen, we'll make the conforming changes in POP 4 (phonetic) to go into an informal hearing process.

And also there are other rulemaking activities, such as 55(a) on in-service inspection. That's the referencing ASME code. If the ASME code decides to take up certain aging activities and goes through 55(a), then we'll probably make the conforming changes in POP 54 (phonetic).

DR. UHRIG: Thank you.

DR. BONACA: Any other comments for Dr. Lee?

MR. GRIMES: Dr. Bonaca, this is Chris Grimes.

I would like to sort of add as a postscript that when the Commission issued the staff requirements memo, I think at that time there was some -- we had mentioned some possibility of trying to incorporate generic aging lessons learned into Part 54 in much the same way that the generic environmental impact statement for license renewal is incorporated in Part 51.

We also discussed that at the public meeting, and we concluded that the need to maintain GALL is a living document and continue to fold back experience and expand and clarify GALL as a tool does not lend itself to rulemaking.

And so implicit in this recommendation was a specific consideration of whether or not to codify GALL in Part 54, and we similarly concluded that that would not be appropriate at this time. We may want to consider that later if GALL matures to the point where we think it's sufficiently stable to codify it in rule, but we don't believe that it's right for that opportunity today.

DR. POWERS: I wonder, Sam, if you can explain a little bit. The Commission asked you to do this what they called a detailed analysis and report back to them. We really haven't done a license renewal study completely through for BWR. Why don't you just ask them for a little more time on this one?

DR. LEE: For PWR?

DR. POWERS: BWR.

DR. LEE: Oh, BWR.

MR. GRIMES: I'll tackle that.

DR. POWERS: Sure.

MR. GRIMES: We think we're sufficiently far along with the Hatch review that we haven't seen anything that makes the system distinctions any different from what we've learned in GALL as treatment of aging effects.

DR. POWERS: Do you think you're in a position now you can go ahead and answer the Commission's question?

MR. GRIMES: That's correct. I don't think that we're going to learn so much more in the back end of the Hatch review or even the start of the Peach Bottom review that would change our view about the immediate question of whether or not rulemaking is going to substantially improve the process.

DR. BONACA: Okay. Any other comments from members?

(No response.)

DR. BONACA: If not, thank you for the presentation.

I understand we have a brief presentation from the industry.

MR. NELSON: I don't even know if I need to sit down.

(Laughter.)

MR. NELSON: My name is Alan Nelson. I'm a senior project manager with NEI.

When they asked me if I'd like to give some brief remarks, that was before I knew that they were going to say they agreed with the industry and no rule was needed, but just the same, we'd like to go on the record today.

Basically you're aware we had sent some correspondence into Mr. Grimes on June the 4th. Industry met with the Commission on June 14th, Mike Huffman, and we met with the staff on June 28th, all expressing our interest in seeing that the no rule be forthwith in the near future.

Actually, we've watched three approved re-licenses, six units. We have some experience under our belt. We feel that the process is stable. It's reasonable, and it's predictable.

As was stated by Dr. Lee, we're in the process of evaluating a demonstration project which would -- four applications which would determine, you know, the most efficient and effective way to provide applications looking at the year 2002 and beyond.

We don't believe even through that demonstration process that there would be a need for a rulemaking change, and essentially we agree with the presentation that was made previously.

So I appreciate the time you've given me, and it's less than a tenth.

(Laughter.)

MR. NELSON: You're not going to let me

off the hook that easy?

DR. POWERS: Maybe not quite that easy. I wonder if you care to address the comments that have been made by the Union of Concerned Scientists.

MR. NELSON: As I stated, I've only been on this project about 30 days.

DR. POWERS: Oh, okay. It might be a little difficult.

MR. NELSON: Yes, I'm not in a position to address that, and we certainly addressed it in -- I think we may have made comments on it before, but I'm not sure what they are.

MR. GRIMES: This is Chris Grimes.

Just to make sure that the record is clear, first, Mr. Nelson said that no rule is necessary. I want to make sure that it's understood there is a rule, and we're not proposing to change it, but in terms of the UCS petition to include rad waste systems was sent out for public comment, and I believe that NEI commented on behalf of the industry, and I think that we received comments from the industry related to clarifying the staff's expectations for aging management programs, for which NEI and UCS both, I think, have encouraged us to more clearly articulate the standards of acceptability for effective aging management programs.

So I think that the industry's comments would direct us towards pursuing that improvement in the guidance.

DR. BONACA: And we have noted, too, you know. We made some remarks in the last letter we wrote regarding, for example, small bore piping and lessons learned from Arkansas, whether that would justify changes to GALL. We received a response that essentially GALL is, in fact, a document which is not completed in a certain way. I mean, it is going to be updated to reflect this kind of experience and insights.

And I think it's appropriate not to have it codified. That's just a personal judgment.

DR. UHRIG: Chris, I noticed in the document handed out this morning that the comment period on the Turkey Point license extension application had been extended. Is there a reason for this that's unique to Turkey point or is it something that's going to be done on all?

MR. GRIMES: That was a direction that applies to all license renewals. We had suggested that we were going to shorten the public comment period on the draft environmental impact statement from 75 days to 45 days, which is what the law requires or what the regulations require, and we were doing so for reasons of process improvement efficiencies.

But the Commission felt that shortening the public comment period would damage public credibility of the process, and so they directed us to revert to the 75 days.

DR. UHRIG: Okay. Thank you.

DR. BONACA: Any other questions? If not, I thank you for your comments.

MR. GRIMES: Thank you.

DR. BONACA: Amazing to see such an agreement between the staff and industry. It's good.

DR. POWERS: There must clearly be something wrong, right?

DR. BONACA: No, but I think that considering the amount of technical work that took place and so many issues that were debated, it's encouraging to see that there has been a real process of resolution.

And with that I wonder if any of the members have additional comments to provide. We are going to write a letter, a report to give our perspective, too.

And with that I give it back to you. I note that --

CHAIRMAN APOSTOLAKIS: Excellent job, Dr. Bonaca.

DR. BONACA: -- the meeting in --

CHAIRMAN APOSTOLAKIS: Excellent job. You run us back to schedule.

PARTICIPANT: Perhaps he should run the rest of them there.

CHAIRMAN APOSTOLAKIS: Oh, oh, oh.

(Laughter.)

CHAIRMAN APOSTOLAKIS: What a mistake to welcome you this morning.

Well, the next presentation is scheduled for 2:15 on control rod drive mechanisms, and I think we should not start before the scheduled time.

DR. SHACK: Especially since no one is here.

CHAIRMAN APOSTOLAKIS: Yeah, that might make it a little difficult. So we shall recess until 2:15.

(Whereupon, the foregoing matter went off the record at 1:52 p.m. and went back on the record at 2:14 p.m.)

CHAIRMAN APOSTOLAKIS: Okay. We're back

in session.

We have lost Dr. Shack.

The next item on the agenda is control rod drive mechanism cracking. Dr. Ford, please lead us through this.

DR. FORD: We had a joint meeting of the Plant Operations Subcommittee yesterday, the 10th of July, and a brief by NRR and the industry on CRDM housing cracking at Units 1, 2, and 3 and ANO. This is the first time we've had such a briefing.

As you probably know, there have been many similar incidences of large diameter penetrations due through pressurized water at the heads in the last ten years abroad. It was the first time in this country.

The objective of the meeting was to be briefed by the NRR and research and industry on these incidences with the specific request that we issue a letter giving our comments on the timeliness of issuing a bulletin on this, on these incidences, and also about the timeliness and appropriateness of the actions that are going to be taken.

And Jack Strosnider is going to lead the presentations.

DR. POWERS: Let me understand a little better, Peter.

DR. FORD: Yeah.

DR. POWERS: It seems to me several years ago the French had some cracks in the --

DR. FORD: That's what I was referring to.

DR. POWERS: And it seems to me that at that time, the NRC reacted to that finding and went through and looked at all of -- asked the licensees to look and gave them all a clean bill of health.

DR. FORD: They started at Bujay 3 (phonetic) in 1991 in France, Framatome. I'll let Jack respond to the question about the NRC's response to those particular instances.

MR. STROSNIDER: Good afternoon. Is the microphone working?

My name is Jack Strosnider. I'm Director of the Division of Engineering.

I appreciate the opportunity to talk to the committee this afternoon.

The industry went first yesterday. So I guess the staff will go first today, but hopefully you'll keep me from going into their time.

Anyway, but do you want me to start off to respond to some of the history there?

DR. FORD: Yes.

MR. STROSNIDER: Just briefly, if you go

back to the discovery of cracking at Bujay and then additional operating experience leading into the mid-'90s, we staff did interact with the industry, and the industry provided an assessment of that issue, and we issued a generic letter in '97, 97-01.

The thrust of that generic letter basically was -- the response from the industry was what I'll characterize as an integrated industry program to monitor this situation, and they came up with a susceptibility ranking, and they indicated that the more highly susceptible plants would do examinations of the CRDM penetrations. And they have been conducting those since that time.

And the idea was that the more susceptible plants could serve as leading indicators for what was going on with the fleet. So that's why those inspections, actual eddy current examinations, have been going on.

In addition, licensees were committed under some prior bulletins back in the late '80s to do boric acid walk-downs and look for that on the head.

One of the things that was addressed in the safety evaluations supporting that activity was that axial cracks, you know, did not constitute a significant safety concern. It was partially a matter of leakage, and it would be something that could be detected. That was the expectation at that time. It could be dealt with.

However, it was acknowledged that a circumferential cracking or cracking that could lead to a failure of a penetration were it to occur, that that would be a different situation. That was addressed in the safety evaluations, and there was an expectation that the industry would inform the NRC if that sort of thing occurred, which is what has now happened.

So that's a little bit of the background. Does that answer your question with regard to that?

DR. POWERS: Yes.

MR. STROSNIDER: Good. I wanted to talk about actually five different things today. I guess first of all, I just wanted to give a very general summary, a safety perspective on this.

Then yesterday we had some discussion. The subcommittee focused on some specific technical issues that we were asked to address at today's briefing. So I'm going to talk about those technical issues.

I also want to take a little bit of time to contrast the difference between what the industry has proposed to do and what the NRC, what the bulletin, in fact, is proposing, and that's something we didn't talk about yesterday, but I felt at the end of yesterday's discussion that it would be important to provide that perspective.

I want to talk a little bit then about some of the risk perspectives, and then about additional work that's planned either ongoing or planned.

And finally, I'd like to talk about how this issue fits into the agency's four performance goals.

So just to start off with a summary, and I'll talk in a little more detail in a later slide about the risk aspects of this, but just to give a general safety perspective, the failure of one of these nozzles, the circumferential crack leading to failure of the CRDM penetration and ejection from the vessel head would constitute a loss of coolant accident and also a control rod ejection accident, and like I said, I'll talk a little bit more about what that means from a risk perspective in a later slide, but --

DR. POWERS: What does it mean from a neutronic --

MR. STROSNIDER: -- just to say at this point in time that when we look at the existing PRAs without doing a lot of additional work to try to tailor them to this specific issue, but just taking what's readily available, it tells us that there's a level of risk associated with this event that requires increased attention.

Having said that, I think we should note that the worst crack found to date at one of the more highly susceptible plants in accordance with the industry plant ranking, the remaining ligament had a factor of safety of approximately six to failure. So it's about 165 degrees around the circumference.

The bad think about inconel (phonetic) is that it cracks in these sorts of environments. The good thing about it is that it's very flaw tolerant. All right?

This assessment does not address the issue of continued crack growth rate. We'll talk about that in the next slide.

DR. POWERS: Well, I mean, that's a non-trivial point, isn't it?

MR. STROSNIDER: It's a very important point.

DR. POWERS: I mean you've got a factor of six to failure right now, but if that goes to a factor of zip in two months, that's not a very comforting thing.

MR. STROSNIDER: Right, and I'm going to talk a little bit more about the crack growth rate in the next slide.

I want to make the point that there's no reason to conclude that cracking won't occur in other units and in other nozzle housing. The expectation is that it will. You know, the environment stresses, the material, it's all the wrong combination to support this sort of thing. It's a matter of time then.

With regard to the bulletin, we believe that timely and effective, and I'll talk a little bit more about what we mean by effective in terms of qualification, inspections should provide additional information on the extent of the problem and provide confidence that safety is maintained and regulatory requirements are satisfied.

We'll talk a little bit more about the bulletin. You know, we're asking if people are not performing inspections by certain dates to provide additional justification for that, which would get into some of these other technical issues.

I think also it's important to note, and we added this bullet since yesterday. There was not a whole lot of discussion on this yesterday, although I think Dr. Kress brought it up. If you look at this size loss of coolant accident in terms of the existing risk assessments, it's not expected to provide a challenge to containment integrity.

So from an overall risk perspective, if you look at risk to public health and safety in terms of Part 100 dose consequences, we wouldn't expect a significant challenge there based on the existing calculations.

MR. ROSEN: Jack, on your fourth bullet you say there's no reason to conclude that cracking won't affect additional units. Would you also be able to say that there's no reason to conclude that cracking won't affect additional housings at the plants that have experienced this cracking?

MR. STROSNIDER: Yeah, there's no reason to conclude that additional housings would not experience cracking.

Now, if the people had additional information with regard to the heats of those materials and the fabrication and their susceptibility, you might be able to make some arguments about the timing and that sort of thing or susceptibility, but that sort of information isn't available, and we can't conclude that it's not going to occur.

DR. POWERS: I'm trying to understand a little better on your last point. You're saying that CRDM nozzle failure, not expected to challenge containment integrity given no additional failures.

MR. STROSNIDER: Yes. Well, no, what I'm saying is if you look at the existing PRAs, if you go to the IPEs as an example and you look at the size breaks that we're talking about, they do not provide a significant challenge to containment integrity.

Now, I'll talk later. Okay? When we talk some of the discussion yesterday with regard to risk insights about collateral issues and other damage that might occur that haven't been specifically considered in this sort of evaluation at this point.

DR. POWERS: Well, I guess I'm still missing something because a large break LOCA clearly can challenge containment.

MR. STROSNIDER: It clearly can't?

DR. POWERS: Can challenge containment. An unmitigated large break LOCA accident will definitely challenge containment.

DR. ELTAWILA: Dr. Powers, this is Farouk

Eltawila from Division of Engineering, NRR.

You're correct. Yeah, small break LOCA can lead into a core damage if you have a multiple failure.

DR. POWERS: That's right.

DR. ELTAWILA: I think Jack is going to get into that. So I'm trying to not steal his thunder, but for that particular scenario, if you look at small LOCA, it occurs at the top of the vessel. So really if you would -- management of the inventory, the operator would be able to extend, prolong the injection phase and does not switch to the collision phase, and that's when most of the core damage happens in that situation.

DR. POWERS: So he has to have an additional failure.

DR. ELTAWILA: Absolutely.

DR. POWERS: Okay. So it's a conditional statement. Given no additional failures. Okay.

And also on your control rod ejection, can you explain what the neutronic effects are?

MR. STROSNIDER: Well, only -- and I was going to get into this later, and I've got a slide on some of the risk considerations.

DR. POWERS: Okay. Whenever.

MR. STROSNIDER: Okay. We'll see if we can address that then.

As I said yesterday, following yesterday's discussions, the subcommittee actually toward the end of the meeting provided a list of technical issues that they asked us to talk about today.

Susceptibility model uncertainties, effectiveness of visual inspections, evaluation of crack growth rate. Some risk assessment issues were also on that list, and like I said, I'm going to address those on a separate slide.

I think the industry did a good job yesterday of explaining the operating experience and explaining what we know from a technical point of view that would help us to assess this issue, and also explaining what we don't know. And I think the subcommittee did a good job in zeroing in on some of those issues and they are listed here.

So when we were asked to address this today, the one thing I've got to tell you up front is we don't have the answers. We don't know, for example, what crack growth rates are because there's uncertainty about the chemistry or crack initiation rates because we don't know what the annulus chemistry looks like, and so there's some questions there.

And that's one of the reasons that we're going out with the bulletin, is the request for information, and what I wanted to focus on is how we consider these technical issues in crafting the bulletin and our expectations with regard to the information we're going to get.

We recognize that the susceptibility model certainly has uncertainties in it. We have a lot of experience with trying to put these kind of susceptibility models together, and they're not perfect.

However, we do think that it's a reasonable basis for the graded approach that we've laid out in the bulletin, and if you've looked at that, what you see is that we're recommending different information requests and justifications based on the level of susceptibility.

We've broken the plants into four different categories. For example, the plants that have actually identified leakage and cracking, they need to do -- need to provide justification why they wouldn't do additional volumetric examinations. Plants that are in the first four effective full power years away from being equivalent to a CONY (phonetic), we'd need to provide justification for not doing examinations by the end of this calendar year.

So we think that this is a reasonable model for laying out that sort of graded approach, recognizing that the intent here is to collect additional information to determine what additional actions may be necessary or appropriate.

DR. POWERS: I guess I'm trying to understand why you use the word "reasonable" associated with this, and maybe I almost need to see something quantitative from your model because if you've got a very uncertain -- that's fine. Things can be very uncertain, and you've broken it up into a bunch of blocks in there, but I don't have a feeling for how relative to the size of those blocks -- how big your uncertainties are.

If you say four effective power years away from a CONY, it could be four or as small as six months?

MR. STROSNIDER: Yeah, and unfortunately, we don't have the information to quantify that uncertainty. When you look at what drives the susceptibility here and you look at the variables that are important, you start off with time and temperature, and those are the two variables that were used in this susceptibility model, and they clearly are the dominant factors.

DR. POWERS: Okay.

MR. STROSNIDER: Then you get into issues like the microstructure of the material, you know, carbide distribution of the grain boundaries, that sort of thing. That information is not available.

Fabrication history, you know. What did it take to get this particular penetration inserted? Did it have to be straightened? What sort of chemicals might have been used in cleaning, et cetera?

And that sort of information just isn't available in some cases or in other cases, you know, it just hasn't been pulled together yet to be put into the sort of quantitative assessment that you're looking for.

So we know there's uncertainties in it. We have experience from the earlier susceptibility ranking, which, in fact, was off by several years, okay, ten years or more in the case of predicting some of the cracking. All right?

So we know that uncertainty is there, but the ability to quantify it doesn't exist, and what we're proposing in the bulletin is that we've just looked at the data in terms of some natural breaks with regard to how the plants are grouped and said, "Here's some higher and medium ranked plants," and you know, tailored the information request based on that.

The idea is to get additional information which will help us then to better understand what those uncertainties are, but right now there's not a quantitative model that I can tell you that you've got this sort of standard deviation or something like that.

DR. POWERS: I mean, I guess what I'm fishing for is why you call this a reasonable basis then.

MR. STROSNIDER: Well, we think it's reasonable because it considers the primary parameters and temperatures.

DR. POWERS: Time and temperatures, things like that.

MR. STROSNIDER: And another way I could say it is it's the best available we have at this point if you want to look at it that way, but we definitely need better information to understand how good it is.

DR. POWERS: I guess it would be interesting to understand why you broke it into four groups instead of just two.

MR. STROSNIDER: Okay, and I can start

with the first group were plants that have actually experienced cracking. All right, and so they have the disease.

The second grouping basically, and I don't know if we have the plot available, but this was pretty simple. There's just some judgment involved here where we looked at the plants and how they stacked up in terms of time to where they would be equivalent to Oconee, where the cracking was discovered.

DR. POWERS: Yeah.

MR. STROSNIDER: We looked for a natural break, and we said for effective full power use, there appears to be a natural break in the ranking of the plants. Again, it would be based on time and temperature. We said these plants that are above four effective full power years looks like the group of most highly susceptible.

Then we went from that break back to another break in the data which went out to I think it's 40 -- 30 full power years. Okay. So there's nota whole lot more to -- okay. What you're looking at here, again, these are effective full power years to where the time and temperature would be equivalent, and using a Errhenius relation to what Oconee had, and we just looked at this break and said, "This is the group of more highly susceptible plants, and we think if we understand what's going on at those plants, you know, we will have information that will help us to understand more about the uncertainties in this assessment."

I should say that when you go beyond here out to 30 effective full power years, we're also asking these people to do examinations. All right? But it's different. This could be a VT-2 visual sort of examination.

DR. POWERS: Yeah, well, we'll get into that, whether that's effective or not.

MR. STROSNIDER: Yeah.

DR. POWERS: I'm just trying to understand why you grouped them as they are, especially since if I had put error bounds on these things, which you couldn't really do because you can't even quantify your uncertainties, but presumably they're big, that you would not see any such breaks.

MR. STROSNIDER: Yeah.

DR. WALLIS: We went through that yesterday, and they were reluctant to put the error bands (phonetic) on, but it's obviously true that if you put the error bands on, the points move around a lot.

DR. POWERS: It has real implications, it seems to me, on the bulletin because it says why have four groups. Why not just have two?

DR. WALLIS: I think we felt there would be a big enough sample or something like that, 25 plants or something by the time you've done that.

DR. KRESS: One of my points, which I'm not sure I made very well, Dana, was that these are relative to a CONY. Now, if they could go to a CONY and look at all of these other parameters that they expect to affect this susceptibility and somehow identify that the cracked parts of a CONY have attributes of these parameters that they would expect to be high with respect to shortening the justification time, if they could somehow make a judgment, then they can say that the error bounds on all of these other things are -- that you don't really need this error band because these things are relative to Oconee and Oconee is already on the high side.

And I don't think I made that point very clear, that you don't have to do the pool uncertainty. You have to go look at Oconee and see if you could make a judgment that it's likely to be on the high side of the uncertainties.

DR. WALLIS: But isn't it normally on the high side? They inspected nine tubes and had no cracks. So it's not all on the high side. It's only some of Oconee that's on the high side.

DR. KRESS: Well, this is relative to the cracks that were there at Oconee. So I'm saying look at the attributes of the ones in Oconee that cracked and see if you can make some judgment about whether or not you caught the most susceptible ones, and then I think you can make some judgment that this susceptibility curve is probably a reasonable basis.

MR. STROSNIDER: I understand the desire to see a more quantitative evaluation and to see these sort of uncertainty bounds.

DR. POWERS: I'm just trying to understand the reasoning.

MR. STROSNIDER: We don't have it, and quite frankly, we don't have all of the information, couldn't do it if we sat down to do it. You could make some assumptions on some of the parameters, but some of these variables we don't have.

DR. KRESS: And you really don't know how the parameters affect the thing, too. You don't have the model.

MR. STROSNIDER: We don't have the model?

DR. KRESS: Yeah. I don't think you can have a relationship between the micro structure and --

MR. STROSNIDER: Well, there's that, too. You can go back and look at the susceptibility ranking that was put together to support 97-01, and in fact, its initial attempt was that to be a more sophisticated model, it did where they had information try to include microstructure and some other variables.

I mentioned earlier it was off. If you look at Arkansas where the cracking was detected early this year, by that original model, that plant was predicted to be 11 or more years away from a condition where you might expect to see that.

So interesting though when you take this model, which is a much more simplified model, just looking at time and temperature. Arkansas moves up, and it moves into this more highly susceptible categorization.

DR. POWERS: See, now, that's very useful information. I mean that explains a lot when you tell me that.

MR. STROSNIDER: I'm sorry. I didn't hear.

DR. POWERS: That explains a lot when you tell me that, okay, you had a model. It was off demonstrably by a lot, its prediction, but now you're using a model which may well be more simplified, but the impact kicks it up.

MR. STROSNIDER: But I want to be very careful here because this is not intended to be a predicted model in terms of how many -- you know, at what point in time you're actually going to see cracking. It's a relative ranking, and there's uncertainties in there. I mean, there's the possibility that there could be plants out there that are cracked, you know --

DR. POWERS: Right now.

MR. STROSNIDER: -- like Oconee or worse, yeah.

DR. POWERS: Oh, yeah.

MR. STROSNIDER: The whole point of the bulletin is to go out and get information, and then when you talk about reasonableness, you say, "Well, you know, the bins that we've grouped the plants into, does it look reasonable for getting that sort of information?

DR. KRESS: And, once again, if you could show somehow that Oconee is somewhat the worse case, then you can make this statement that this ranking is a pretty doggone good way to do it.

MR. STROSNIDER: If you could, but you need more information to make that --

DR. KRESS: Yeah, you need some more information about Oconee, like what is the -- you need some information about those things you think affect the susceptibility to cracking, and I don't know how you get there, but I thought perhaps there might be a chance for one plant of getting some of that.

MR. ROSEN: So what this adds up to, Jack, in my mind is you're telling us that you would not be greatly surprised if the plants in the four to 30 year range, some number of them reported cracking.

MR. STROSNIDER: There's a possibility that when they go out and do leakage monitoring that they're going to find some leakage, yeah. Based on the last susceptibility model, there's a plant that was 11 or more years, and it found --

MR. ROSEN: So there could be some in the four to 30 that end up reporting some leakage and some in the earlier group that don't.

MR. STROSNIDER: That's correct.

MR. SIEBER: Well, I guess when I listened yesterday and considered all of the uncertainties that appeared to be in the data and the analysis, it seemed to me that the cutoff point would have been better set at ten years rather than four years. That's 25 plans. So all of the cold head plants would be in the latter category.

MR. STROSNIDER: And there's a matter of some judgment and then the timing that's associated with that.

MR. SIEBER: Right.

MR. STROSNIDER: And in the next viewgraph I'll compare some of the industry proposal to what the --

DR. BONACA: Well, one thing that at least for some of us stopped the questioning was that you have approximately 24 plants that are going to perform inspection between now and next spring in the group. It's a large number, if I remember.

MR. STROSNIDER: We're getting into the next viewgraph.

DR. BONACA: No, but I'm just saying, however, that that was the reason why I felt comfortable with what you had because I think we'll gather a lot of information over the next few months, and then the focus of our attention then became the effectiveness of the visuals because, you know, hopefully if they're effective, then we'll learn a lot about what's taking place, much more than we know right now.

MR. STROSNIDER: Yeah, and I'll talk about some of those numbers.

DR. WALLIS: Are you going to talk about the visual inspections?

MR. STROSNIDER: Yeah. If I could talk about effectiveness of visual inspections, there was a lot of discussion yesterday about effectiveness. Basically, to put that in regulatory terms, how would you qualify this sort of examination?

And in the bulletin, and we presented yesterday we have some specific criteria or issues that need to be considered when the industry goes to qualify these sorts of examinations.

The first thing is the availability of deposits on the head, and this gets to the issue of understanding what the interference fit is, the size of the crevice between the penetration and the reactor vessel head, and what we've suggested in the bulletin is that for those plants that are highly susceptible, if they're going to do a visual examination, they need to convince themselves and then have a basis to say that you're actually going to get leakage up out of the crevice, and that you're going to have deposits on the head. That's the first issue.

Now, we know that some plants have actual as built dimensions on those interference fits, and they can do analyses, you know, to measure those fits, and there was discussion yesterday about the ability perhaps to do some calculations and understand the deposits and how that --

DR. WALLIS: But I think the key point was how does the deposit correlate with the crack you're worried about. If the deposit is due to an axial crack in the weld which squirts stuff through and eventually it makes it up to the head, but you don't foresee it. First it creates this aggressive chemical environment around the highly stressed bottom just above the weld, bottom of the guide tube, and there's a race between the beginning to form circumferential cracks there and the emergence of this deposit on the top, and we don't really have a good basis for deciding how quickly these two processes occur and whether the deposit is really visible before all the cracks got big enough and all of that.

That's sort of really --

MR. STROSNIDER: And as you describe it, it really is a race between getting that deposit on the head and detecting --

DR. WALLIS: I mean, the assumption seems to be that if you don't see the deposit, there isn't a crack which you worry about, and that's not necessarily so.

MR. STROSNIDER: Well, a ;couple of observations. One is that if you look at the experience to date where these deposits have been identified, we noted Oconee was the worst situation. There are other situations where there were axial cracks that have led to leakage, and that's been detected.

So the experience to date would suggest that those deposits can deposit, but on a plant specific basis, you need to understand whether that mechanism is really going to work or not. If you have a very tight interference fit or if you have some different conditions, then it may not happen.

So what we talk about in the bulletin is for each licensee to provide a basis to say, yes, we think that, in fact, those deposits would accumulate.

DR. WALLIS: But they have to do this correlation between the time where you can actually see the deposits and the time where the crack has grown to the point where you worry about it. They have to do all of that analysis. Do they have a basis for that?

If you wait long enough, you're going to get deposits because other things may be happening while you're waiting for the deposit to be visible.

MR. STROSNIDER: Yeah, it's not specifically addressed.

DR. WALLIS: And that seems to be a weakness of relying only on visual inspection.

MR. STROSNIDER: Well, let me go through the rest of the logic because there's more there.

Once a plant, one of the higher susceptibility plants, if they convince themselves that, yes, they will get deposits on the head, then you've got the issue of being able to discriminate those deposits possibly from preexisting deposits.

We saw some photos yesterday. There are leaks from other sources, from flanges and seals that are up above, and depending upon what the history of the plant is in terms of cleaning those or perhaps what their photographic documentation is, there's questions about can you discriminate new deposits from old deposits.

And the other issue that comes up here is the insulation because there are various types of insulation. At least we heard yesterday that the B&W

units, the insulation is raised off the head. So there is access. For some units it conforms to the head, but it's lifted off, access, but perhaps more difficult, and there's other units where it lays and it's, in fact, glued right to the head, and there's other issues associated with that.

So in order to qualify visual exam, you have to address those issues, and that's addressed in the bulletin.

So our expectation is that the industry would come up with methods for doing those sorts of qualifications.

Now, with regard to growth rate and annulus chemistry, all right, and this is an issue that got a lot of attention yesterday, and as was pointed out, it is important to understand and what is a factor of safety of six mean in time. All right?

We don't have data to help us understand that, particularly because of understanding what the environment and what the chemistry in the annulus might be and how that could impact us. We've got some work going on and the industry is doing some work to try to understand that better.

But what we're telling the industry in the bulletin is if you don't plan on doing inspections by a certain time, either by the end of the year, depending on your susceptibility or your next outage, you need to provide a basis, and that basis would have to address this issue.

All right. So we don't have the answer right now. That's the purpose of the bulletin, is to basically force that sort of evaluation, if that's the basis.

DR. WALLIS: I guess what I was saying just now is that in order to assess the effectiveness of visual inspections, you may also have to do some of that.

MR. STROSNIDER: Well, when I come back to that, you know, in assessing the effectiveness of the visual exams in this race between the crack growth and whether you're going to see the deposit, the best thing we have to point at at this point is like you said the operating experience, where when you see those deposits and you go in and actually look at the crack sizes, they have had margin. And that's the best logic I can offer right now.

MR. ROSEN: But you don't know how many other cracks there are.

MR. STROSNIDER: That's right. Well, you have this whole question of will, in fact, some of these penetrations leak or not.

MR. ROSEN: I'm just saying that we found a lot of cracking from looking at boron deposits. It doesn't give me a lot of comfort that there isn't cracking going on because it's not going to call you up and tell you, "We're cracking down here." It's just going to keep on cracking until one of two things happens, one very bad, and the other which is detectable.

MR. STROSNIDER: Which supports the basis for a need for an assessment, and if you can't provide the data and assessment to support that you don't have this problem, that you need to do timely inspections. That's the logic we're trying to build into the bulletin.

MR. ROSEN: You know what they say about absence of evidence.

MR. STROSNIDER: Excuse me?

MR. ROSEN: You know what they say about absence of evidence, not evidence of absence.

MR. STROSNIDER: One other comment I wanted to make on this is, again, if you look at the logic we're laying out in the bulletin, it goes along the lines of if you're not going to do an inspection by the end of this calendar year, for example, for high susceptibility plants, and I just point out, you know, with this uncertainty in the growth rate, we're saying you need to do a timely inspection, and again, there's some judgment involved here, but we're saying at the end of the year for high susceptibility plants is reasonable.

But the other point I wanted to make is that the bulletin offers the opportunity for the licensee to provide a basis for not doing that inspection by the end of the year and doing it on some other schedule, and they need to address these and a number of other issues that were raised in requests for additional information that we provided in response to the industry report on this.

And the point I wanted to make is that the information that was provided in that report and in the responses to those requests for additional information was not sufficient to answer this question. If it had been sufficient, then we wouldn't be talking about this bulletin.

So there needs to be additional information provided to provide justification for why these inspections could not be done sooner.

So as I said, there are a lot of good questions. We would like to understand in a quantitative sense these issues better, and actually there is work going on to try to do that, but at this point in time when we don't have all of those answers, the intent is to try to address them through the bulletin.

Now, I wanted to summarize perhaps briefly if I can the difference between what was proposed by the industry and the logic in the bulletin, and let me start with the industry approach.

If we talk about the examination method, the recommendation that the industry made was a visual examination capable of detecting small amounts of boric acid deposits for plants that are within ten effective full power years of Oconee 3 and continued boric acid walk-downs for others.

Now, this is basically the extent of the recommendation. In the generic letter, we've laid out a graded approach, but it talks about the issues that need to be addressed as part of the qualification, and I talked about some of that on the last viewgraph. You know, what's the interference of it at your plant? What's the history of deposits? Can you really discriminate or can't you? What's the insulation situation? Do you have to remove insulation?

Those are all issues that would have to be addressed in response to the bulletin.

DR. WALLIS: These are small amounts. Has anyone tried to quantify this? You have to have a certain amount before you can see it.

MR. STROSNIDER: Well --

DR. WALLIS: Some sort of quantification of how much that implies by the time you see it it's been going on all that time while it's been building up and so on, or you just sort of assume that by the time you can see it, you've got enough information or something?

MR. STROSNIDER: The discussions to date have been a small amount. The example being given is Oconee, which is our understanding was less than one cubic inch, and when you look at the photo of the head, you see a lot of white deposits on there. Some of that is residue from prior cleaning, et cetera, but what we were informed is that what actually came from the leaking nozzles was less than a cubic inch.

So it is a very small amount, and in fact, it's a change in mind set, if you will, I think, for the industry perhaps. When we talk about these boric acid walk-downs where people have in the past found hundreds of bounds of boric acid, and now the focus has to be on a much smaller amount because that's the expectation, the sort of thing we would expect to see addressed in qualification of these visual exams.

DR. WALLIS: Do you see it because it reflects differently from the steel? It has a different color from the steel or something? It's something you detect which is --

MR. STROSNIDER: Different color from the steel. There's been discussions with the industry about different morphology, if you will, of what the texture of it looks like, depending upon whether it's bubbling up with a crevice or running down from someplace else, but I think the point here is that all of those sorts of things need to be assessed and qualified. You need some sort of quantitative method for saying that this examiner can actually identify --

DR. WALLIS: Perhaps 180 degrees around the tube, too. You mustn't just look at it. You've got to look around the back of it and look as well because it might be building up there.

MR. STROSNIDER: Okay, and when we talk about this graded approach, again, to come back to the examination method, what we're asking for in the bulletin is for plants that have identified leakage, unless they can provide some other basis, a volumetric examination, the point being here that the intent is to avoid a recurrence of reactor coolant pressure boundary leakage.

They've actually had this. They've had leakage. They've had through wall cracks, and we want to see an examination that's capable of maintaining the sort of criteria that exists in the ASME code, which would say you're not supposed to have through wall cracks in the reactor coolant pressure boundary.

In order to do that, you basically need some sort of volumetric exam.

DR. WALLIS: What does volumetric mean here?

MR. STROSNIDER: It means being able to interrogate not just the surface, but actually the volume of material.

DR. WALLIS: Look for cracks throughout the whole volume.

MR. STROSNIDER: And I want to be a little careful here, you know. I guess that could suggest there's the possibility of using surface exams, like a penetrant exam or something like that. Even the eddy current that was done is a very shallow exam, and depending upon what a licensee would do if they find something, an analogy might be steam generator tubes where --

DR. WALLIS: Well, you know what --

MR. STROSNIDER: -- if you find an eddy current indication and you can't size it, you repair it.

DR. WALLIS: You know what the most susceptible place is for the centrifugal -- the circumferential crack, right?

MR. STROSNIDER: Yeah.

DR. WALLIS: And you know that's not on the surface. So you're going to have to look inside quite a way.

MR. STROSNIDER: Plant specific visual examinations for plants that are within a less than four effective full power years, and that's what I was talking about, the qualification there, you know, providing a justification that they will, in fact, see deposits, that the deposits will exist, and that they will see them.

And it goes on to talk about if you do see a leakage, you know, what's the follow-up. And you know, without some additional justification, and if you look at the regulations it would appear to drive you into a volumetric examination.

A visual examination for these moderate susceptibility plants, that's what's in the four to

30, and that requires something more than what's stated here. You still need to be able to discriminate. You've got issues with regard to insulation, but it might not require quite as much as for high susceptibility plants.

DR. POWERS: Could you explain a little bit about the phenomenology of the cracking here? We have a stress corrosion cracking process going on. So we get some initiated cracks. Did they go through wall before they propagate farther in distance or can they propagate along before they go through wall?

MR. STROSNIDER: The possibility exists for multiple initiation sites.

DR. POWERS: Right.

MR. STROSNIDER: All right? Which could lead to what we call complex crack geometry.

DR. POWERS: Right.

MR. STROSNIDER: You might get one part growing through a wall and part through a wall at others. To my knowledge, what was found at Oconee was more a simple through wall crack. I don't know that they -- you know, we didn't have reported any other initiation sites, but the possibility is there, and it's going to be driven, again, by the environment, the residual stresses, you know, what the residual stresses look like and how they relax as the crack rose, and that could depend upon different initiation sites.

There's a lot of questions there, more questions than I have answers.

DR. POWERS: It seems to me that your visual inspection depends on it going through wall, doesn't it?

MR. STROSNIDER: Well, let me back up a second and make sure that -- because I'm not sure if you understood this part of it. The residual stress distribution on the inside of the penetration tends to drive axial cracks. That's pretty well demonstrated by the analyses and by the operating experience.

There's also the possibility for cracks to initiate on the outside of the J groove weld and grow up behind them, but the mechanism appears to be that you first grow a crack of that type such that you provide a pathway for coolant to get into the crevice between the tube and the shell, the vessel.

Once that crevice or annulus has an environment in it that will support stress corrosion cracking, the residual stresses on the outside support the circumferential crack growth.

So the race that was discussed earlier is from the time that you get coolant into that annulus, presumably from an axial flaw, all right? And it works its way up to where you can see a deposit. How much circumferential crack growth would you expect to see?

So but there is at least the notion that you're going to have this axial crack through wall that's going to begin leaking. Now, there's questions about once you get that axial crack does it require an independent initiation site with a circumferential crack or can the axial crack turn. That becomes important because initiation times can be significant.

DR. WALLIS: The initial axial crack can be just through weld and give you deposits. It doesn't have to go through any wall at all. It doesn't have to affect the wall at al.

MR. STROSNIDER: That's true.

If you look at what's involved in these different categories, plants that have actually experienced leakage, there's four of those. Other plants that would be in this high susceptibility ranking, there's another ten, and there's in the medium susceptibility another 31 plants, which the generic letter is asking those licensees to tell us if they're not planning inspections to provide a basis for that, and that's a total -- it's a different type of inspections, but it's a total of 45 plants compared to the industry proposal which would capture those plants in the first ten EFPY, which is 25 plants.

DR. POWERS: And the first 14 of yours are totally encompassed in the first 25 of theirs?

MR. STROSNIDER: Yes.

The other issue that come sup here is with regard to the timing of the inspections, and again, we're asking for justification for not doing inspections before the end of this calendar year. Six of those 14 high susceptibility plants are not scheduled for outages before the end of the year.

Actually I wanted people to understand that, compared to the industry proposal, which would be at the next refueling outage. So some of these 25 plants would go out to next spring, and I think a few of them until next fall, based on the industry proposal.

DR. POWERS: When I think about timing the issues of quantitative measures of risk, I mean, that's almost my first question. When you discuss risk, are you going to go into something more quantitative on this?

MR. STROSNIDER: No, not much more. You

raised a question right at the beginning about crack growth rates, and as I said, we really don't have a good handle on the initiation times and the growth rates.

The point we're making here is that we're looking for what we consider an appropriate sample of plants to look or just why they're not looking at what we think is a fairly timely manner, by the end of the year. The question is: are you willing to go off an additional six months or if you'll look at the proposal here, are you willing to go off an additional year and a half with this unknown parameter of growth rate?

DR. POWERS: Well, I'm going to say, "Look. That's a known." But Farouk just told me that we really don't get into a CDF situation until I have some additional failure.

Okay. Additional failures I've got some handle on in my risk assessments. That's where I would start asking the PRA --

MR. STROSNIDER: Well, let's try to -- when we get to that slide, which I think it might be the next one, let's see if we can't address that.

DR. POWERS: Okay.

MR. STROSNIDER: Sample size is another

issue that comes up here, and talking about 100 percent of the head penetrations. That's similar to the industry for visual examinations.

When you get into doing volumetric examinations, however, we're also asking for justification why 100 percent shouldn't be looked at. I think the industry approach was really silent on this, although you could look at the ASME code, which indicates that you basically double your sample size, which at a CONY, for example, found nine leaking penetrations. Then they went and looked at another nine beyond that.

Our basis for this is when you look, if you try to approach this from a statistical point of view and you ask yourself, you know, if success is not having one penetration with an unacceptable crack in it, define that however you want to define it; you know, the statistics are the sampling, so you basically need to go look at all of them.

Now, you want to temper that a little bit with engineering judgment. All right. But if you go look at Oconee and you look at the distribution of penetrations that experience cracking, there were some on the outer periphery, which is expected to have higher residual stresses because of the geometry, but there were some that were just a few rows from the center that hadn't.

All right. So it's very difficult even to construct an engineering argument that says look at these first based on the operating experience.

MR. LEITCH: Jacks, just before you leave that one, could you differentiate under the examination method between Group 2 plants and Group 3 plants? What's different about a plant specific visual qualification between the two?

MR. STROSNIDER: The major difference that we discuss is providing an assessment that says that the boric acid deposits will really find their way up the crevice --

MR. LEITCH: Okay.

MR. STROSNIDER: -- and deposit themselves on the head.

That may not be a trivial thing to do. For plants, we know from the public meeting we had that at least the B&W units do have some as built dimensions that they could use to put into an analysis to do that. We don't know if all the vendors have that sort of information.

Absent being able to demonstrate that, you basically have to justify why you wouldn't do a volumetric examination.

MR. LEITCH: So absent that data, that means that some of that family of plants might have to take the head off. The volumetric exam means take the head of basically.

MR. STROSNIDER: Yes. And again, that reflects the graded approach where for these moderate susceptible plants as we've characterized them, and we are not looking for quite as stringent a qualification, but depending upon what comes out of -- you know, what information we get between now and the end of the year, we'll have to look at that.

DR. POWERS: Can I ask you about the volumetric examination and into reliability? It seems to me in the 1997 time frame some examinations, volumetric examinations, yielded fuzziness that indicated there might be something and there might not be something. Is that a problem here?

MR. STROSNIDER: Well, there's a significant issue here, and it's a significant challenge for the industry in that for some portions of this penetration, for the welds in particular, there aren't any qualified examination methods right now.

Okay. Now, when we talk about qualified, there's various levels of qualification. You know, Appendix 8 code talks about a PDI, performance demonstration initiative type qualification. Frankly, from a practical point of view, there's not going to be enough mock-ups built in order for them to do that between now and the end of the year.

There are some examination methods, and we've asked some of the experts instead of being contracted by research, Steve Docteur in particular, to tell us what sort of capabilities, you know, might be possible.

So looking at that, but there is a challenge in terms of qualifying these methods, and I think we're going to have to work with the industry to understand what they can do.

The volumetric exams are not perfect. In fact, if you go back and look at the Oconee experience, the volumetric exam did not detect the circumferential cracking. All right? That was detected actually when they went in to do the repairs, and they had to do some penetrant examinations as part of the repair process.

So there needs to be work done in this area. It is a challenge, and the industry will tell you we don't have a qualified method at this point.

MR. SIEBER: Well, it depends on the plant, too. B&W plants have cylindrical CRDMs so you can shoot through it with a UT probe and find the weld, except the geometry is real complex. It's not clear what it is you're looking at.

MR. STROSNIDER: There's different geometries with different access. Some plants may have thermal sleeves in here. Some may not. There's --

MR. SIEBER: Well, the Westinghouse plants have a thermal sleeve. So there's no way to get the transducer in contact with the cylindrical portion unless you get one thin enough that you can slide down between the thermal sleeve and the actual base metal of the CRDM housing, and so under those circumstances, I don't know how you would do a volumetric exam, but --

MR. STROSNIDER: So I want to make it clear when we talk about an information request. That may sound somewhat benign, but it really isn't. There's a significant challenges to justifying why a plant wouldn't do inspections, and if a plant get into inspections, depending on the time, there's some challenges being able to --

DR. WALLIS: Well, are you in some cases

asking them to do things beyond the state of the art?

MR. STROSNIDER: Some of the things that they might be driven into here are going to require additional development between now and the fall.

Now, I would point out that regardless of what goes out in the bulletin, there is the potential for people to finally -- with the current examinations and have to deal with these issues, all right, and if you look at the Oconee experience and other experience, there should be a real motivation to develop this technology because the exposures and the costs associated with these inspections and repairs can be very high.

DR. FORD: Excuse me. Could I just have a sanity check here? Larry, we're supposed to finish this whole meeting at quarter to four. We do have the presentation by -- could I ask, Larry, approximately how long would you need? I notice you've got pretty well the same presentation you had yesterday.

MR. MATTHEWS: As long as they ask questions --

(Laughter.)

DR. FORD: I just wanted to know. They identify nine leakers at Oconee, and they understand that nine additional ones were inspected, right, of the nozzles?

MR. STROSNIDER: Right.

DR. FORD: And typically do an inspection of that type to verify that there isn't further leakage. I understand the difficulty of inspecting, but given the number, the number grew from zero to nine. Why didn't we have 100 percent inspection of the other nozzles?

MR. STROSNIDER: I think the licensee's action at the time -- and they'd have to speak to this -- but I'm assuming that they were looking at ASME code requirements which say, you know, double your sample size, and they didn't find anything in that additional sample. But I point out in developing this communication, we went back and did some statistical analyses and said, "What does that really tell us?"

And statistical evaluation says it doesn't really give you a high level of confidence that there aren't other cracks out there.

DR. BONACA: Because it's hard to believe that, you know, there were only nine there, and they evolved over the years until they all came up at the same time, and now they're all Scott free. I mean, but that's considerations for the next inspections.

DR. WALLIS: Well, it didn't happen at the same time. I think Oconee told us that probably they've been occurring over several years. They happened to be detected at the same time.

DR. BONACA: I understand that, but I'm saying that so why not affect the other nine the next outage.

DR. FORD: Could I make, again, a sanity check request? Larry, would it be acceptable to you to cut down your talk and address quite specifically the areas where you might disagree with what Jack is saying?

None of the background slides that you have --

(Laughter.)

DR. FORD: Would that be okay, Larry?

MR. MATTHEWS: Yeah.

DR. FORD: Good.

MR. STROSNIDER: Let me try to move through the rest of this a little bit more quickly if I can. A lot of discussion about risk, right insights yesterday. Some questions have already been raised today.

The failure or ejection of one of these housings, there's two different issues or events you can look at here. One is a loss of coolant accident, and the other is a reactivity insertion, loss of the rod.

Let's talk about the LOCA for a second. As I understand this, if you look at existing risk assessments, okay, they include small or medium -- excuse me -- this would be medium in PRA space, medium break LOCAs as one of the initiating events, and then you go on from there with additional failures and you figure out what the probability of the core damage might be.

The point here is that if you just take that break and you look at the reliability of the mitigating systems, you look at the operator's ability to configure the system into the recirculation mode, which is an important aspect that tends to drive some of the risk numbers, but that's pretty well understood in terms of, you know, there's an existing analysis that tells you how it's going to work.

Now, those analyses aren't necessarily, in fact, probably aren't for this specific location. Some people will characterize this as if you're going to have a medium LOCA, this is one of the better places to have it. All right?

It's more forgiving. There's a longer depressurization time, which gives the operator more time to align the system. Okay? So you could go back and look at this and try to understand better the specific thermal hydraulics in this event with this break location and understand is there more time and can you credit operator action as being more reliable. So that's on the plus side.

All right. Now, I'll get down here and talk about some collateral issues in a minute. Now, the other issue is the rod ejection which could cause an insertion, a reactivity insertion event, right? Now, if this occurs at full power, the rods are out in most plants the way they operate today. So there's no real activity issue or reactivity issue there.

If you look, however, from the hot zero power condition, all right, it could be a more significant event. Now, there was some discussion yesterday about the fact that that event is analyzed as part of the licensing basis for the plant, and those license basis analyses show that you could have some fuel damage, as I understand it.

However, we had some discussions yesterday, and we wanted to point out there's some additional, more recent work that's been done and is ongoing in the Office of Research using more realistic assumptions, which might be appropriate from a risk assessment perspective that say that you would not experience core damage in that event.

So that's just sort of an understanding of, you know, what exists in the licensing basis evaluations and what you might conclude from looking at existing risk assessments.

Now, again, if we look at this specific situation, there are some questions that can come up which we categorize as collateral issues, and what's the potential for multiple rod ejection? If one rod comes out, can it damage another to the point where it might fail or where it might render it unable to insert, in which case you get something that's beyond what's been evaluated to date?

DR. POWERS: Well, I guess I would ask the question as do we understand the kinds of loads placed on the other CRDMs when we have the depressurization associated with one fracturing? And does that lead to other cracks, cracked housing, having the crack propagate?

MR. STROSNIDER: And the answer is that we've initiated; we're working right now to get information on what the configuration, the design looks like, the missile shield, the supports. There's seismic supports up there, which I think provide mainly lateral support, but we're collecting information to understand what those structures look like so that we can provide some assessment of that.

But that's work that has been initiated. We don't have the answer at this point.

There was a discussion yesterday about pressurization effects and that sort of thing. The industry is initiating some risk assessment. We're going to be discussing with them some of these areas.

DR. POWERS: Your statement that core damage is unlikely based on some of the more modern reactivity analysis for the hot zero power event, but it seems to me that I recall a test in France where there was a reactivity insertion on a fuel rod, and they got fuel damage at relatively modern insertion energies.

MR. STROSNIDER: I'm not the person to answer that question.

DR. POWERS: Farouk is.

DR. ELTAWILA: Dr. Powers, as you know, the Office of Research has an extensive fuel program, and what we are trying to utilize here is a snapshot of the information that we have. We know that research is going on. So from the neutronic point of view, if you look at the amount of energy, the U-3D neutronic (phonetic), the amount of energy inserted for the high worth rod, you will find that the amount of energy in the order of about 15 calorie per gram, and if you look at the worst situation, can go all the way up to 50 calorie per grams.

Now, I'm aware of the test in the A-1 debt field (phonetic), and there is a lot of disagreement about that, and I think there is a consensus that test might be an anomaly and not representative of what really might happen in the reactivity insertion accident.

The third point that I would like to make is that if you look at all the tests in A-1, you found that we never had any dispersal for a pulse with greater than 20 milliseconds. All of them have a very small pulse width.

If you look at the actor itself, the pulse width is in the order of .29 to .5 millisecond. So, again, as a snapshot we're utilizing the best information that we have and say, "Okay. We're continuing the research, but based on the collective information that we have, we really don't think that it's an issue that is going to lead into core damage at this time."

MR. STROSNIDER: Thank you, Farouk.

One other point I'd make with regard to this failure under this particular condition, is that plants are in that condition for a very short period of time. So you're going to start off with a window of vulnerability that's fairly small, and it's going to drive down the initiating event frequency.

But, you know, these are areas -- I guess the other point that was made here, just one thing is recirculation issues. I think you heard something this week about some blockage issues. That's an issue that's being developed, that's being looked at now. These are things that would probably need to be considered in some additional work.

Probabilistic fraction mechanics analysis. The subject came up yesterday. We talked about everything pretty much that we're talking about up here is the consequences of an event should it occur, and we had quite a bit of discussion yesterday about what assumptions do you make on the frequency of that initiating event.

The answer to that will come up through some probabilistic fraction mechanics assessments. The industry is working on that now.

I wanted to make a point with this, with regard to this. The NRC was involved in some of the -- in fact, developed some of the original computer codes and models that are used to do this, and so we're fairly familiar with this. The point I want to make here is that like any other computer model, it's only as good as the information that goes into it. All right?

So there's a real challenge again here because you get back to some of the same questions we were talking about earlier. What do you assume for growth rates? What do you assume for the environment? What are the material properties, et cetera?

People often fall into the trap of saying, "Well, I don't have enough information to do a deterministic analysis. So I'll do a probabilistic analysis."

Well, the fact of the matter is you need more information to do a credible probabilistic assessment than you need to do the deterministic assessment. All right?

And I make this point just to emphasize that if you're going to look at numbers that come out of this sort of analysis in a quantitative sense, you need to have some good confidence on the input parameters.

All right. Now, having said that, these

models can also provide very good sensitivity insights to understand where the most important parameters, and you know, that can help you to just decide how to manage an issue.

But we're going to see some calculations like this which are going to be driving it, trying to establish an initiating frequency, and we're going to have to look real hard in terms of do we have confidence in the inputs to that model.

Again, we talked briefly on my first slide with regard to if you want to take this risk assessment all the way out about, you know, what challenge there might be to the containment.

MR. ROSEN: About that probabilistic fraction mechanics analysis, when you get it, it's going to be time dependent. It will be a snapshot in time for a nozzle at this much time and temperature, with these properties, but the time and temperature will change, of course, as it continues to operate. So you'll need as a function of time and temperature.

MR. STROSNIDER: If temperature changes, yes.

MR. ROSEN: Well, time is going to change.

MR. STROSNIDER: You need to modify the model.

In regard to time, these models have the capability of incorporating crack growth rate, and if you've got the distributions to put in there. All right? So they --

DR. POWERS: Don't worry, Steve. That will show ten to the minus 11th, your return frequencies. They always do.

(Laughter.)

MR. STROSNIDER: Okay. Additional work. You know, we've talked about information that we don't have, we'd like to have to better quantify some of these issues. The first thing is I want to acknowledge the support we've had from the Office of Research. They've contracted some experts in the area of NDE, fracture mechanics, and nondestructive testing, and they've also been providing support in this risk assessment. We've asked them to independently look at our assessment of the existing risk analyses, and they've been helping us out there.

So that work needs to be completed. It will be documented, and that will be made available.

In addition to that, I want to point out that we have back in June actually -- the Office of Nuclear Reactor Regulation provided the Office of Research with a user need to address issues associated with cracking of inconel. I'm not going to go through this whole list, but you'll see that a lot of issues we're talking about in terms of NDE growth rate, et cetera, is on this list, and you know, we've already started to initiate work in that area.

Similarly, and nuclear reactor regulation is working with research in these areas of understanding risk and systems evaluation.

I want to emphasize the additional work here of continued review of industries activities. It's industry's responsibility to address these issues, and we're working with the Office of Research. We're doing our own evaluations in nuclear reactor regulation to understand it and to be in a position to do a review, but this is a responsibility of the industry.

The bulletin, I think, is intended to make that point.

DR. POWERS: On this general subject of additional work, everywhere we seem to use Inconel 600 it seems to crack. Other than job security, are there other places that we should be looking where Inconel 600 is used?

MR. STROSNIDER: Well, in fact, we do have piping issues, and there's another industry initiative underway by the Jules (phonetic) Reliability Project, and we've been interacting with the industry. VC Summer had a crack in the pipe last year, and so we are in fact -- this work that I just described is not limited to control rod drive mechanisms, but -- and our interactions to the industry is not limited to that either.

So if we're looking to understand where in the system inconel was used, where it is susceptible, and you know, a lot of the work, however, when you start talking about some of these different things, it does overlap. You can apply it, and so -- but we're not restricting this just to control rod drive mechanisms.

DR. POWERS: I guess I was looking for a little more specifics, and you certainly mentioned the Summer issue. You probably just assume I'd never brought up the word "steam generators" again. Now we've got control rod drive mechanisms.

Are there any other particular locations in the plant that we should be concerned about?

MR. SIEBER: Don't some plants have inconel pressurizer heater thimbles?

MR. STROSNIDER: Yeah. Well, in fact, we've asked the industry, and they're working through their initiative to identify various locations, various susceptibilities. You can get into issues like were the inconel welds shop fabricated or field fabricated, which can have some influence, and they're doing an assessment of that now.

I would point out with regard to the Summer pipe cracking that in our assessment of that we don't see the risk or the safety significance at this point in time associated with that that we see with the CRDMs. The crack was axial. It was limited to the width of the weld.

One of the issues that we're working to understand is the potential for circumferential cracking, which of course would again change the --

DR. POWERS: Ten to the minus 11th, I know. It's a constant in these calculations.

MR. STROSNIDER: Then I wanted just briefly to, if I could, conclude with summarizing this issue in terms of the NRC performance goals. In terms of maintaining safety, we talked a little bit about the risk perspectives that we have based on existing analyses, and clearly, you know, there's a number of issues there that can be -- that need to be worked, but based on what we understand for this issue and based on existing PRA analyses, you know, we conclude that this is an issue that required additional attention.

That's reflected in the fact that we're proceeding to issue a bulletin.

With regard to reducing unnecessary burden, I want to emphasize the word "unnecessary." All right. There will be burden. The industry is going to have to spend resources to deal with this issue.

All right. Having said that, we have challenged ourselves and, in fact, as part of our process in developing this bulletin, we've been challenged by our various review committees to try to minimize the information requests, to focus it on the information that we really think is necessary to understand this issue, and make sure that, in fact, we can maintain safety.

Some of that is reflected in the graded approach, and if you look at the information that we're requesting.

Improved efficiency and effectiveness. First, to deal with efficiency, I think it's important to understand in previous issues like that the industry has chosen to go out and try to develop generic responses to the extent possible.

Now, the bulletin goes out on a plant specific basis, but there may be some aspects of this that can be dealt with by those plants referencing generic evaluations, showing that they're applicable to their plants, and we're certainly amenable to that process. It tends to be more efficient.

With regard to effectiveness, we have had good communications with the industry. Those communications need to continue right through this issue. We need to have good understanding between the staff and the industry as to these responses and what's acceptable and what isn't acceptable in terms of addressing the issue.

It's not going to serve anybody well if these responses come in in early September, in late August or early September time frame, and I think that the industry has missed the mark. So from an effectiveness point of view, we need to continue the communications.

DR. WALLIS: What would be an effective ultimate conclusion of this issue?

MR. STROSNIDER: Well, you have to go back to the logic in the bulletin. The industry needs to provide additional information --

DR. WALLIS: Are you just going to keep

inspecting forever and gathering information forever?

MR. SIEBER: For a new reactor head.

MR. STROSNIDER: Well, let me first address the short term, which is the bulletin recognizes a snapshot in time. So the options that are in there provide additional information, as I noted earlier, beyond what's been provided to the staff to date, to provide a justification for not doing inspections on the sort of schedule that we've --

DR. WALLIS: Well, eventually it's not replacing your head.

MR. STROSNIDER: -- that we've suggested.

DR. WALLIS: Eventually it's not replacing the head.

MR. STROSNIDER: Or doing inspection. In the longer term, okay, and I come back to the comment I had on the first viewgraph, there's no reason to expect that this cracking is not going to continue to occur and to affect more plants. So there needs to be a long-term program. They include inspection, head replacements.

The industry needs -- that's their determination based on the finances, et cetera.

The ASME code has recognized this issue.

They have a group that's off already looking at augmented inspections, and we want to encourage that effort. This just gets us through the first -- you know, the near term here. There needs to be a longer term program to manage the issue.

Finally, with regard to increased public confidence, one of our main efforts here is to keep the public informed. It's the industry and other stakeholders. We have a Web site where we're trying to get information on there as rapidly as we can. So I just want to make sure that everybody understands that that's available.

We've had some feedback that people find it pretty useful. If there's any comments on how to improve it, let us know.

DR. FORD: Thank you, Jack.

MR. STROSNIDER: That concludes what I planned on saying.

DR. FORD: Thank you very much.

Any last minute questions for Jack?

DR. POWERS: I guess what I'm still wrestling with a little bit is the effectiveness of the inspections you're proposing people to do. Have you given any thought to the advantages that might accrue to having an improved inspection method if you gave them more time to develop one perhaps generically?

Is there any way in the, say, reasonably short term between now and the end of the next or the following refueling outage to have a better way of inspecting?

MR. STROSNIDER: My expectation based on experience with these sort of issues is that the inspection technology would improve with time. You mention steam generators. You can see the changes in the technology that existed there.

We understand that there are limitations to what's available today, and that there's a challenge for the industry, but we have to balance that against maintaining safety of the plants, and we put that challenge out there that they need to be able to do effective inspections.

Bolton, you know, puts that responsibility, I think, squarely on the responsibility of the industry.

DR. POWERS: I'm struggling trying to understand your timing because I don't have this conditional probabilities for core damage in mind on these things. I mean, you've told me you're not going to threaten containment integrity, but I know you can if you have other failures.

What I don't understand right now is what the probability, conditional probability of having these other failures is.

MR. STROSNIDER: We had a prolonged discussion on that yesterday. At the risk of repeating it, I'll just tell you that we did present yesterday -- we asked that question. What's the conditional probability of core damage, given this event occurs?

And I want to emphasize because it came up yesterday we're not saying that we think the initiating event has a probability of one, but we're trying from, as I characterized it yesterday, a decision making under uncertainty. You know, can we get any insights?

The conditional core probability, damage probabilities that you get out of looking at existing PRAs, and I think that's basically the IPEs, ranges from like ten to the minus third to as high as actually a little higher than ten to the minus second in some cases. It's driven largely by the ability and the configuration the plant needs to go to to get to the recirculation mode.

But when I said that when we look at this issue from a risk perspective, based on what we know today, okay, we look at those numbers and say, "This issue needs additional attention."

All right. Now, we need to take into consideration what the initiating event frequency is, and we don't have a good estimate of that now, and that's why we want to go out and get more information.

But those were the numbers that if you look at the range from the IPEs.

DR. WALLIS: So you would want to get the initiating event frequency down to ten to the minus three as a result of better understanding and regulation.

DR. FORD: Jack, thank you. We appreciate it.

I'd like to ask Larry Matthews from the Materials Reliability Program at NEI to give a presentation.

Larry, do not feel confined by the quarter to four. I've been told that I'm not supposed to tell you that.

(Laughter.)

DR. FORD: Go as long as you want, but recognize most of the panel have already heard your presentation of yesterday, apart from Dana.

MR. MATTHEWS: Yes.

DR. FORD: Was I correct in saying that? No? Five minutes? Four o'clock.

MR. MATTHEWS: Maybe I can get through in time for some discussion.

DR. FORD: Good.

MR. MATTHEWS: I'll start with Slide 76 if you want to thumb through there from yesterday's presentation. I didn't realize I needed to bring a separate package today, so what we passed out yesterday.

Basically the industry feels there's reasonable assurance that the PWRs don't have circumferential cracking that would exceed the structural margins based on a few things. Oconee and ANO-1 says here in the highest grouping these four units are the four highest units in America on time at temperature.

These leaks that were found at these plants were discovered by careful visual examination. We recognize, everybody recognizes we're looking for something different than we probably were looking for a year ago.

Oconee-1, when they found out a very small amount of leakage, everybody recognizes that that's what we have to be looking for now.

Volumetric exams that were done at Oconee-1 and 3 on a scope expansion or whatever you want to call it, extent of condition examination of the other nozzles that were not leaking, and only found minor craze cracking, which they've been seeing in other nozzles and tracking for years.

These leaks were discovered in time with plenty of structural margin remaining at the time they were discovered and repaired.

DR. POWERS: Could I ask you what the significance of that second bullet is or maybe it's the third one? Volumetric examination, minor craze cracks. Are you saying the volumetric examination is not a reliable --

MR. MATTHEWS: No, that's not what I'm saying. I'm saying -- I'm not talking about the nozzles that were leaking. I'm talking about the nozzles that were leaking. I'm talking about other nozzles.

The volumetric examination did not, and we have to admit this right now, a priori pick up the circumferential flaws, et cetera, that were found in Oconee. Going back and looking now at the data, you know, NDE's hindsight is great, but now we have the lessons learned. They call it lesson learned. Now those things are available to the people as we move into the future.

DR. POWERS: What you're saying is the volumetric examination for those that crack, the volumetric examination detected nothing, not even minor craze cracks?

MR. MATTHEWS: No, no, no, no, no. The volumetric exam could pick up the cracking, and when they go back and look at it, they could find all sorts of cracks in those nozzles that did crack. The one thing they missed was the circumferential flaws.

Then when they go back and look at the data after they discover those circumferential flaws in the process of repairing the nozzle and look at the data, they say, "Oh, yeah, there was evidence."

And we're working with the industry right now and with the NDE Center and with the vendors to refine those techniques so that we've got a better shot at finding those kinds of things when we do volumetric.

DR. POWERS: Well, I guess I'd come back. What's the significance of only minor craze cracks?

MR. MATTHEWS: Oconee units and several other units have seen this kind of very, very shallow, multi-initiation sites, axial flaws on the ID of the nozzle that don't grow, and they've tracked those for years at Oconee. They call it craze cracking, and they haven't grown, and they've tracked those for, I think, three examinations, three outages at Oconee, and just there they are. They don't grow.

The significance is when they look at the other nine nozzles, they found no significant flaws. That was the significance of that.

DR. POWERS: They looked at the nozzles the first time around and they found no significant flaws either.

MR. MATTHEWS: Which ones?

DR. POWERS: The ones that were cracked.

MR. MATTHEWS: On Oconee-1 that's true, on Oconee-1. They were looking -- on Oconee-1, the detection, I mean, the NDE was different. They used eddy current. Eddy current would not see the OD flaw. Now that's not what we're talking about on volumetric exams here.

DR. FORD: You're talking about ultrasonic?

MR. MATTHEWS: Ultrasonic and/or I heard someone today talking about complete with the surface eddy current, which is where you come down all the way back up the OD of the tube and the weld, do eddy current on all of that.

And if you've got no initiation sites and no cracks there, you don't have anything in the annulus, but, yeah, UT also for the volume of the tube.

PARTICIPANT: You find a lot of stuff that isn't there.

MR. MATTHEWS: Okay. The other point, several other plants this past spring after they knew about Oconee-1 and Oconee-3, several other plants and some of those in the highest group went and did top of the head, under the insulation visual inspections and found no evidence of leakage.

DR. POWERS: So license renewal is the key here. If you get your license renewed, then you get cracks.

(Laughter.)

MR. MATTHEWS: I hope not. Hatch is up next, but Hatch cracked a long time ago all over the place.

DR. POWERS: Short parameters come to mind here.

MR. MATTHEWS: I hope Calvert isn't in that list.

The schedule for some of this stuff, we weren't going to get some revised inspection recommendations by the end of this month, but due to the pending bulletin, we decided to hold off and see what we could work out.

We have convened an expert panel to look at the crack growth issue both in annulus and normal, and their first meeting is next month.

DR. POWERS: Since the experts never anticipated this kind of a cracking to occur, why are they experts?

MR. MATTHEWS: They're the guys from all over the world who have been doing this lab work on crack growth data and --

DR. POWERS: But in 1997 we have everybody in an uproar looking at this stuff, and they gave us a clean bill of health, I mean.

MR. MATTHEWS: Well, this is a new -- the OD initiated clause is new.

We were planning numerous inspections during the fall 2001 outage. The final RPV penetration safety assessment was scheduled for the end of this year, and reassessment of the inspection results that come out of the fall outages, we were going to get that in time to give some help to the spring outages.

We have other activities ongoing. We're working on the risk assessments. That's going now. We're going to try and get something here very shortly to work with the staff and make sure we're kind of in agreement on what the risk of this event is.

We're initiating some probabilistic fraction mechanics as part of our risk assessments.

NDE demonstration, that's ongoing now or not the actual demonstrations, but discussions with the vendors about what kind of NDE capabilities they have, what kind of sabers they can throw up, the Westinghouse or any of them. That's under technique development.

We're designing a block with OD initiated flaws to get that thing available so that these vendors -- and it won't be a PDI qualification. It will be an open demonstration, but at least we can take a look at what the capabilities are before we throw this under a head.

We're developing an information and training package for those people who will be doing the visual examinations, will be using lessons learned from the plants that have already done them, including Oconee and some of the other plants that did them this spring.

They're working on flaw evaluation guidelines and review and repair of mitigation strategies would be a longer term approach.

DR. POWERS: In the material that the staff has put together, they make quite a point about training people to distinguish old boric acid crystals from new boric acid crystals or something like that. What are you telling people in this training package?

MR. MATTHEWS: We're going to show them what old looks like. We're going to show them what new looks like.

DR. POWERS: I'm fascinated. They have different wave -- different vibrational frequencies, different -- I mean, what is different about an old crystal and a new crystal?

PARTICIPANT: Color.

MR. MATTHEWS: This is what a leak looks like.

DR. POWERS: That's 100 percent of every leak that will possibly occur, is going to look like that?

MR. MATTHEWS: Everyone we've seen has had something that's similar. Here's the Oconee-1 one. This was one at Oconee-3. This was another one at

Oconee-3.

DR. POWERS: That tells me about Oconee.

MR. MATTHEWS: Yes. The only other one we've got is ANO, and it looks pretty similar.

DR. WALLIS: So you look for white stuff appearing around the --

MR. MATTHEWS: Yeah, white stuff right around, and every one of them has had downhill -- on the downhill side, if there is a downhill side, that's where the stuff has accumulated. Basically there's an annulus that's kind of angled here, but it's flat on the bottom, and this is the low point, and so anything that liquid got in there would run out down here.

DR. WALLIS: Well, liquid is available because the acid changes the boiling point so much that you don't boil off all the water. It is a hot surface.

MR. MATTHEWS: Yeah, it's hot.

DR. WALLIS: You expect the water to disappear.

MR. MATTHEWS: It could be leaking when it's cold, too.

DR. WALLIS: When it's cold it leaks?

MR. MATTHEWS: I don't know. I don't know where this stuff is coming from.

(Laughter.)

MR. MATTHEWS: It's coming from down there, and it leaks out.

MR. SIEBER: It's not leaking when it's cold because you can't pressurize the vessel when it's cold because of brittle fracture.

MR. MATTHEWS: That's true.

DR. POWERS: It seems to me that I would be very suspicious of using color as an indicator because that says something about how dirty or not dirty the head was at the time the material came out.

DR. FORD: Radiochemistry -- when we asked this question yesterday and had your E-mail, we asked this question. There was an answer to do with radiochemistry. I don't know if they --

DR. POWERS: F centers? F centers and boric acid crystals or something?

DR. FORD: All I'm doing is just repeating what the answer to it was.

MR. MATTHEWS: Looking at the activation and the decay, they can tell to some extent.

DR. FORD: Can tell the age of the --

MR. MATTHEWS: How old the boron deposits are, if they got irradiated in the vessel, picked up neutrons. They can look at the ratios and figure out is this new boron or old born.

DR. WALLIS: That means you actually grab the boron and do tests of it?

MR. MATTHEWS: Yeah. You got up there, and you scrap some off, and you take it to the county lab.

DR. WALLIS: That's very different from relying on visual inspections.

MR. MATTHEWS: Yeah.

DR. POWERS: Well, I mean, it sounds like fairly fuzzy --

MR. MATTHEWS: But they didn't do that until they had the leak and they were trying to figure it out how long it had been leaking.

DR. POWERS: I mean, quite frankly, it sounds preposterous. The crystal forms only when the boric acid solution gets outside of the vessel, right?

MR. MATTHEWS: Right.

DR. POWERS: Okay. Is it the irradiation there that does something to --

MR. MATTHEWS: No, no, no, no, no. It was when it was whipping through the core over and over.

DR. POWERS: When it was whipping through the core, it was in solution.

MR. MATTHEWS: Yeah, and then it leaked

out and formed a crystal, but the boron didn't change a lot from the time it was inside the core until the time it leaked out, but --

DR. POWERS: Yes, it did. It crystallized.

MR. MATTHEWS: Okay. We're looking for the --

DR. POWERS: -- absorbed the neutron or something like that --

MR. MATTHEWS: It did.

DR. POWERS: -- and changed its --

MR. MATTHEWS: It did.

MR. SIEBER: There's plenty of neutrons on the outside of the head, I think. So you look at the ratio between boron and whatever it turns into, lithium, and from that ratio you can get some sort of an estimate sa to how many neutrons this stuff absorbed.

DR. POWERS: Once it's outside and crystallized.

MR. SIEBER: Once it's outside, yeah.

DR. POWERS: Nothing to do with what it was inside.

MR. SIEBER: Well, the same process goes on, but there's a different removal process.

DR. POWERS: How do you distinguish the lithium form by transmutation from the lithium that was formed because they put lithium in the solution?

MR. SIEBER: Well, at hot zero power, the boron concentration is 1,800 ppm, and the lithium that's added provided that you have a plant where you add it is at 2 ppm. So, you know, I would suspect that the lithium --

DR. POWERS: That's good. Two ppm of lithium represents how much neutron absorption? A bunch.

MR. SIEBER: Yeah. That's right.

DR. POWERS: Okay. All taking place on the outside of this head.

MR. SIEBER: Some, and it's not a very good method.

MR. MATTHEWS: Sine we don't know much about the driving forces here, like Jack said, he did a pretty good job of describing the model. What we've done is an effective time and temperature model to rank the plants, the point being not to try and predict that this plant is going to leak in 15 years, but to try and decide where we should concentrate our resources as an industry to try and learn more about this issue.

And it's an effective time at temperature because these plants don't all have the same head temperature, and it's very driven by the temperature. So we normalized everything to 600 degrees and ranked them up here. The three Oconee units are right at the top of the heap.

One of the things is will it leak. These are the interference fits of all the leakers, and even nozzles that have interference fits as tight as 1.4 mLs here leaked when they developed the through wall cracks.

This is a cold, as manufactured. We have calculations which I thought --

DR. WALLIS: You were telling us that they opened up when they're actually --

MR. MATTHEWS: Yeah, they do tend to open up when you pressurize the head because the dilation of the head, and I could put that up. I think I'll skip it.

Several plants did inspections. These are the ones that did inspections this spring. Robinson-2, Salem-1, Farley-2, Prairie Island-1. Prairie Island has a configuration not exactly like, but similar to the --

DR. WALLIS: You're talking about this

interference fit opening up, and it opens up essentially an enormous area compared with the size of the -- it's a huge flow area compared with the little crack area.

MR. MATTHEWS: The flow area.

DR. WALLIS: That's what we need to think about. The area of the annulus interference is enormous compared with flow area.

MR. MATTHEWS: Well, the PWSCC cracked.

DR. POWERS: -- will crack, which is supplying it.

MR. MATTHEWS: Yeah. Most of these heads on these plants which are all Westinghouse units except SONGS are reasonably free of any kind of masking, boric acid deposits. These deposits have a tendency to be much more evident on the B&W plants because of their flanged CRDM configuration.

Basically the industry believes that most, if not every single one of these, penetrations would leak if you -- and show boric acid. This is something that the staff says we need to prove or at least those high susceptibility plants need to prove it.

This is just another way of looking at the histogram. These plants that come out here that show hundreds of years to being equivalent to a CONY are actually co-head plants. Their heads are running in the 560 range. Most of these heads are hot or warm head plants. "Warm" might not be a right term, but it's pretty hot.

DR. POWERS: "Hot head" is probably not the right term either.

MR. MATTHEWS: Yeah. Well, the Oconee head is pretty hot, and all of the B&W units. These are the Oconee units. I believe this is the A&O unit. These histograms were on preliminary information, but this is the first ten years. This is where we proposed as an industry that all of these plants do a visual of the top of their head at the next refueling outage.

And what we were showing here is that this plant here and that one and that one would be the only three that would not have done a visual inspection by the end of the spring outage season, and they would be into the fall.

DR. WALLIS: The thing I've been dying to ask is when you've done all this, is there some sort of idea of how you interpret the data when you find something, or are you just going to figure that out when you find it?

MR. MATTHEWS: When we find a leak, you

know, we start over.

DR. WALLIS: Anyway, you start thinking again?

MR. MATTHEWS: Pardon me?

DR. WALLIS: You haven't thought about -- you're doing an experiment here. So you want to think about how you interpret the data when you get it.

MR. MATTHEWS: Yes.

DR. WALLIS: I haven't seen any of that. It's all just when we get the data, then we'll think about what it might mean.

MR. MATTHEWS: Well, when we get the data and we find a leak, we go find out what it is.

DR. WALLIS: It makes a big difference whether it's one on the left of that curve or one on the right.

MR. MATTHEWS: Yes. If it's one over here, then that brings --

MR. ROSEN: I didn't see your -- if it's one over?

MR. MATTHEWS: If it's one over here or out there somewhere, then that's a totally different scenario than if this plant here or that plant there finds a leak.

And recognize that all of these plants

that do have leaks so far are B&W design units. We don't know if that means anything or not, other than the fact that they typically run with fairly high --

DR. WALLIS: It's a very interesting drama. When you find the next leaker, everyone is going to scurry around saying, "What does he mean? What does he mean? What do we do?"

MR. SIEBER: Well, if you found one that was half way --

MR. MATTHEWS: If we found one here.

MR. SIEBER: -- on the right-hand side of this particular curve, it would destroy the theorem upon which susceptibility is based.

MR. MATTHEWS: Yeah, if one of those cold head plants finds a leak and it is a PWSCC leak, et cetera, then you know we've got a lot of rethinking to do and so does the standard and everybody else.

DR. POWERS: I mean before I would trash the whole theory, I would say that right now they're operating on the basis of temperature and time being their two dominate variables and residual stresses which they can't really estimate as being something that's secondary in the effect. If you found one off in the other group, you'd probably just find that that other variable was very important.

MR. MATTHEWS: Yes.

DR. POWERS: And so it's not clear to me that everything is lost.

MR. MATTHEWS: Stress is a very important factor in PWSCC also, and you can override a lot of stuff if you put enough stress on it, but you can't get much beyond yield.

MR. SIEBER: I think the problem is there aren't enough records, for example, what heat, what solvents, what the fit was, the welding technique. You can probably find in your lay records welding rod records. You might have copper intrusion or some other phenomenon.

MR. MATTHEWS: I guess the thing I really wanted to say -- oh, somebody had mentioned about will it leak before or the rates between leak and a circ crack, and basically we've had 15 nozzles in the U.S. to leak so far, and three of those have had circ cracks, and 12 of them have had only axial or through wall cracks in the axial direction and no circ cracks. And one of the circ cracks was a very shallow on the OD of the tube that had not propagated anywhere near through wall. It was only an inch or so long.

So the horse race seems to be won by the leakage over the circumferential crack growth at this point in time based on those 15 leakers that we've had to date.

MR. SIEBER: Yeah, but you can't detect that leakage until you do the visual inspection.

MR. MATTHEWS: Exactly, and if it's all going to happen within two months, you know, we're --

MR. SIEBER: You can't pick it up while the plant's operating.

MR. MATTHEWS: Right.

MR. SIEBER: Leakage instruments just aren't sensitive enough.

MR. MATTHEWS: I guess the reason I was putting this up was because I wanted to just address the fact that these are analyzed events. The rod ejection accident is an analyzed event, but it was selected as the bounding reactivity insertion event that's possible, and you blow the rod out in 100 milliseconds. The transient is over before the rod gets out of the core. It's already turned around, and the reactor is subcritical again before the rod is completely withdrawn in the ejection event.

Another ejection, very unlikely in our opinion. These are very heavy tubes. This is a very tolerant material. We haven't done the calculations yet. We're going to have to. It's a four inch diameter tube with a five-eighths inch wall. It's going to take something else to knock that thing off of there. It's going to take a lot of force and --

PARTICIPANT: Well, we have to go figure all of that. We don't know what it is yet.

DR. POWERS: If it's intact.

MR. MATTHEWS: If you've got a bunch of them sitting there that are already cracked all the way to where they're just barely staying in there, yeah, we don't think that's very likely either.

DR. POWERS: Well, I mean, you had how many of them cracked in your 20 plants?

MR. MATTHEWS: We had only two on Oconee-3 that had circumferential flaws. We had one that was a partial through wall on Oconee-2. Those are the only three circ flaws that have been discovered. That's the only thing that threatens an ejection. Axial flaws will not threaten an ejection.

DR. POWERS: So if I -- what you're saying is at Oconee we could have had two ejections.

MR. MATTHEWS: No. If we'd have buried our head in the sand for a long time, there was plenty of structural margin there, plenty of structural margin there, a factor of six to ejection, I think.

DR. POWERS: Yeah, and two much how much

of a factor?

MR. MATTHEWS: Well, we think, you know, if you assume reasonable crack growth rates, I believe they had years, but if you assume that the crack growth rates just from Alloy 600, the crack growth rates that we've been using in other arenas, it was four to five years before they had got to the ASME code margin, which has a factor of three in it, and it was more years than that before they would have ejected the rod.

DR. POWERS: Yeah, but we have just given it a 20 year extension of license. We've got lots of time here.

MR. MATTHEWS: Well, the Oconee units have committed to replace their heads. I'm not saying the rest of the industry is going to do that by any stretch, but --

DR. FORD: Larry, could you put Slide 18 up?

MR. MATTHEWS: Eighteen? I'm not sure we have 18.

DR. ELTAWILA: Then can I try to answer the issue of multiple ejection?

This is Farouk Eltawila.

Really all what you need is a period the distance between the multiple ejection greater than the .5 millisecond. So because they are not relative, you know, by the time the first policy goes and you decay immediately in about .5 second, even if the second policy started, they are not going to add together, and it could be a different deposition.

So you really -- it's not the summation of the individual policies. It would be -- so all what you need is .5 seconds between policies, and you can accommodate that.

DR. POWERS: So anything over a half a second --

DR. ELTAWILA: If they are delayed by over half a second, I really think the first pulse will completely disappear before the second one takes effect.

DR. POWERS: So it's not coherent in that. Now let me ask the next question. How many do I have to eject before I have a recriticality issue?

DR. ELTAWILA: We need to do this analysis. There is no doubt. I just tried to answer, you know, that even if you have them more than one, you know, that -- that's to say they are not having in a sense continuously at the same time.

DR. POWERS: One of the things you worry

about is suppose you eject one. Now you've got coolant blowing out of here, and you propagate. You cause a crack in the next one, and that one becomes coherent with the three next to it, for instance, in this map that I'm looking at here. They have a problem there.

I mean it's a little tricky thing, but what you're saying is the time constant you're looking for is a half a second less.

DR. ELTAWILA: A half a second.

DR. POWERS: And that's good information. The criticality would be a good information, too.

MR. MATTHEWS: Well, if you get into multiple ejections, you're going to have SI going. You're putting high concentration boric acid in there. So, you know, that's going to help to keep the thing shut down.

All of the cores are designed with between one and two percent shutdown margin with the strongest rod shut out. I mean out, and that's at the cold condition. So, you know, if you took the thing from hot to cold and left the strongest rod out because you blew it out, you've still got one to two percent shutdown by the time --

DR. POWERS: And I wonder if the safety

injection would have time to have any influence in your time schedules that we're looking at here.

MR. MATTHEWS: I Understand.

DR. FORD: Well, your risk assessment would be taking into account, for instance, the groupings of those, all those circle point and housings there presumably had circumferential cracks. They had boron deposits.

MR. MATTHEWS: Oh, absolutely not. The only ones that had circ cracks, there were only two.

DR. FORD: Oh, okay.

MR. MATTHEWS: It was 56 and 50. These are the only two that had circ cracks anywhere, and this is an agglomeration of Oconee-1 and 3. So --

MR. ROSEN: Show me again which ones.

MR. MATTHEWS: Fifty-six and 50. Those are peripheral penetrations, and those are the only two on Oconee-3 that had circ flaws. I'm not sure which one -- I don't have Oconee-2. Yeah, the four leakers on Oconee-2 I don't think I have on here. So I'm not sure which one is leaking.

DR. UHRIG: The fact that that is circumferential is not there related to the steeper slope?

MR. MATTHEWS: I don't know. You know,

that's something we'll have to figure out. We used to think these are the only ones that are really, really susceptible before of the stress, the residual stresses, but maybe it means that because of the residual stresses, they crack first and they've had longer to grow a circ crack.

DR. FORD: Any last minute questions for Larry?

DR. POWERS: Well, I guess one. The bulletin proposes some fairly prompt inspections and whatnot, and certainly you have outlined both in your oral presentation and in looking through your slide package quite a lot of activities going on. I wonder if you could speak to the issue of how much better of a job you could do if you had a little relaxation, especially for those units that are not in your very highest susceptibility category.

MR. MATTHEWS: Well, the ones that aren't in the highest susceptibility category, what the staff is proposing is the VT-2, qualified VT-2. That's not a cheap exam. In some plants it could be a million and a half dollars depending on their inspection -- I mean they insulation packages.

But the improvement on the VT exams is probably not going to grow tremendously. The volumetric exams, I think we're on the leading edge, and we are scrambling to develop technology, and the vendors are working to try and get it in the field and get it demonstrated for those plants that may wind up doing volumetric in the fall, and that's a scramble. It's a real scramble, and the demonstration that we're going to pull off, we hope, before the fall for those vendors is not -- it's not a qualification like we did in the 97-01 response. It's an open test. Here's the sample; here's what's there. Can you find it?

DR. POWERS: I understand what you're going to do. I'm trying to understand how much better could you do if you had a little more time.

MR. MATTHEWS: Well, I think we could do better. How much better I'm not sure. They could refine what ducers to use, what angles to use. They could be refining, and maybe the eddy current technology, and especially the delivery technology might be improved significantly over the next few months as we move toward trying to make this a cheaper, better, faster exam.

DR. UHRIG: But you would lose the opportunity for those plants to refuel in the fall if you delayed it.

MR. MATTHEWS: If we delayed the

volumetric, yes. But I'm not sure how many of them are going to do volumetric, and you know, it's been proposed by the staff for the ones that are leakers or have leakers, those four units, only one of which is coming down this fall. I suspect the other three are going to try and put together some alternative, and I'm not sure. You know, they're going to be working with the staff to figure out what that is.

DR. FORD: Thanks so much, indeed.

MR. MATTHEWS: Thank you very much.

DR. FORD: Sorry we pushed you at the end there.

MR. MATTHEWS: It's okay.

DR. BONACA: Okay. Thank you very much, and we'll take a break now for half an hour, and I guess we'll get together again at 25 of five.

(Whereupon at, at 4:04 p.m., the Advisory Committee meeting was adjourned.)

CERTIFICATE

This is to certify that the attached proceedings before the United States Nuclear Regulatory Commission in the matter of:

Name of Proceeding: ACRS Full Committee Meeting

Docket Number: (Not Applicable)

Location: Rockville, Maryland

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.

John Mongoven
Official Reporter
Neal R. Gross & Co., Inc.

RECOMMENDATIONS FOR COMPLETING THE SPENT FUEL POOL RISK ASSESSMENT

Presented by:

Robert E. Henry
Lynette Hendricks

Presented to:
ACRS

July 11, 2001

NEI VIEW OF THE CURRENT STATUS

- The draft study, which is the technical basis for the June 4 Policy Issues and Options document, provides a good start for quantifying the risk of significant fission product releases from spent fuel pools.
- The study provides a good foundation for evaluating the probability of losing cooling to the fuel pool due to equipment failure.
- However, it is important for a document, which is the basis for risk-informed decisions, to give a best estimate of the accident timing and consequences for the events identified as significant risk contributors.
- In this regard, the study should incorporate the results of large scale spent fuel pool cask dropping experiments as well as those investigating large impact loads on reinforced concrete walls.
- Furthermore, the study currently represents the bounds of possible releases of ruthenium, we believe it should also provide a best estimate analysis consistent with relevant fission product release experiments.

SCREENING CRITERIA WHICH NEED A BEST ESTIMATE ANALYSIS

4. Would a risk-informed approach help to effectively communicate a regulatory decision or situation?

5. Do information (data) and analytical models exist that are of sufficient quality or could they be reasonably developed to support risk-informing a regulatory activity?

WHY SHOULD THE STUDY FOCUS ON BEST ESTIMATE?

- It is difficult to provide the necessary foundation for this type of risk-informed decision-making without having a calculation which is the best representation of the technical information, in particular, relevant experiments. Also, the best estimate representation should be accompanied by uncertainty boundaries.
- After a study is completed, the results are likely to be used for other tangentially related evaluations in which the users of the information may not be well informed with respect to the technical basis. In this circumstance a best estimate evaluation is essential.

WHY SHOULD THE STUDY FOCUS ON BEST ESTIMATE? (Continued)

- An example of the misuse of PRA information is the Swedish Reactor Safety Study (1978) on the Barseback plant which was represented as using WASH-1400 technology. Specifically, the SRSS used the WASH-1400 probabilities for steam explosions and multiplied these by three since the authors (none of which were experts in steam explosions) believed there were three separate locations where steam explosions could occur. This is a misuse of the information developed for WASH-1400, i.e. the conditional probability of alpha-mode failure (0.01) was sufficiently low that it was no longer a significant risk contributor. At this value there was no benefit in further refinements of the value. The SRSS authors ignored this aspect and grossly misrepresented the application in WASH-1400. Similar misapplications could occur with respect to the spent fuel pool study.

CONTAINMENT FAILURE MODE COMPARING WASH-1400 AND SRSS* RESULTS
(Abstracted from Table 4-8 SRSS)

Failure Mode		**Relative Frequency of Failure Modes**	
		WASH-1400	**SRSS**
α	Vessel Steam Explosion	.01	.03
β	Containment Steam Explosion	.07	.21

* Swedish Reactor Safety Study

-Additional References to be Included for Assessing the Consequence of a Cask Drop – IMPORTANT EXPERIMENTS CHARACTERIZING CONCRETE TOUGHNESS

BNFL, 1984, “Full Scale Drop Test for Benchmarking Concrete Pads for Dry Spent Fuel Storage Casks: Tests 3 and 4,” BNFL Commercial-In-Confidence Report AEA-D&W-0676 (work performed at AEA Technology, Winfrith).

BNFL, 1993, “Full Scale Drop Test for Benchmarking Concrete Pads for Dry Spent Fuel Storage Casks,” BNFL Commercial-In-Confidence Report AEA-D&W-0622 (work performed at Sandia National Laboratories).

Witte, M. C. et al., 1998, “Summary of Evaluation of Low-Velocity Impact Test of Solid Steel Billet Onto Concrete Pads,” NUREG/CR-6608, UCRL-ID-129211.

Stephenson, A. E., 1977, “Full-Scale Tornado-Missile Impact Test,” EPRI Report NP-440 (work performed at Sandia Laboratories).

IMPORTANT EXPERIMENTS TO BE ANALYZED FOR CHARACTERIZING Ru FISSION PRODUCT RELEASES

- Oak Ridge Test VI-7 – BWR irradiated fuel segment (6 in.) with Zr cladding – No significant ruthenium release until essentially complete oxidation of the Zircaloy cladding.
- CANDU experiments H02 and H05 – irradiated fuel segment (1 in.) with Zr cladding – No significant ruthenium release until complete oxidation of the cladding.

RECOMMENDED EXPANSION OF THE TECHNICAL BASIS TO DEVELOP A BEST ESTIMATE ASSESSMENT WITH UNCERTAINTY BOUNDARIES

- Provide estimates of the oxidation extent before the fuel slumps
  - CODEX,
  - TMI-2,
  - MELCOR calculations.
- Use the available experiments basis to estimate the Ru releases based on ZrO oxidation and debris temperature
  - ORNL tests (unclad pellets),
  - Chalk River experiments
    - unclad fuel,
    - with fuel cladding.
- Need to consider that some fuel from the top of the pins could be declad (exposed). However, this would also form a particle bed on the upper surface and would be at a lower temperature due to thermal radiation.

CONCLUSIONS

1. Best estimate evaluations should be included in the study to promote technology transfer for risk informed decisions as well as for other studies that could use this information.
2. A peer review is recommended. This is an efficient manner to assure that the relevant experience and experimental insights have been incorporated.

MRP - Alloy 600 ITG
RPV Penetrations

Presentation To ACRS Subcommittees
July 10, 2001

Purpose

- Industry Goals:
  - Near Term: Assure Structural Integrity
  - Longer Term: Develop Program to Manage PWSCC
- Explain Background of Head Penetration Issue
- Present Status of MRP Program
- MRP Recommendations for Industry

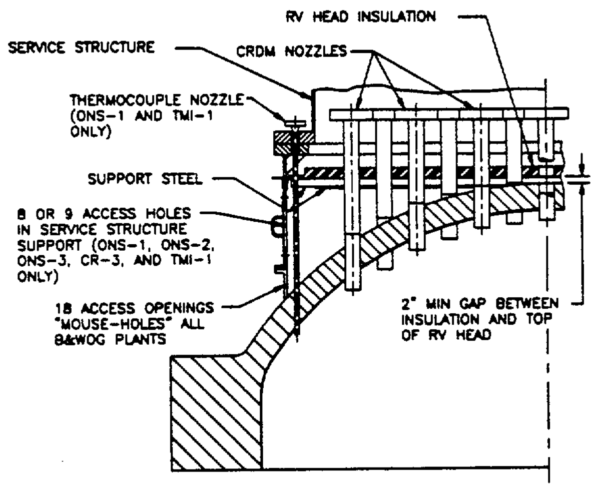
RPV Penetration Summary

- Near Term Conclusions:
  - Axial PWSCC in CRDM nozzles does not impact plant safety
    - Bounded by previously submitted Safety Assessments (1993/94)
  - Reasonable assurance that other PWRs do not have circumferential cracking that would exceed structural margin
    - Oconee and ANO-1 in highest grouping based on effective time-at-temperature
    - Leaks discovered by careful visual inspection of top head surface
    - Volumetric examination of other nozzles found only minor craze cracks
    - Leaks discovered with significant structural margin remaining
    - Several other plants in highest groupings have no evidence of leakage

Other Ongoing MRP Activities

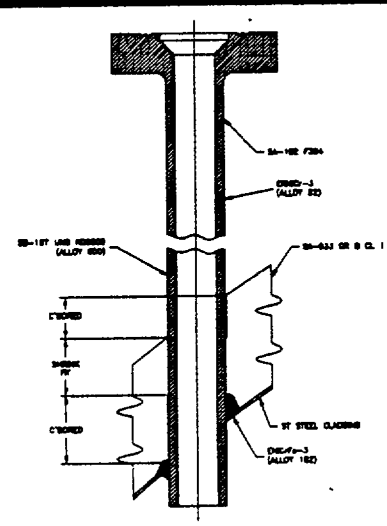
- Risk Assessments
- Probabilistic Fracture Mechanics
- Assessment of Crack Growth Data and Needs
- NDE Demonstration
  - Block Design and Fabrication
  - Technique Development and Demonstration
- Information and Training Package for Visual Examination
- Flaw Evaluation Guidelines
- Review of Repair and Mitigation Strategies

Side View Schematic of B&W-Design Reactor Vessel Head, CRDM Nozzles, Thermocouple Nozzles, and Insulation



EPRI

Schematic View of B&W-Design CRDM Nozzle Area



EPRI

Issue Background

- Bugey-3 cracking in 1991 characterized as:
  - ID-initiated, through-wall axial flaws
  - Through-wall axial flaw initiated OD circumferential flaw in RV head penetration crevice
- Lack of fusion detected in attachment welds at Ringhals-2 (1992)
- Industry safety assessments prepared (early 90's) for these types of cracking
- Additional European PWRs Discovered Axial Penetration Cracks and Initiated Head Replacements
- DC Cook 2 Found and Repaired a Single Cracked Penetration (1994)
- Owners Groups Programs to Manage for Their Units

Background: GL 97-01

- GL 97-01 Issued April 1, 1997
- Owners Groups Prepared Generic Responses
- Responses Coordinated Between Owners Groups by NEI Task Force
  - Histogram Ranked Plants, Normalizing Both Industry Models to DC Cook 2
- Individual Utilities Supplied Information for Their Plants
- Lead Plants Scheduled for Inspections Based on Histogram
  - ET for Detection
  - UT for Sizing of ID Flaws

Background: GL 97-01 Histogram

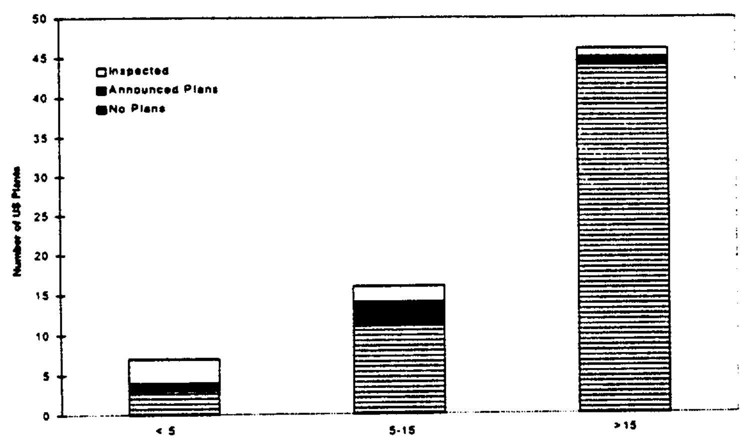
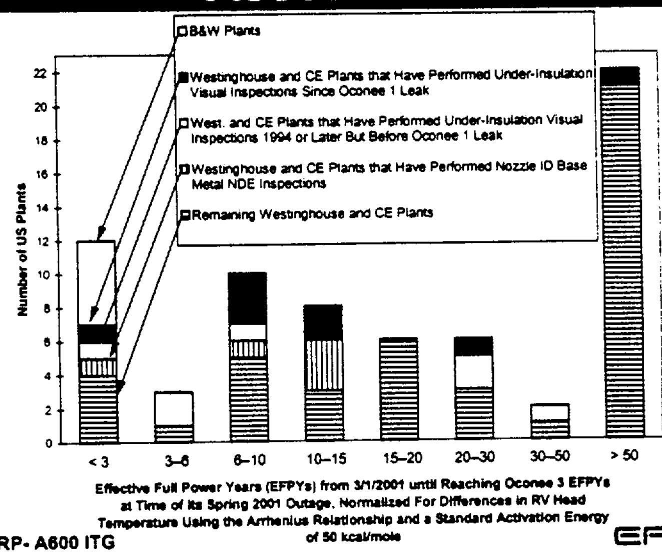


Figure 1: Effective Full Power Years, Measured from January 1997

Recent Experience

- Recent **J-groove Weld and OD-initiated** Cracking Observed at B&W-Design Plants
  - ONS-1 (November 2000)
  - ONS-3 (February 2001)
  - ANO-1 (March 2001)
  - ONS-2 (April 2001)

Time-Temperature Histogram Chart in MRP-44 Part 2 Interim Safety Assessment



EPRI

Recent Experience

EPRI

Oconee Experience

- Visual inspection of Unit 1 RV head identified small amounts of boron accumulation at the base of CRDM nozzle 21 and several T/C nozzles.
- Visual inspection of Unit 3 reactor vessel head identified small amounts of boron accumulation at the base of several CRDM nozzles. The suspect nozzles were #'s 3, 7, 11, 23, 28, 34, 50, 56, 63.
- Visual inspection of Unit 2 reactor vessel head identified boron accumulation at the base of CRDM nozzle #'s 4,6,18, and 30

Oconee Background Information

- Modifications to cut access ports (9 each - 12 in diameter) into the Oconee service structure were completed during outages in Spring 1994, Spring 1993, and Fall 1994 for Units 1, 2, and 3 respectively.
- Modifications to service structure allowed access to domed portion of head for bare metal inspections and wash down of the head to remove old boron deposits.

Oconee Background Information

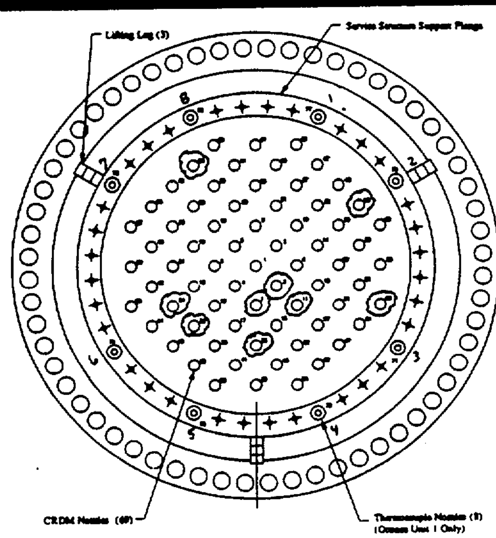
- T/C nozzles installed in Unit 1(only) for instrumentation purposes, but were never put into service.
- Located outboard of the CRDMs and fabricated from 0.75" Schedule 160 Alloy 600 pipe
- Material Specification is SB-167 and procured from Huntington Alloys as cold drawn, ground, and annealed pipe
- Procured to 1965 ASME B&PV Code

ONS-1 RV Head Showing Boric Acid At Thermocouple Nozzle

Oconee Background Information

- CRDM (69) nozzles are constructed of Alloy 600 and procured in accordance with requirements of SB-167, Section II to 1965 Edition including addenda through Summer 1967 of ASME B&PV Code.
- CRDM nozzle material was hot rolled and annealed by B&W Tubular Products Division.
- CRDM nozzles were shrink fit into reactor vessel head penetration and welded with a J-groove weld with Alloy 600 filler

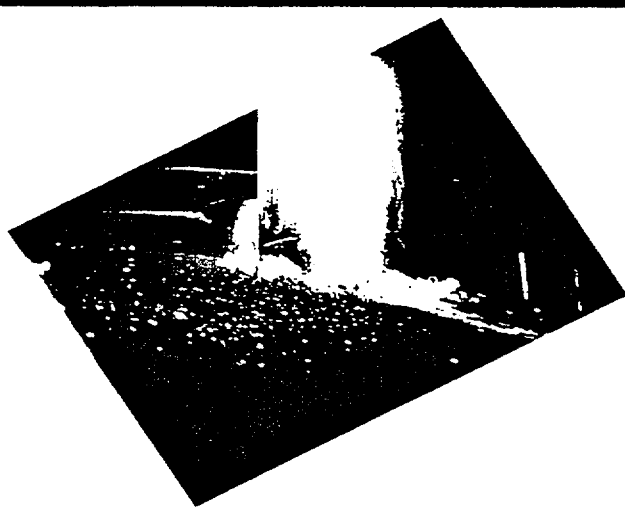
CRDM Nozzle Layout



Summary of Recent Cracking Incidents

- ONS-1:
  - All eight thermocouple nozzles contained flaws predominantly axial in orientation
    - Five nozzles identified as leaking
    - ID cracking observed on all eight nozzles
    - Cracking penetrated into all eight nozzle welds
  - CRDM nozzle 21 did not contain ID flaws
    - Flaws in weld material, predominantly axial/radial in orientation, identified as leak source
    - Flaw propagated through the weld and nozzle base material

ONS-1 RV Head Showing Boric Acid At CRDM Nozzle 21

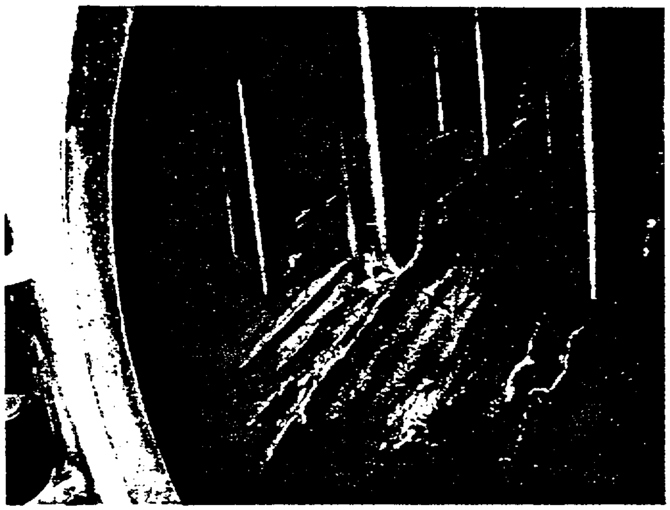


Summary of Recent Cracking Incidents (Cont.)

- ONS-3:
  - Nine CRDM nozzles found leaking
    - Numerous axially oriented flaws identified
    - OD-initiated circumferential flaws (relatively deep and below the weld) identified on four nozzles
    - OD-initiated circumferential flaws (above the weld and up to through-wall) identified on two nozzles
    - Some weld cracking also identified

CRDM Nozzle #56

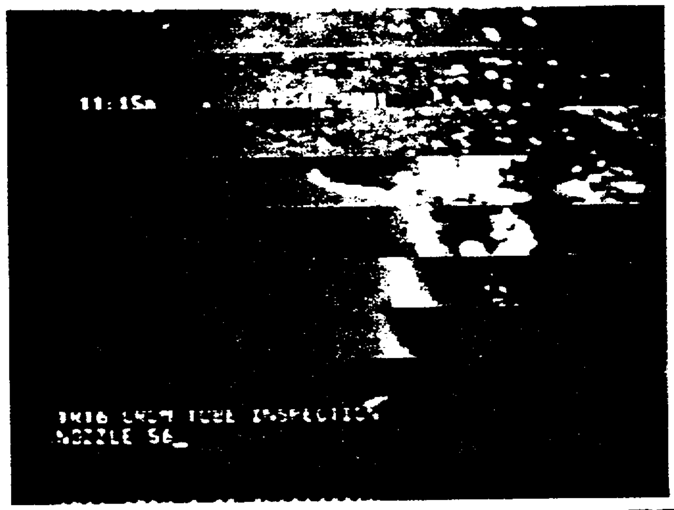
CRDM Nozzle #50



Summary of Recent Cracking Incidents (Cont.)

- ANO 1 CRDM nozzle 56 found leaking
  - No ID axially oriented flaws identified
  - One OD-initiated circumferential flaw below the weld that turned axial identified
  - Flaw propagated through the weld area along the nozzle OD

Visual Inspection
ANO 1



Investigations Performed
ONS 1 & 3

- Non-Destructive Examinations
- Metallurgical Examinations
- Analytical Evaluations

Non-Destructive Examinations

- Pre-Repair Inspections Performed
  - Visual inspections of all 69 CRDM nozzles
  - Dye Penetrant (PT)
  - Eddy Current Testing (ECT)
  - Ultrasonic Examination-Axial
  - Ultrasonic Examination-Circumferential

Visual Inspections

- Bare head inspections are performed through the modified openings in the head service structure
- Visual inspections are performed as part of each refueling outage for our response to GL 88-05 and 97-01
  - The same experienced system engineer performs these inspections
- Heads essentially clear of old boron deposits
- Amount of leakage from each leaking nozzle has been very small, which suggests, low leak rates
- No evidence of boric acid corrosion on top of head

Non-Destructive Inspections

- Dye Penetrant (PT) Inspection
  - Surface examination that looks at the weld surface area and the top 1 inch of the nozzle that projects down into the plenum of the head
  - Performed on suspected leaking CRDM nozzles
- Eddy Current (ECT) Inspection
  - Surface examination (plus 2 to 3 mm into the material) from the nozzle ID
  - Performed on suspected leaking nozzles
  - Checks a band 6 inches above the weld down to free end of nozzle
  - Later performed on additional nozzles, to address extent of condition
    - 8 Unit 1 CRDM nozzles
    - 9 Unit 3 CRDM nozzles

Non-Destructive Inspections

- Ultrasonic Examinations (UT) Axial
  - Volumetric examination to locate and depth size axial indications on both the nozzle inside diameter and the nozzle outside diameter
  - Performed on the suspected leaking nozzles and on additional nozzles to address extent of condition
    - 18 nozzles on Unit 3 inspected
- Ultrasonic Examinations (UT) Circumferential
  - Volumetric examination to detect the presence of circumferential cracking or indications and lack of bond
  - Performed on the suspected leaking nozzles and on additional nozzles to address extent of condition
    - 18 nozzles on Unit 1 (lack of bond)
    - 18 nozzles on Unit 3 (circumferential)

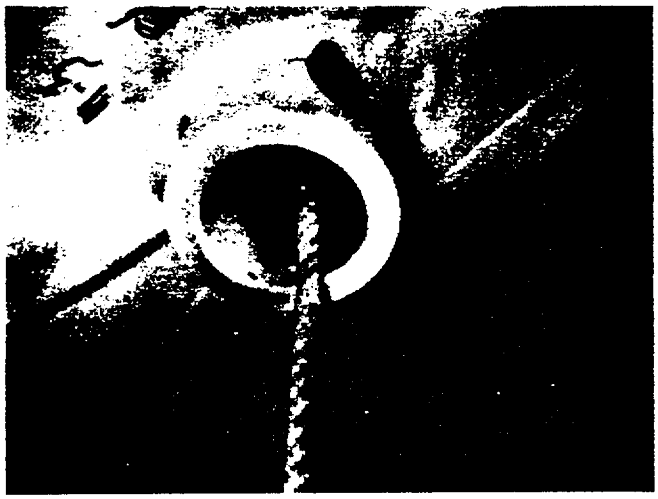
CRDM Nozzle #11

EPRI

CRDM Nozzle #23

EPRI

CRDM Nozzle #56



ONS 3: Summary Nozzle Indications and Characterization

- Total of 48 indications in the nine leaking CRDMs
  - 39 are axial and located beneath the weld at the uphill and downhill
  - 16 indications thru wall (39%), all are axial, and occur on 6 of 9 nozzles
- Confirmed two (2) above the weld circumferential cracks
  - Nozzle 56 crack was thru wall
  - Nozzle 50 except for pin hole indications on ID was not thru wall
  - Inspection and metallurgical results indicate the circumferential cracks were O.D. initiated.
- Unit 3 CRDMs extent of condition inspections (9 additional nozzles):
  - Cluster indications above and/or below the J groove weld.

Circumferential Cracks Above Weld

- Discovered during post weld repair NDE of Nozzles 50 & 56
- Circumferential cracks followed the weld profile contour and were O.D. initiated.
- Both ECT and UT inspections identified indications in these areas but were dispositioned as crazed cracks with unusual characteristics
- The original NDE characterization for nozzles 50 and 56 subsequently changed.
- This change in interpretation of the NDE signals is related to the flaw orientation with respect to the sound beam of the UT search units.
- Actions taken as a result of this discovery were:
  - All Unit 1 and 3 ECT and UT data re-reviewed applying the LLs
  - EPRI NDEC led an independent review of ONS 1 & 3 data to confirm results and findings

Metallurgical Examinations

- T/C nozzle specimen (2) from Unit 1
- CRDM #21 182 weld filler material boat sample from Unit 1
- CRDM nozzle end pieces (7) from Unit 3
- CRDM nozzle 56 circumferential crack boat sample, Unit 3

Unit 1: Summary Results of Metallurgical Examinations

- T/C Nozzles:
  - Cracks are intergranular and branched
  - Cracks are axial and radial in orientation
  - Material appears to be typical of mill annealed Alloy 600 with some evidence of cold working on both the OD and ID surfaces
  - Microstructure mixed with both intra and intergranular carbides
  - Microstructure characterized by small clusters of small grain with some large grains; Grain size ASTM 7-8
  - No indication of aggressive chemical species on the crack face
  - PWSCC was the primary mechanism for crack propagation

Unit 1: Summary Results of Metallurgical Examinations

- CRDM Nozzle 21:
  - Crack in weld was completely interdendritic
  - No conclusive evidence of manufacturing defects in the original weld
  - Crack in weld was connected to a branched intergranular crack in the nozzle wall
  - Qualitative comparison of boat sample to a 182 weld pad confirmed alloy type material, as expected
  - PWSCC was the primary mechanism for crack propagation in the CRDM weld and housing

Unit 3: Summary Results of Metallurgical Examinations

- CRDM Housing Material Specimen:
  - Microstructure of all nozzle materials very similar and typical for mill annealed Alloy 600. Grain size is ASTM 4.
  - Grain boundaries contain a semi-continuous carbide decoration
  - No ghost grain boundaries or segregated carbide clusters
  - All cracks in the samples were intergranular with slight branching
  - Micro-hardness survey across the thickness shows a range from about Rb 80 at the ID to Rb 95 at the OD
  - Several nozzles exhibited cracks originating at free end of nozzle
  - All cracks are stress corrosion cracks with PWSCC as the primary mechanism for crack propagation

Unit 3: Summary Results of Metallurgical Examinations

- CRDM 56 Boat Sample (Circ Crack):
  - Boat sample in the area of circ crack that was found above the weld after the weld repairs were completed
  - Boat sample contained a face of the circ crack along with 3 small axial cracks that intersect the circ crack
  - Section through the axial crack confirms crack is totally intergranular with small intergranular branches
  - Scanning electron microscopy of the circ crack face revealed only intergranular morphology.
  - There are no tears or other indications of the origin of the circ crack
  - Circ crack is indicative of PWSCC

Correlation of Observed Crack Locations with FE Stress Analysis

- Cracks are:
  - predominantly axial and located on the uphill and downhill sides of the nozzle
  - most initiate on the OD of the nozzle
  - circumferential cracks found below and above the weld, at the weld toe on the uphill and downhill sides of the nozzle

Correlation of Observed Crack Locations with FE Stress Analysis

- Stress analysis (residual + operation) preliminary results:
  - Hoop stresses exceed axial stresses at most locations which suggests axial cracking would be expected. This is consistent with observed field conditions
  - Axial stresses are higher on the uphill side of the nozzle relative to downhill side of nozzle. Field observed locations of the above the weld circumferential cracks align with this analysis prediction.
  - Microhardness measurements suggest the material yield strength is significantly higher on outside of nozzle than on the inside. The high outside yield strength may explain the preferred OD cracking

Oconee Repairs

- Repairs performed in accordance with 1992 Section XI of ASME Code, applicable Code Cases, and NRC approved alternatives, as required
- Removed flaws from both weld material and nozzle base material for Units 1 & 3
  - Automated weld process to apply protective layer over J groove weld
- Automated repair method used for Unit 2 removed cracked nozzle material and established new pressure boundary location. Cracks left in remaining J-groove weld

CRDM Nozzle #50

ANO 1 Repair

- Embedded Flaw Repair
  - OD axial flaw removed down to the butter
  - Weld repaired, isolating remaining flaw above the weld from the environment
  - Peened repair area
- Post-repair UT to confirm remaining flaw did not grow during repair process

Industry Response

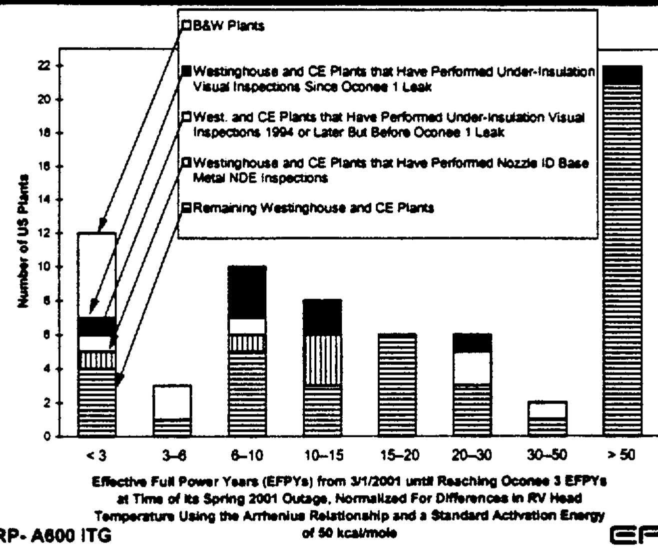
Industry Response Organization

- Integrated effort is being coordinated through
  - EPRI Materials Reliability Project - Alloy 600 ITG
    - NEI - Regulatory Interface
    - Committees Under Alloy 600 ITG
      - Assessment
      - Inspection
      - Repair/Mitigation
    - Owners Groups
- Work is being performed by
  - Utilities
  - NSSS Vendors
  - Contractors

MRP Interim Safety Assessment

- Interim Safety Assessment Submitted May 18, 2001
- Developed a Histogram of Time for Each Unit to Reach the Equivalent Time at Temperature as ONS 3 (normalized to 600F)
  - Sorted plants into bins, <3 EFPY, 3-6 EFPY, 6-10 EFPY, etc.
- Recommended Plants <10 EFPY from ONS 3 with Fall Outages perform visual inspections
  - Capable of detecting small amounts of Boron similar to ONS & ANO

Time-Temperature Histogram Chart in MRP-44 Part 2 Interim Safety Assessment



MRP Interim Safety Assessment

- Bases for No Significant Near-term Impact on Plant Safety:
  - The Three Oconee Units and ANO-1 Are Among the Lead Units in the US Based on Time at Temperature
  - Leaks Were Found by Careful Visual Inspections
  - Structural Integrity Evaluations Showed the Nozzles and Welds Were Well Within Required Margins
  - Leakage Should Also Be Detectable in Other Plants
  - Several Other Lead Units With Long Operating Times and High Head Temperatures Had Already Performed Inspections From Above and Below the Head Without Any Significant Findings
  - A CRDM Nozzle Ejection Is an Analyzed Event in Plant FSARs
  - Existing Symptom Based EOPs and Operator Training Adequate

NRC Questions

- NRC identified several questions on May 25, 2001:
  - Leak detection
    - Effect of initial interference fit on leak detection
  - Time-temperature histogram
    - Effect of activation energy on predictions
    - Benchmarking against foreign plant inspections
    - Basis for ten year inspection criterion
  - Growth rate of circumferential cracks
    - Time until Oconee 3 would have reached allowable flaw size
    - Effect of crack growth rates on histogram
  - Loose parts
  - Risk assessment

NRC Questions

- NRC Documented Those and Asked Additional Questions on June 22, 2001:
  - Photos of visual inspections performed at other units
  - Inspection Capabilities
    - Ability to Perform Volumetric NDE
      - Nozzles for ID/OD Flaws
      - J-groove Welds
    - Estimate of Number, Time, Other Costs to Perform Volumetric and Visual Inspections by 1/1/2002
      - During Scheduled Outage
      - During Unscheduled Outage

Safety Assessment Status

- The Interim Safety Assessment was prepared to demonstrate safety of operating plants
- Additional effort is ongoing in several areas
  - Analysis associated with the Final Safety Assessment
  - Visual inspections of the reactor vessel top head surface for plants coming down for Fall 2001 refueling outages
  - Research into improved inspection and repair technology
  - Risk assessment
- Results will be factored into the Final Safety Assessment

Leakage Detection

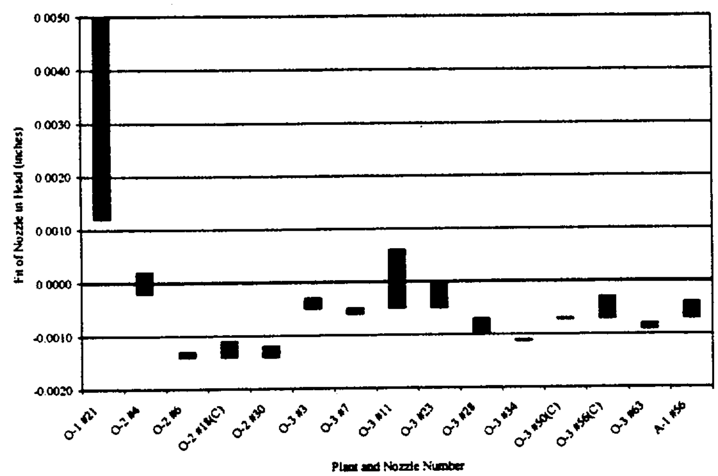
Leakage Detection

- Oconee and ANO-1 detected leakage, but
  - Some other plants have greater interference fits (see Table 3-2 of Interim Safety Assessment)
- Leakage should be detectable at most other penetrations given similar cracks
  - Only minor craze cracking was found in NDE examinations of 17 additional "non-leaking" Oconee 1 and 3 CRDM nozzles. This supports appropriateness of visual inspections for detection of through-wall cracks in CRDM nozzles
  - Interference fits at other plants are only slightly larger than Oconee and ANO-1
  - Further experience has shown that it is difficult to prevent leakage of 2,250 psi water without roll, hydraulic or explosive expansion or use of a sealant

Leakage Detection
Actual Fits at Oconee and ANO-1

- Fabrication records for Oconee 1, 2, and 3 and ANO-1 vessel heads have been reviewed
- The following measurements were taken
  - ID of the hole in the vessel head at the top and bottom of the interference fit region
  - OD of the nozzle
- Results for the 14 leaking CRDM nozzles at Oconee 1, 2, and 3 and ANO-1 are shown on next slide
  - One nozzle had a clearance fit (gap)
  - The remaining nozzles had at least one end within the specified diametral interference range of 0.0005 - 0.0015 inches. Three of the four leaking ONS 2 nozzles had interference fits of 0.0014 inches on one end and at least 0.0011 inches on the other.

Leakage Detection
Actual Fits at Oconee 1, 2, and 3 and ANO-1



Leakage Detection
Effect of Operating Conditions on Fit

- Differential thermal expansion has only a small effect, increasing the initial interference fit by <0.0014"
- The change in fit under operating conditions is primarily due to pressure dilation of the vessel head
- For the example, the change in diametral fit due to pressure dilation is approximately
  - ΔD = 0.00402" - 0.00048" = 0.0035"
  - The hole will open up further when the effect of reduced effective modulus due to the effect of multiple nozzles is considered
- Therefore annular gaps are expected for most CRDM nozzles under operating conditions

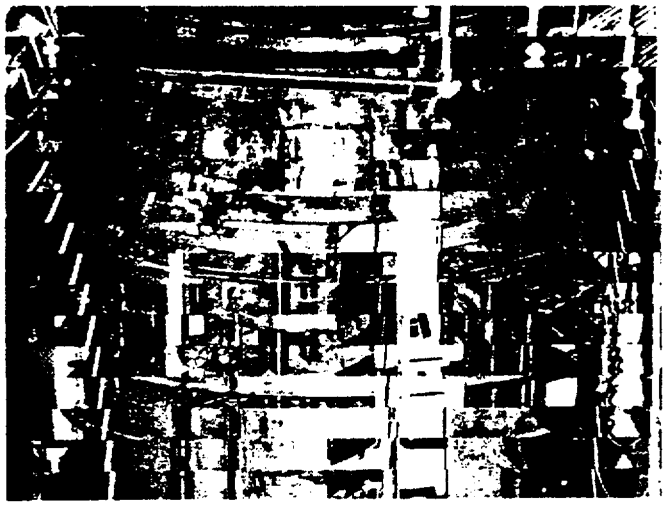
Leakage Detection
Other Effects on Fit

- Finite element analyses show that outer row CRDM nozzles displace laterally and become slightly ovalized in the vessel head as a clearance opens up under operating conditions
  - The displacement and ovalization reduce the leak path at some locations and increase the leak path at other locations
  - The net effect is to create a spiral flow path which has less resistance than a uniform annular gap
- Finite element analyses also show a minor (~20%) increase in ovality for peripheral CRDMs from flange tensioning and rotation

Visual Inspections Spring 2001

- Several other plants performed visual inspections during Spring outages
  - Robinson 2
  - Salem 1
  - Farley 2
  - Prairie Island 1
  - McGuire 1 (partial)
  - SONGS 3 (partial)
- Heads reasonably free of masking boric acid deposits
- No evidence of leakage found

Visual Inspection
Salem 1



Time Temperature Histogram

Time-Temperature Histogram Background

- The time-temperature model groups plants according to the time (EFPY) required for each unit to reach the equivalent effective time at temperature as Oconee 3 at the time the above-weld circumferential cracks were discovered in February 2001
- The reference date for the time-temperature assessments is March 1, 2001
- The industry standard activation energy of 50 kcal/mole for PWSCC initiation in Alloy 600 material was used to normalize plant operating time to a head temperature of 600°F

Time-Temperature Histogram Effect of Activation Energy (cont.)

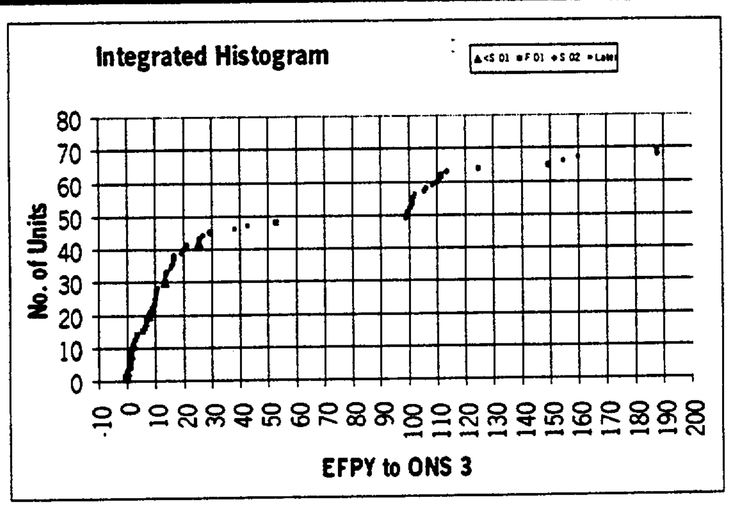
- A sensitivity study for the results of the plant assessments was performed
- The effect is small, as shown below:

Activation Energy	*Assessment Groups*							
	< 3 EFPYs	3–6 EFPYs	6–10 EFPYs	10–15 EFPYs	15–20 EFPYs	20–30 EFPYs	30–50 EFPYs	> 50 EFPYs
50 kcal/mole	**12**	**3**	**10**	**8**	**6**	**6**	**2**	**22**
40 kcal/mole	**12**	**4**	**14**	**9**	**4**	**3**	**2**	**21**

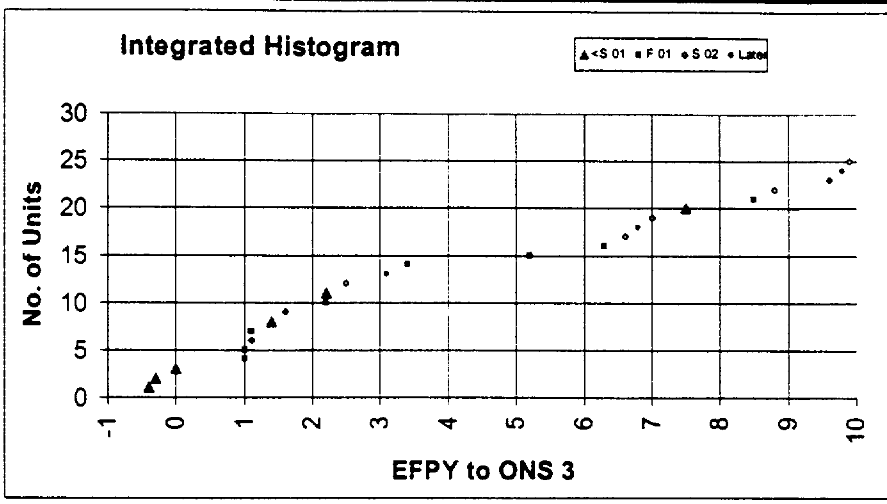
Time-Temperature Histogram Ten-Year Period

- 10 Year Period for Near-Term Inspection
  - The ten year period for recommending visual inspections of the top of the vessel head for small amounts of leakage similar to that observed at Oconee and ANO-1 was selected to provide some margin for uncertainties
  - Encompasses 25 units
  - All but two will have outages by Spring '02
  - The ten year period will be re-assessed based on results of upcoming outages

Time-Temperature Histogram



Time-Temperature Histogram



Circumferential Crack Growth
Growth Rate in Annulus Environment

- Data are available from 5 sources for carefully controlled PWSCC tests of Alloy 600 and 182, using PWR conditions
- OD initiated cracking requires the presence of water or steam, so a pressure boundary leak is necessary
- The crevice region could contain some Oxygen from the containment atmosphere, but at temperature this Oxygen would be quickly consumed by reaction with the low alloy steel nearby
- This reaction, plus the extremely tight fit and the distance to the OD of the head, make a high Oxygen environment unlikely

Crack Growth

Circumferential Crack Growth Growth Rate in Annulus Environment

- Since the fluid will contain lithium hydroxide and boric acid, it will likely be similar to a controlled PWR environment
- Comparison of BWR and PWR crack growth rates for Alloy 600 and 182 shows that, at a given temperature, the growth rates are comparable
- Temperature is a stronger variable than environment for these materials
- MRP has scheduled an international expert panel to assess crack growth rates
  - Initial meeting in August

Circumferential Crack Growth Margin for Oconee 3 Cracks

- Two Oconee 3 nozzles were cracked approximately 165°
- Stress analyses show that cracks initiated in a high stress region and propagated into a lower stress region
- The remaining time for Oconee 3 circ cracks to reach ASME Code allowable ligament (safety factor of 3) was estimated to be 4-5 years, based on the modified Peter Scott model and also by assuming the maximum crack growth measured in lab
- Efforts are underway to refine the stress intensity calculations in the nozzle in the intact and cracked conditions

Loose Parts & Risk Assessment

Loose Parts

- The potential for, and consequences of, loose parts in B&W designed plants such as Oconee and ANO-1 was described to the NRC on April 12, 2001
- Creation of loose parts was deemed unlikely
- Worst postulated condition is a single stuck rod
- While analyses for other plant designs have not been completed, results are expected to be similar
- Loose parts analyses will be included in final report

Risk Assessment

- Risk calculations are in process now
- The effort includes interaction with all PWR vendors and others to ensure applicability to all plants
  - Consistent with past approaches
- Staff has conservatively estimated CCDP about 10-3, assuming rod ejection, but probability of ejection event likely to be a few orders of magnitude less than 1 for all plants

Summary & Ongoing Activities

Summary

- Near Term Conclusion:
  - Axial cracks alone in CRDM nozzles do not impact plant safety
    - Bounded by previously submitted Safety Assessments (1993/94)
    - But through wall axial cracks can be a precursor to circumferential cracking
  - There is reasonable assurance that PWRs do not have circumferential cracking that would exceed structural margin
    - Oconee and ANO-1 in highest grouping based on effective time-at-temperature
    - Leaks discovered by careful visual inspection of top head surface
    - Volumetric examination of other nozzles found only minor craze cracks
    - Leaks discovered with significant structural margin remaining
    - Several other plants in highest groupings have no evidence of leakage

Schedule

- Revised Inspection Recommendations - July-August
- Expert Panel on Crack Growth - First Meeting 8/01
- Inspections during Fall 2001 outages
- Final RPV Penetration Safety Assessment - 12/01
- Reassessment of Inspection Recommendations - 2/02

Other Ongoing MRP Activities

- Risk Assessments
- Probabilistic Fracture Mechanics
- NDE Demonstration
  - Block Design and Fabrication
  - Technique Development and Demonstration
- Information and Training Package for Visual Examination
- Flaw Evaluation Guidelines
- Review of Repair and Mitigation Strategies

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

July 11, 2001

LICENSE RENEWAL RULEMAKING RECOMMENDATIONS

Sam Lee, NRR/DRIP/RLSB

COMMISSION REQUEST

August 27, 1999, Staff Requirements Memorandum (SRM) responding to SECY 99-148, "Credit for Existing Programs for License Renewal":

> "[T]he staff should prepare a detailed analysis and provide recommendations to the Commission on whether it would be appropriate to resolve generic technical issues, including any credit for existing programs, by rulemaking."

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS (ACRS) COMMENT
(April 13, 2001, ACRS letter)

ACRS Comment	Staff Recommendation
Include results of scoping process in license renewal applications	Clarify guidance documents

UNION OF CONCERNED SCIENTISTS (UCS) COMMENTS
(June 26, 2001, UCS letter)

UCS Comment	Staff Recommendation
Radwaste systems should be covered in scope of license renewal	Address under rulemaking petition process
Define criteria for acceptable minimum standards for effective aging management programs	Clarify guidance documents
Define basis for reliance on one-time inspections	Clarify guidance documents

NUCLEAR ENERGY INSTITUTE (NEI) COMMENT
(June 4, 2001, NEI letter)

NEI Comment	Staff Recommendation
Rulemaking is not necessary at this time	Agree

STAFF RECOMMENDATIONS

- Rulemaking is not necessary at this time
- Clarify renewal guidance to address comments
- Continue to monitor renewal lessons and other rulemaking for opportunities to improve process

Industry Views on SFP Risk Study and Policy Options

ACRS

July 11, 2001

NEI

Overview

- Impacts of not completing risk study
- What's needed to complete the study (Dr. Henry, Fauske and Associates)
- Industry Views on Policy Options
- Recommendations

NEI

Risk Study Should be Completed

- Failure to complete has impacts on:
  - Policy options for decommissioning rules
  - Use of results in plant PRAs (<3E-6??)
  - Accuracy of value/impact and backfit analyses
  - Unrealistic conclusions (e.g., cask drop results) being applied elsewhere (PRA for casks)

NEI

Safeguards Option

- Protect against the DBT to a performance standard of 5 rem to the public or,
- Demonstrate through plant specific analyses that a zirconium fire is <u>precluded</u>. Includes:
  - Design features, heat-up analysis, or mitigating actions including response by law enforcement before fire commences

NEI

Issues/Safeguards Option

- No opportunity to comment on guidance for performing plant specific analyses
- Any change to adversary characteristics could invalidate the entire program
- Standard to "preclude" a zirconium fire not reflected in EP policy analyses

NEI

Insurance Option

- 60-days after shutdown:
  - Primary coverage reduced to $100M
  - Exempted from participation in secondary pool
  - On-site property damage not required
- Facility must comply with staff assumptions and industry commitments

NEI

Issues/Insurance Option

None, appears to be rational, risk informed approach.

NEI

EP Option

- Some reduction in offsite EP in the first year
- Elimination of offsite EP at 5 years.
- Licensee must comply with staff assumptions and industry commitments

NEI

Issues/EP Option

- Can't quantify benefits without more information on reduction in offsite requirements
- Defense in depth?? May be non existent if adhoc EP is just as effective shortly after shutdown and/or if evacuation is ineffective for large seismic events
- Cask drop is not a realistic event
- Sabotage already uses standard of "precluding" the event

NEI

Recommendations

- Complete the risk study, peer review results and derive a best estimate using existing data on cask drops, Ruthenium release and EPRI seismic numbers
- Revisit conservatism in seismic checklist
- Ensure EP reductions are commensurate with the risk and quantifiable defense in depth

NEI

NRR STAFF PRESENTATION TO THE ACRS

SUBJECT:	SECY-01-100, "Policy Issues Related to Safeguards, Insurance, and Emergency Preparedness at Decommissioning Nuclear Power Plants Storing Fuel in Spent Fuel Pools"
DATE:	July 11, 2001
PRESENTER:	Bill Huffman
PRESENTER'S TITLE:	Project Manager, Division of Regulatory Improvement Programs Office of Nuclear Reactor Regulation
PRESENTER'S TEL. NO.:	(301) 415-1141

Policy SECY Background

- Decommissioning nuclear power plants seek early regulatory relief from various Part 50 requirements. Three areas involve consideration of zirconium fire:
  - Insurance
  - Security
  - Emergency Preparedness (EP)
- Relief provided by exemption process
- Several rulemaking attempts initiated
  - Stopped; technical bases inadequate
- Industry challenged zirconium fire criteria
- Commission meeting March 17, 1999
  - SRM sanctioned risk-informed approach
- Staff committed to perform detailed technical study on decommissioning plant spent fuel pool accident risk
- Risk study now complete (NUREG-1738)

RISK STUDY FINDINGS

- Spent fuel pool accident risk is low
- Agency quantitative health objectives are met; risk well within Commission's safety goals
- Risk findings can be used consistent with RG 1.174 guidelines for small increase in risk
  - e.g., small change in risk if offsite EP is relaxed at decommissioning plants
- Cannot define a generic decay heat time beyond which a zirconium fire is not physically possible

Policy Issue 1

Policy Issue 1 Should the Safety Goals for Operating Nuclear Power Plants be Applied to Decommissioning Plants?

Options: (1) Yes

(2) No

Recommendation: Option (1)

Apply the Commission safety goal policy statement to decommissioning nuclear power plants storing spent fuel in the spent fuel pool (SFP)

- Operating plant safety goals are appropriate since consequence from a postulated SFP zirconium fire can be similar to a large early release event at an operating reactor
- Permits application of SFP risk study, NUREG-1738, and existing risk-informed decision making guidance to decommissioning plant regulatory improvements

Policy Issue 2

Policy Issue 2 Should the Commission develop an approach using probabilistic risk assessments for quantifying the likelihood of sabotage?

Options:

(1) Commit resources to begin development of a PRA methodology that can be used to assess the likelihood of sabotage

(2) Evaluate current state-of-art PRA methodologies for assessing sabotage and determine if further development is warranted

(3) Continue to assess likelihood of sabotage in a qualitative manner using deterministic and performance-based safeguards design criteria

Recommendation: Option (3)

The approach for developing new safeguards regulatory requirements for decommissioning plants will be based on deterministic and performance-based criteria because:

- Methods for estimating the likelihood of sabotage is considered to be beyond the state of the art of PRA

- Attempting to develop PRA methods for estimating the likelihood of sabotage would require substantial resources and cannot be done unilaterally by the NRC

Policy Issue 3

Policy Issue 3 What safeguards protection goal should the Commission apply to SFPs at decommissioning plants?

Options: (1) Maintain a level of security commensurate with that of an operating plant

- Design criteria - protect against radiological sabotage by the design basis threat (DBT)

(2) Apply a performance-based protection goal for spent fuel stored in decommissioning SFPs as recommended in the newly proposed rule changes for physical protection at nuclear power reactors in SECY-01-101, dated June 4, 2001

- Design criteria - protect against radiological sabotage by the design basis threat (DBT)
- Performance standard - no fuel damage that exceeds the offsite dose limits of 10 CFR 72.106

Policy Issue 3 (cont.)

(3) Apply the protection goal for an independent spent fuel storage installation (ISFSI)

- Design criteria - protect against radiological sabotage that results in a loss of control of the facility

- Performance standard - no fuel damage that exceeds the offsite dose limits of 10 CFR 72.106

Recommendation: Option (2)

Applies the performance-based protection goal recommended in the proposed revision to 10 CFR 73.55 in SECY-01-101

- Appropriate level of physical protection for decommissioning plant SFPs (provides transition between operating reactors and dry cask ISFSIs)

- Should provide sufficient flexibility to permit a decommissioning licensee to focus their security program and response strategies in a manner that reduces regulatory burden below operating reactor levels (Option 1) while maintaining safety

Policy Issue 4

Policy Issue 4 What level of insurance is appropriate for licensees of decommissioning plants with fuel stored in the SFP?

Options:

(1) Maintain insurance at operating reactor levels until all spent fuel is removed from the SFP

(2) Maintain insurance at operating reactor levels until a plant-specific thermal-hydraulic heatup analysis demonstrates that uncovered spent fuel would not reach zirconium ignition temperature

(3) Relax insurance after a generic fixed period of time based on qualitative policy judgment that zirconium fires are unlikely based on decay time alone (although still possible)

(4) Relax insurance requirements shortly after permanent shutdown based on the low generic frequency of events leading to a zirconium fire contingent on implementation of certain SFP design, operational, and administrative features committed to by the industry or assumed by the staff in the risk study (these controls are referred to as industry decommissioning commitments - IDCs and staff decommissioning assumptions - SDAs in the policy SECY)

Policy Issue 4 (cont.)

Recommendation: Option (4)

Since the presence or absence of insurance has no effect on the probability or consequences of a zirconium fire, reducing insurance does not increase the radiological risk to the public. Reducing insurance coverage shortly after permanent shutdown is justified based on the low likelihood of events leading to a zirconium fire (contingent on implementation of the risk study IDCs and SDAs)

NRR STAFF PRESENTATION TO THE ACRS

SUBJECT:	**SECY-01-100 Emergency Preparedness Policy Issue**
DATE:	**July 11, 2001**
PRESENTER:	**R. L. Sullivan, CHP**
PRESENTER'S TITLE:	**EP Specialist** **Division of Inspection Program Management** **Office of Nuclear Reactor Regulation**
PRESENTER'S TEL. NO.:	**(301) 415-1123**

Policy Issue 5

Policy Issue 5 What level of offsite emergency preparedness (EP) is appropriate for decommissioning plants given the low likelihood of a radiological release large enough to exceed protective action guides offsite?

Options:

(1) Substantially reduce or eliminate offsite EP requirements shortly after permanent shutdown based on the low generic frequency of events leading to a zirconium fire (contingent on implementation of IDCs and SDAs)

(2) Maintain offsite EP at operating reactor levels until all spent fuel is removed from the SFP

(3) Modify the level of offsite EP required at decommissioning plants based on sufficient time to take ad hoc mitigative and protective actions before a large release can begin

Recommendation: Option (3)

Incrementally reduce and eventually eliminate offsite EP for decommissioning plants based primarily on sufficient time to implement ad hoc protective and mitigative actions.

Maintains Commission defense-in-depth philosophy and is risk-informed by a reasonable assurance that the likelihood of a zirconium fire event is very low (contingent on implementation of the risk study IDCs and SDAs)

Incrementally Reduce EP

- Maintain full scope EP for a period not expected to exceed one year

- Eliminate portions of EP requirements IAW the physics of the spent fuel e.g., little Iodine, no rapidly evolving accidents, no need for rapid multi-discipline engineering assessment

Based on:

- The length of time available for protective actions before a zirconium fire can begin,
- the length of time available for and relative simplicity of mitigative actions,
- the effectiveness of protective measures implemented by trained public agencies, and
- the very low frequency of initiating events that can cause a zirconium fire when IDCs and SDAs are implemented.

Eventually Eliminate EP

- When fuel is decayed such that the fuel can not reach ignition temperature for at least 10 hours (but not more than 24 hours)

- Require offsite EP at a level similar to that in 10 CFR 72.32 for MRS facilities

Based on:

- The effectiveness of ad hoc protective measures for the protection of the public, especially when there is time to prepare

RISK-INFORMING 10 CFR 50.46

Presented to
Advisory Committee on Reactor Safeguards
(Full-committee)

Presented by
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OUTLINE

- Purpose/goal of meeting
- Background - Option 3
- Tentative Recommendations and schedule
- Activities
  - Feasibility assessment of changing 10 CFR 50.46
  - Feasibility assessment of additional changes to 10 CFR 50.46
  - Other Option 3 activities
- Status and schedule

PURPOSE/GOAL OF MEETING

- Provide status report on staff's efforts to risk-inform 10 CFR 50.46 (Paper currently pre-decisional)
- Solicit feedback and comments from ACRS:
  - Options
  - Implementation issues
  - Feasibility
- Letter requested

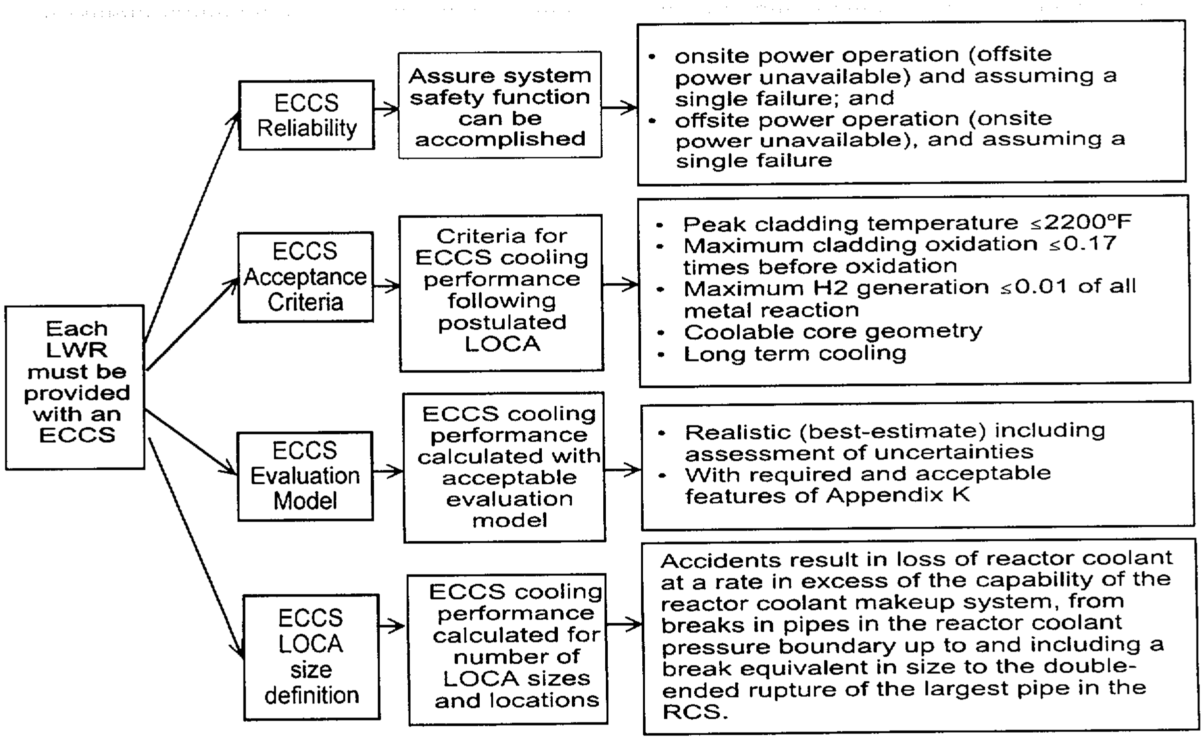
BACKGROUND

SECY-99-264 (Nov 9, 1999) defined plan for Option 3 work

OPTION 3 FRAMEWORK:

- Phase I:
  - Part A: Identify candidate requirement
  - Part B: Prioritize
  - Part C: Evaluate feasibility and provide recommendations to Commission
    - ★ Develop technical content and basis for alternative
    - ★ Identify policy issues
    - ★ Identify required technical work
    - ★ Identify required resources
- Phase II:
  - Part A: Perform technical work
  - Part B: Develop and implement rulemaking

OVERVIEW OF 50.46 (including Appendix K and GDC 35)



FEASIBILITY ASSESSMENT OF CHANGING 10 CFR 50.46 (including Appendix K and GDC 35)

- Changes to reliability, acceptance criteria and evaluation model feasible
  - ECCS reliability resulting from technical requirements not commensurate with risk significance of the various LOCA sizes
  - Unnecessary conservatisms exist in the requirements
- Changes to spectrum of LOCA sizes definition more complex
  - Current estimates of the frequency of large-break LOCAs are uncertain and are not low enough to allow elimination of all large-break LOCA sizes from the design bases

FEASIBILITY ASSESSMENT OF CHANGING 10 CFR 50.46 (cont'd)

- Short-term considerations:
  - A. Changes to the technical requirements of the ***current*** 50.46 related to acceptance criteria and evaluation model
  - B. Development of a voluntary risk-informed ***alternative*** to the reliability requirements in 50.46
- Long-term considerations:
  - Evaluation of the definition of the spectrum of break sizes
- Follows the guidelines in Option 3 framework
- Framework is designed to ensure that changes are risk-informed, and include consideration of defense-in-depth principles

SCHEDULE

A. Modification of the existing 10 CFR 50.46 and Appendix K:
- Develop proposed rule — 12 months from date of SRM or 2 months after completion of technical work (whichever is later)
- Perform technical work — On or before July 2002

B. Development of a risk-informed alternative to 10 CFR 50.46, Appendix K and GDC 35:
- Develop proposed rule — 12 months from date of SRM or 2 months after completion of technical work (whichever is later)
- Perform technical work — On or before April 2002

- Continue longer-term feasibility assessment on additional changes to 50.46, including rigorous analysis of LOCA frequencies
  - Up to 3 years

A. POSSIBLE CHANGES TO THE CURRENT 50.46

- Replace the current prescriptive ECCS acceptance criteria in 50.46 with a performance-based requirement

- This requirement would:
  - demonstrate adequate post- quench cladding ductility and adequate core-coolant flow area to ensure that the core remains amenable to cooling, and,
  - for the duration of the accident, maintain the calculated core temperature at an acceptably low value and remove decay heat.

- Allows use of cladding materials other than zircaloy or ZIRLO without licensees having to submit an exemption request

A. POSSIBLE CHANGES TO THE CURRENT 50.46 (cont'd)

- Revise the requirements for the ECCS evaluation model to be based on more realistic analyses
- Specifically this update could involve:
  - replacing the current 1971 American Nuclear Society (ANS) decay heat curve with a model based on the 1994 ANS standard.
  - replacing the current decay heat multiplier of 1.2 with an NRC-prescribed uncertainty treatment.
  - deleting the limitation on PWR reflood steam cooling for small reflood rates.
  - replacing the Baker-Just zirconium steam model with the Cathcart-Pawel zirconium steam oxidation model for heat generation.
  - deleting the prohibition on return to nucleate boiling during blowdown.
- Rule requirements would include a provision that would account for recognized nonconservatisms and model limitations

A. POSSIBLE CHANGES TO THE CURRENT 50.46 (cont'd)

Additional technical work would be required to support the actual rule changes

- Support removal of unnecessary conservatisms from Appendix K
- Develop guidelines for demonstrating adequate post-quench ductility as a replacement for the current prescriptive acceptance criteria
- Support development of the regulatory guides needed for implementing the modifications to the existing rule

B. DEVELOP A VOLUNTARY RISK-INFORMED ALTERNATIVE 50.466

- Include technical requirements to ensure an ECCS reliability that is commensurate with the frequency of challenge to systems

- Two options to accomplish ECCS system reliability (in place of the simultaneous loss of offsite power requirement and single failure criterion):
  1. A deterministic system reliability requirement based on risk information
     - e.g., an ECCS design requirement that only one train of ECCS is required for LOCAs larger than a specified size
  2. An ECCS functional reliability requirement that is commensurate with the LOCA frequency
     - e.g., a requirement that ECCS design must be such that the core damage frequency [CDF] associated with a specified set of LOCAs is less than an NRC-specified CDF threshold

B. DEVELOP A VOLUNTARY RISK-INFORMED ALTERNATIVE 50.46 (cont'd)

Additional technical work would be required to support the actual rule changes

- Determine acceptable methods and assumptions for performing LOCA CDF and ECCS reliability analyses for those alternatives requiring such analyses

- Determine appropriate reliability and CDF threshold values

- Identify features that tend to decrease the likelihood of loss of offsite power following a LOCA

- Determine acceptable methods and assumptions for estimating plant-specific probability of loss of offsite power given a LOCA.

- Support development of the regulatory guides needed for implementing the recommended risk-informed alternative rule

POSSIBLE LONGER-TERM FEASIBILITY ASSESSMENT OF ADDITIONAL CHANGES TO 50.46

- Additional changes to 50.46 may also have merit:
  - evaluation of the definition of the spectrum of breaks and locations
- The extent of potential change to the definition of pipe break size is dependent on the state-of-knowledge of the frequency of LOCAs of various break sizes
- For example, if a set of LOCAs can be demonstrated to have a collective mean frequency of occurrence of below —
  - 10^{-4}/yr, some regulatory relief may be appropriate
  - 10^{-5}/yr; may be appropriate to remove these LOCAs from the plant design basis, with some mitigative capability
  - 10^{-6}/yr, may be appropriate to remove these LOCAs from the plant design basis
- Staff to continue to perform the technical work to determine its feasibility

POSSIBLE LONGER-TERM FEASIBILITY ASSESSMENT OF ADDITIONAL CHANGES TO 50.46 (cont'd)

- The staff will continue to meet with representatives of the nuclear industry in public meetings to address and resolve the technical issues
- These issues include, for example,
  - initial flaw distributions, degradation mechanisms, material response and uncertainty analysis
- If found feasible, the staff would recommend additional changes, potentially including rulemaking to change the wording in 50.46 and Appendices A and K of Part 50 which would allow the licensee to use an alternate pipe size, subject to some level of NRC approval

OTHER OPTION 3 ACTIVITIES

- GDC 35 requires that the ECCS safety function be accomplished assuming a single failure
- Considering replacing this single failure criterion in the alternative rule, but only as it affects ECCS
- The single failure criterion is applied to more than just the ECCS. GDCs 17, 34, 38, 41 and 44 also contain the single failure criterion.
- A generic change to the Part 50 Appendix A single failure criterion definition may be warranted
  - Staff intends to assess the feasibility of a single generic change under Option 3
  - Such a risk-informed definition would also address the Commission's guidance in the SRM of February 3, 2000
- The staff has also begun to investigate changes to the special treatment technical requirements of Part 50
- The staff has deferred further work on this to better focus its resources on assessments of 50.44 and 50.46, but would reassess its priority late this year

STATUS AND SCHEDULE

- Paper pre-decisional
- Requesting letter from ACRS
- Short-term change:
  - Develop proposed rule — 12 months from SRM or 2 months after technical work (whichever later)
  - Perform technical work
    - Modify current 50.46 — On or before July 2002
    - Alternative 50.46 — On or before April 2002
- Longer-term Option:
  - Up to 3 years