Official Transcript of Proceedings

NUCLEAR REGULATORY COMMISSION

Title:	Advisory Committee on Reactor Safeguards
Docket Number:	(not applicable)
Location:	Rockville, Maryland
Date:	Thursday, March 8, 2007
Work Order No.:	NRC-1451 — Pages 1-342

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NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS (ACRS)

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THURSDAY,

MARCH 8, 2007

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

MEMBERS PRESENT:

WILLIAM J. SHACK	Chairman
GRAHAM B. WALLIS	Vice-Chairman
SANJOY BANERJEE	Member
SAID ABDEL-KHALIK	Member
DANA A. POWERS	Member
THOMAS S. KRESS	Member
OTTO L. MAYNARD	Member
MICHAEL CORRADINI	Member
GEORGE APOSTOLAKIS	Member

NRC STAFF PRESENT:

GARY HAMMER
RALPH CARUSO
TED SULLIVAN
AL CSONTOS
MICHELLE EVANS
TAI HUANG
JOSE MARCH-LEUBA
SAMUEL MIRANDA
JARED WERMIEL
ERVIN GEIGER
TONY SHAW
PAULETTE TORRES
ROB TREGONING
WILLIAM KROTIUK
TOM HAFERA
JOHN MONNINGER
MARY DROUIN
EILEEN McKENNA
FAROUK ELTAWILA

ALSO PRESENT:

DAVE RUDLAND (via video teleconference)
CRAIG HARRINGTON
WARREN BAMFORD
ALEX MARION
DENNIS WEAKLAND
WILLIAM SIMS
PETE RICCARDELLA
MIKE SCOTT

I-N-D-E-X

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

8:30 a.m.

CHAIRMAN SHACK: On the record. The meeting will now come to order. This is the first day of the 540th meeting of the Advisory Committee on Reactor Safeguards. During today's meeting, the Committee will consider the following: technical basis associated with proposed NRC staff action for dealing with dissimilar metal weld issue; proposed revisions to Standard Review Plan Sections 15.0, Accident Analysis Introduction and 15.9 BWR Core Stability; final results of the chemical effects head loss tests related to the resolution of the PWR sump performance issues; technology neutral licensing framework and related matters; and preparation of ACRS reports.

This meeting is being conducted in accordance with the provisions of the Federal Advisory Committee Act. Mr. Sam Draiswamy is the Designated Federal Official for the initial portion of the meeting. We have received no written comments or requests for time to make oral statements from members of the public regarding today's sessions. A transcript of portions of the meeting is being kept and it is requested that speakers use one of the microphones, identify themselves and speak with sufficient clarity and volume so they can be readily heard.

I will begin with some items of current interest. During lunchtime today, the members are scheduled to interview two candidates for membership on the ACRS. You should have a schedule and some background information on the candidates.

Eric Thornsbury who has been with the NRC for 10 years of which two years have been with the ACRS staff is leaving the NRC to join Aaron Engineering and Research in West Chester, Pennsylvania on March 16, 2007. For the past two years, he has provided outstanding technical support to the Committee in reviewing numerous matters including risk-informing 10 CFR 50.46, digital alliance research plan, SPAR models development program, human reliability analysis, safeguard and security matters, ESBWR, PRA, several regulatory guides and SRP sections. His technical competence, dedication, hard work and professionalism are very much appreciated and I certainly enjoyed working with Eric and I've enjoyed working with him before he joined the ACRS and we want to thank him for his exceptional contributions to the Committee and good luck in his new job.

(Applause.)

CHAIRMAN SHACK: Jermila Perry joined the Operations Support branch staff on February 12th. She will be working on budget formulation, financial analysis, records management and IT-related items. So members may be able to get back on their computers soon. Jermila has a Bachelors degree in English from the University of Maryland College Park. She joined the NRC in the Office of the Chief Financial Officer in August 2003 and was a program analyst with primary responsibilities for several offices including ACRS/ACNW.

Prior to coming to the NRC, Jermila worked for over four years at the National Academy of Sciences as the senior procurement assistant and as a contract assistant. Jermila has also worked FEMA, Department of Commerce, Patent and Trademark Office and the Department of Treasury. Welcome aboard to Jermila.

(Applause.)

CHAIRMAN SHACK: A portion of today's meeting will be closed to discuss safeguards and security matters. This matter is being conducted in accordance with the provisions of the Federal Advisory Committee Act. That's tomorrow. Sorry.

Our first item today is the NRC staff action or the technical basis associated with NRC staff actions for addressing the dissimilar metal weld issue arising from the Wolf Creek pressurizer flaw inspection results. We heard a little bit about this before in October 2006.

There was an inspection at the Wolf Creek plant. The UT inspection produced some UT indications that the licensee and industry experts had decided were circumferential stress corrosion cracking flaws, although no samples were taken to actually confirm that. But again, the staff and the industry are moving ahead on the assumption that those flaws were fairly sizable circumferential flaws.

Again, it's not unexpected that we have cracking in this Alloy 182 weld metal. The industry has already had a program under way to do inspection and mitigation on these welds. It involves putting on an overlay of much more resistant metal that will provide full structural reinforcement, so that even if there was a full 360 degree crack through the original weld metal the pressurizer nozzle would retain its original structural strength.

There is some discussion with the cracks that have been found at Wolf Creek and the fact that we've only inspected something like 11 to 15 percent of the pressurizer nozzle welds so that the characterization of the state of the rest of the nozzles is somewhat uncertain whether there needs to be an acceleration in this schedule and the staff and the industry are working together to really assess the technical basis for deciding whether an accelerated schedule is necessary or not and the staff will be opening their presentation today and Ted Sullivan will be leading us in discussion for the staff.

I should mention that we did have a Subcommittee meeting Tuesday in which we had much more discussion of the technical details than we'll be able to go through today.

MR. SULLIVAN: Thank you very much, Dr. Shack. My name is Ted Sullivan and I'm joined by Al Csontos. We're dividing up the presentation material this morning for the NRC staff.

On February 2nd, we had about an hour and a quarter, an hour and a half, something like that to brief the full Committee. We shared that time with the industry and what we talked about just to elaborate a little bit more on the introduction was the inspection findings where five flaws were identified in three pressurizer nozzle welds. NRC performed fracture mechanics analyses and they were not bounding analyses or best estimate as we said at the time, but they were scoping analyses to try to understand what could happen and we concluded that a distinct possibility would be that there would be little or not time between leakage and rupture particularly for the relief nozzle cases that we analyzed.

Our conclusion as we tried to capture them on February 2nd was that we did not consider the Wolf Creek indications to be anomalous. They couldn't be treated that way despite the fact that there are limitations in our understanding of that information.

VICE-CHAIRMAN WALLIS: Can you say what you mean by "anomalous"? Do you mean that it's likely there will be similar events somewhere else if they're not anomalous? Or what do you mean?

MR. SULLIVAN: We think it is possible that it could occur somewhere else. I think what we were trying to reflect was that we hadn't seen indications like this at other plants in terms of size, multiple circumferential indications. They were all of similar depth which is a little bit puzzling and so there was a fair amount of discussion about whether these indications were some sort of artifact that we didn't understand or whether we should treat them as PWSCC and we concluded we needed to treat them as PWSCC.

VICE-CHAIRMAN WALLIS: Thank you.

MR. SULLIVAN: We also concluded that based on the information available, inspections and mitigations need to be accelerated for some plants and later in the presentation I'll be a little bit more clear about what those particular plants are as distinguished from the rest of the group of plants.

Then we also concluded that in the interest of safety, enhanced leakage monitoring should be put in place to shut down the plant and visually inspect welds.

VICE-CHAIRMAN WALLIS: When you visually inspect, you simply look for water. Is that what you look for?

MR. SULLIVAN: What they would have to do is remove the insulation from these nozzles if the action levels are tripped that would put them into a shutdown and they would -- I'm sort of getting at this at a high level.

VICE-CHAIRMAN WALLIS: What can they really see.

MR. SULLIVAN: They would have to be able to really see. They'd be looking for boric acid.

VICE-CHAIRMAN WALLIS: They're looking for a leak.

MR. SULLIVAN: Right. Okay. And we believe these actions only need to be put in place until the nozzles are inspected one time or mitigated and for the most part --

VICE-CHAIRMAN WALLIS: If there's a short time between leak and break as you said on your first slide, who's going to go and look for it?

MR. SULLIVAN: That's why I tried to couch it in terms of in the interest of safety. It's not an absolute guarantee or else I think we wouldn't be uncomfortable with the schedule they're on. We didn't find the same lack of time between leak and rupture for the surge line and for the safety line which had smaller nozzles we saw that most of the cases we analyzed did show time between leakage and rupture. So it's kind of a balance. It wasn't all one-sided in terms of saying this is a useless exercise. We thought it would be a fruitful thing to do.

On page 4 what I wanted to just indicated was that we discussed the fraction mechanisms analyses and results on February 2nd and again in some detail, two days ago. But at the February 2nd meeting with the full Committee, we didn't get into leakage. There were some questions that were raised and we didn't think we were in the best position at the time to answer them. So we have about three slides on leakage today just to introduce the subject and that's what Al's going to talk about. Then after Al is done, I'll get back into picking up more of the regulatory picture of what we've been doing in regulatory space and where we see that we're going. So with that, I'll turn it over to Al.

MR. CSONTOS: My name is Al Csontos and I will be discussing the results of the weld evaluation study that we evaluated back in late October or actually mid November of `06. On the VTC over here, we have Dave Rudland who was a principal investigator and the principal author to the report that I believe you all received on our analysis. He is at Engineer Mechanics Corporation of Columbus and he is the RES contractor responsible for this evaluation.

So I'll just go through quickly the analysis. Let me say that we broke this down. We had six cases individually that we evaluated, three different weld residual stress cases, a weld residual stress that we picked from one of our other older programs and then a weld residual stress plus a repair residual stress and a no residual stress case and then we also looked at normal operating conditions and faulted operating conditions which included normal operating plus the safe shutdown earthquake loads.

We broke this down into the three nozzle types, surge, relief and safety nozzles. For the first case, the surge nozzle, we had three cracks or three flaws in them. We evaluated the worst case, the worst of the three flaws. We didn't evaluate any connection or any crack linkage between the three. The relief and safety, there was just one flaw. So we looked at that individually.

For the case of the surge line, leakage was predicted to occur between 1.0 to 2.2 years after the discovery in October `06 and in all cases for that, all residual stress cases and all operating conditions, we had six months between leakage or at least six months between leakage and rupture.

For the relief nozzle, the leakage was predicted to occur 1.9 to 2.6 years after the discovery in October `06 and in that case, 20 out of 24 cases showed no time, no margin, between leakage and rupture. The four cases or all the cases had no residual stresses which is sort of -- That is the non-conservative, bounding assumption.

In that case, many of those flaws, in fact, all of them, the surface cracks were unstable before they ever went through-wall and so that is something that we evaluated two cases. We evaluated a critical through-wall flaw and we also evaluated a critical surface flaw and in those cases we have a surface flaw going unstable before they even went through-wall. So that time we would have no time between leakage and rupture.

MEMBER BANERJEE: Is this also for the case with no residual stress?

MS. CSONTOS: Yes. No, I just said that. That's no, no-residual stress before cases, no.

MR. SULLIVAN: But when you look at 20 out of 24 the remaining four are the no-residual stress cases.

MS. CSONTOS: That's correct. There are four in the no-residual stress case for what we call a constant C/R ratio that shows no time between leakage and rupture. But the more realistic K-driven analysis for the only four that showed a little bit of time between leakage and rupture was the K-driven, no-residual stress case and in the slides from the Subcommittee we had those all listed out, each 24 cases.

MEMBER BANERJEE: And all the other cases had a --

MS. CSONTOS: Had no time. Right. For the safety nozzle, leakage was predicted to occur 2.6 to 8.0 years. That also depends on what conditions you're looking at. Out of those cases 8 out of 24 showed no time between leaking and rupture.

MEMBER BONACA: For the surge line, how far apart were the flaws from each other?

MS. CSONTOS: We really don't have much information, I don't think, on that.

MR. SULLIVAN: I can get that information.

MS. CSONTOS: Yes.

MR. SULLIVAN: I'm not sure we brought it today.

MS. CSONTOS: In the industry's White Paper they have --

MEMBER BONACA: Would that be a consideration, I mean, if you have multiple?

MS. CSONTOS: It is something that we are considering in the next finite element modeling that the industry is proposing to do that one of the issues that we have is crack leakage and the effects of multiple cracks because as anyone knows it looks at PW SCC or just stress corrosion cracking. A lot of times it's multiple initiation, multiple cracks, that do link up and they look like they're one large crack, but in reality, they may be multiple small cracks that link up.

MEMBER BONACA: If you could find the information, I would appreciate it.

MR. SULLIVAN: Right. One thing we're not going to be able to show you is whether they're in the same plane. We don't know that.

MS. CSONTOS: Yes, the co-planarity of the flaws, the UT was not able to distinguish that. So we don't know if the cracks are like this or if they are in the same plane where they could link up.

So here is the leak rate. I don't know who asked this question at the last ACRS meeting, but there was a question on leak rates and what kind of leaks would be coming out of some of these flaws or these through-wall cracks and that's the purpose of this study. We did this as a corollary at the end of the study and we used the validated NRC Code called SQUiRT and you can read what the title is there for these leak rate calculations.

The assumptions we used here are that we used an idealized equivalent through-wall crack size. The "idealized" means that the flaw goes all the way through-wall and it's circumferential all the way for that size. But then the "equivalent" is that -- This shows the idealized through-wall crack, a surface crack that goes through-wall at this point. You can choose -- What we did is we chose two types. One was the idealized where all these red lines were where this entire length here was considered the crack size. We thought that was a little over conservative or too conservative and so we went to what we called the "equivalent" through-wall crack size which is saying that the area under this crack size, we take that area and make the through-wall crack size which is this size here (Indicating). So it reduces the size, but it's more realistic in terms of these kinds of calculations.

CHAIRMAN SHACK: If you need a new integration routine though.

MS. CSONTOS: Yes. Let me just say this is not drawn to scale.

MEMBER ABDEL-KHALIK: Wouldn't this burr sort of break up as soon as the ligaments --

MS. CSONTOS: The ligaments.

MEMBER ABDEL-KHALIK: That's right.

MS. CSONTOS: Yes, it would and so we did the calculation for both. What we're going to show you here is the equivalent through-wall crack size which will show --

MR. RUDLAND: The purpose of the equivalent size was to try to at the time (Voice breaking up.)

MS. CSONTOS: Dave, you're breaking up.

MR. RUDLAND: Yes, I hear a lot of echo.

MEMBER ABDEL-KHALIK: Could you repeat what you just said.

MS. CSONTOS: Can you repeat what you said?

MR. RUDLAND: We chose the equivalent size because we were trying to estimate the time from first leakage, from initial leakage, until the non-idealized through-wall crack had an idealized size since we recognized that there would be some time between the first leakage and the time where it reached an idealized size.

MS. CSONTOS: There's a time period between where it goes through-wall where there's a little pinhole leak to when it goes complete through-wall and what we said is that by estimating this initial first idealized through-wall crack that was really over estimating and we wanted to see -- We were being non-conservative because we were estimating more leakage and we were concerned about detectability. So we wanted to see how small and be more conservative on that end.

That's where we have to say -- Let me go back one second. This model, the SQUiRT model, when we looked at this, this was built for the LOCA program in the past and so we were -- Conservative in that case was over predicting leakage. In this case, we're trying to make sure that we are more realistic because we're trying to determine detectability limits and determine whether or not we can get to those detectability limits and what those detectability limits should be. So in that case, that's where we're going with this, the time between the pinhole through through-wall and we're trying to be more conservative. So we chose a smaller size.

MR. RUDLAND: And the K solutions and the open displacement solutions don't exist for these non-idealized through-wall cracks at this point. So we had to make an approximation.

VICE-CHAIRMAN WALLIS: What does it look like in the other dimension? Is it just a slot with a uniform thickness?

MS. CSONTOS: It looks like a -- Yes, it's almost --

VICE-CHAIRMAN WALLIS: It's a slot and then it distorts under pressure to make a hole.

MS. CSONTOS: Yes, and that's what we called the crack opening displacement. If you have that and it opens up, obviously the greater COD will be called crack opening displacement which the more leakage you can get out.

MEMBER CORRADINI: You create a fisheye.

MS. CSONTOS: No, these are tiny. These are microns in depth.

CHAIRMAN SHACK: They open.

MS. CSONTOS: Yes, they open when they get larger.

CHAIRMAN SHACK: But not the fish mouth that you're thinking about.

MS. CSONTOS: Right.

CHAIRMAN SHACK: By the time we're at the fish mouth, we're in trouble.

MS. CSONTOS: We're in trouble especially for circumferential cracks.

CHAIRMAN SHACK: This through-wall crack size works quite well in steam generator tubes. So I don't know that we have a whole lot more data on pipes, but when we do the leakage calculation for steam generator tubes we use a similar type model and it actually predicts the leakage at the pop-through when you fail that initial through-wall ligament and you get the first pop-through and leakage, it works pretty well.

MS. CSONTOS: I'll just go through quickly the assumptions here. I wanted to go through the equivalent through-wall crack size. The crack opening displacement, what I just talked about, is dependent upon what we call the PWSCC crack morphology parameters. The crack for PWSCC is very tortuous and so to account for that we have a parameter there that limits the amount of water that comes through because of the water having to go through all these channels.

We used the GE EPRI estimation steam to evaluate or to calculate the COD and also there is another factor here where weld residual stresses can actually shift the crack face and the crack fronts and if that's the case, the crack opening displacement can be reduced even more.

For the surge line we used a sub-cooled liquid. For the spray and the relief lines, we used 100 percent steam and we didn't predict or we didn't evaluate the restraint of pressure induced bending. When you have a rigid pipe, that can also effectively close or keep the crack opening displacement tighter.

We didn't account for that and those are some non-conservatisms in our analysis.

So what we did here is we calculated the leak rate by crack size and COD and that's on slide 8. The results of our analysis show that for the surge line depending upon the weld residual stress case that you're looking at, 0.2 being the no residual stress case meaning the smallest crack and the 3.1 being the larger crack for the weld residual stress plus the repair weld residual stress, that gives you a 3.1 gallon per minute leak rate.

VICE-CHAIRMAN WALLIS: 3.1 gallons per minute at 2,000 psi is a pretty powerful jet.

MS. CSONTOS: And it's steam. No, that's water. Sorry.

VICE-CHAIRMAN WALLIS: Sub-cooled water, it's pretty powerful.

MEMBER BANERJEE: But it's turning to steam, won't it?

VICE-CHAIRMAN WALLIS: Yes. But it will draw holes through the insulation presumably. What kind of insulation do you have?

MS. CSONTOS: I think it's different for each. I don't know the kinetics.

MEMBER POWERS: It's probably the

insulation restraining the leak rate pretty much.

VICE-CHAIRMAN WALLIS: You're not going to get a tie like that. You're going to get something that punches out and you're going to get some kind of --

MS. CSONTOS: Yes, that's equivalent to, I think, about an eight crack size that you'll get a 3.1 gpm leak.

MEMBER ABDEL-KHALIK: Even on the low end, the 0.2 gpm is above the tech spec action point for various plants. Isn't that at 0.1 gallons per minute?

MR. SULLIVAN: No, the spec tech actually says 0.1 gpm.

MEMBER ABDEL-KHALIK: 1.0 gpm.

MR. SULLIVAN: But licensee in general have administrative procedures in effect that would cause them to react at level probably less than 0.2 gpm, not necessarily shut down, but react and start to try to find the leakage.

MEMBER ABDEL-KHALIK: But if the minimum leakage is calculated to be 0.2 gpm that means those actions are really irrelevant because --

MR. SULLIVAN: I think there's a couple of things. One is that as Al was mentioning there were some non-conservatisms in his analysis, the analysis that we need to go back and get a better handle on. So we don't really know exactly what the value is going to be. We need to get a better handle on that.

But what we did in regulatory space and I'm getting a little bit ahead of myself, but what we did was we reached an agreement with the licensees that have not yet inspected or mitigated that if the day-to-day leak rate changes like 0.1 gpm or 0.25 gpm above a baseline value, so we're getting either slowly evolving changes or more rapidly evolving changes, that they'll start to basically enter some action levels that would require them to shut down if that level of leakage is sustained for three days. But those are the kinds of numbers.

MEMBER BANERJEE: What is the accuracy of -- This is done by mass balance I take it.

MR. SULLIVAN: Right.

MEMBER BANERJEE: How accurately can you get that?

MR. SULLIVAN: Maybe somebody from industry could correct me if I misstate but I think it's generally believed that it's accurate within about 0.05 gpm per day.

MEMBER CORRADINI: That's an integrated number over so much time window.

MR. SULLIVAN: Right.

MEMBER BANERJEE: What is the time window?

MEMBER CORRADINI: What is the typical time window?

MR. SULLIVAN: They do these calculations at least once a day, not per tech specs but per the agreement that we reached with licensees.

MEMBER BANERJEE: You're getting a difference between large numbers. Right?

MR. HARRINGTON: Craig Harrington with EPRI. The best people to answer that question aren't here, but the 0.05 number is at least -- That may be a little bit low for accuracy, but it's just the kind of range, 0.05, 0.1, someplace in there is I think what is generally considered a number that can be fairly precisely identified as a change through the mass balance systems and things like that.

MEMBER CORRADINI: Just so I'm clear, I guess I was thinking the same thing that Sanjoy was asking. So it's 0.1 plus or minus ten percent, plus or minus 20 percent, plus or minus 50 percent. When you say 0.1 I'm trying to -- Or is it 0.1 plus or minus zero to 0.2. Do you see my question?

MEMBER MAYNARD: I don't remember the exact accurately. It is fairly -- It's not just a mass balance on how much goes in versus how much comes out of the big mass of the RCS. It incorporates sumps and other measurements. It's not just a mass balance.

MEMBER CORRADINI: So it's detectability of other things.

MEMBER MAYNARD: Yes and of course, you have other things that can help identify locations and stuff. But if you have a leak you're also going to be raising radiation levels. You're going to be changing pressures and there are other things that factor into that, not just a mass balance of the whole RCS.

MR. BAMFORD: I'm Warren Bamford from Westinghouse. Let me try to help a little bit. The utilities are looking at leakage from several different points of view. One is from an actual leakage at a given time which is what you guys are talking about. The other thing they're doing is they're doing a trending over a period of time and so they're going to take like a five day or a seven day moving average and when the leakage, the unidentified leakage, departs from that moving average they use that too and that's far more useful than looking at the leakage at any given time. So I'm not sure you can attach a specific accuracy, plus or minus, but I think they're doing a really nice job of trending, far better than they have in the past.

MEMBER CORRADINI: Okay. Thank you.

VICE-CHAIRMAN WALLIS: This gets back to my question then of how long does it take to detect this if it's going to take you five days and you have three gallons per minute. You have 20,000 gallons of water somewhere in the containment.

MR. SULLIVAN: If it were ever at the level of 1.0 gpm, they'd already shut the plant down.

VICE-CHAIRMAN WALLIS: But how long does it take them to know that? How long does it take them to detect 1.0 gpm? If they're doing an average over time or something, it must take some time.

MR. SULLIVAN: It couldn't take longer than a day under the current regime.

MEMBER MAYNARD: One gpm, you're going to know very quickly.

MR. SULLIVAN: Yes.

MEMBER BANERJEE: Yes, it's more the 0.1 gpm. You had numbers of 0.1 and 0.25 as action levels. I was wondering how accurately you could determine that.

MEMBER MAYNARD: I don't remember exactly. I think with 0.1 you're going to see within -- You'll starting seeing it within 6 to 12 hours again depending on the location because there may be other indications besides just your leak balance there. But at 6 to 12 hours, you're going to start seeing it and be able to confirm it usually in 12, something like that.

MEMBER BANERJEE: How large was Davis-Besse?

(Off the record comments.)

MR. SULLIVAN: I'm sorry. I wasn't involved in Davis-Besse.

CHAIRMAN SHACK: I think the on-going leak rates as I remember were on the order of 0.2 gpm.

MEMBER CORRADINI: That's what I thought. That's the number that I remember.

MEMBER BANERJEE: So they should have been detected. Right?

CHAIRMAN SHACK: You can detect it. You have to then decide what you're going to do about it.

MR. SULLIVAN: I think that the fleet of reactors has gotten much more sensitive to leakage since Davis-Besse. The climate has changed quite a bit.

All right. I would like to move onto some of the maybe more forward-looking things since the analyses were done. PWRs can be put in various types of categories and with respect to pressurizer nozzle welds we would break it down into these four categories. There are 69 PWRs in the United States. Nineteen of them don't have Alloy 82/182 welds at their pressurizer nozzles. They either weren't there originally which is the case for most of these 19. Four of them happen to be replacement pressurizers that didn't use this alloy.

There are also plants that have already inspected or mitigated. The MRP-139 program came out in late 2005 and between them and now there's another group of plants, I don't know exactly what the number is, that have already done inspections or mitigations of the welds that we're talking about in today's presentation.

Then there's another group of plants that plan to inspect or mitigate in 2007, both the spring outages, there's at least one plant if not more in an outage just as we speak, and then there's the fall outages. And then there's also nine plants whose outages, next outages in fact, are in 2008 and that's when they had planned to do inspections or mitigations.

As you might recall in the second or third slide, I indicated that one of our conclusions was that we wanted plants to get this job done sooner rather than waiting until 2008. It's the plants with 2008 outages that we were concerned having the problem or having the situation possibly go that long. So we reached agreements with licensees to both implement and enhance leakage monitoring as well as complete the inspections or mitigations this year which for those nine plants would require mid-cycle shutdowns. But that's pending some advanced analyses that are just getting underway by industry and which are discussed in correspondence that I know was given to the Subcommittee. I'm not sure if the full Committee members have copies of that. Did the full Committee get copies of all that correspondence related to --

PARTICIPANT: Everybody got everything.

MR. SULLIVAN: Great. Now what we're trying to do in those advanced analyses or what industry is trying to do and the agreement that we've reached with industry is kind of captured on page 11 and what we're saying there is if industry's advanced analyses provide reasonable assurance to the NRC staff that PWSCC will remain stable and will not lead to rupture without significant time from the onset of detectable leakage, plants with 2008 outages will not have to shut down in 2007.

VICE-CHAIRMAN WALLIS: Could you clarify what you're going to inspect? Are you going to inspect the locations similar to Wolf Creek or a much broader band of locations where there might be cracks?

MR. SULLIVAN: In this particular case, we're just focusing on the pressurizer nozzle welds. I think I could answer the question a little more fully but I think the industry presentation may capture that. I'll just give a little bit a preview. The MRP-139 document which industry is following as a mandatory industry program under their programs, not the regulatory program, has a different schedule for different locations. The schedule in their program for the pressurizer nozzle locations was to get all this work done in 2007.

The next group of plants or the next group of locations, I think, is hot leg locations that are less than 14 inches and they have to be done in 2008. Greater than 14 inches has to be done or 14, I'm not sure exactly where the cutoff is at 14 inches, but greater than 14 inches has to be done by 2009 and then cold legs have to be done by 2010. So we're really focusing here on the pressurizer locations.

Industry has a process that they refer to as the deviation process that if they justify it within their definitions of the deviation process, they're allowed to extend those actions and that's why there are some plants in 2009 time frame.

VICE-CHAIRMAN WALLIS: But we don't have a predictive tool for saying where and when there will be cracks.

MR. SULLIVAN: No.

VICE-CHAIRMAN WALLIS: We don't really know the likelihood of them being somewhere else.

MR. SULLIVAN: What they're trying to do is balance between the temperature which affects the susceptibility to cracking and trying to get all this work done in a manageable time frame given the resources that are available to get all this kind of overlay work done. I think that's more a question for industry, but that's how they set up their program and we thought it seemed to be a reasonable approach.

VICE-CHAIRMAN WALLIS: The hot leg, okay. But temperature makes a big difference, doesn't it?

MR. SULLIVAN: Yes.

MEMBER MAYNARD: Yes, I would suspect that with the industry's presentation, especially EPRI, I see they have a presentation here. I'm not sure there's a predictive tool, but I know there was a process to go through to prioritize and identify the potential locations and prioritize those. So I know there was a process used.

CHAIRMAN SHACK: Yes. Just in a rough sense, you look at the hottest locations where you're most likely to get the cracking. You look at the smallest diameters where you're most likely to violate leak before break and you can almost start your priority process.

MEMBER BANERJEE: But presumably some estimates of residual stress have to be made as well. I mean this obviously must come into the equation somewhere.

CHAIRMAN SHACK: But almost all welds have bad stress states from this point of view.

MEMBER BANERJEE: Right. So you take -- You put some upper bound on that.

CHAIRMAN SHACK: Yes.

MEMBER BANERJEE: And the chemistry doesn't play any role in this or the history? I would think that all of these would have a role, residual stress, temperature, chemistry, history. I mean it's not a straightforward thing to do.

CHAIRMAN SHACK: The chemistries are fairly well -- We're on the primary side. So the chemistries, they're just aggressive for these materials.

MEMBER BANERJEE: Some history affect that.

VICE-CHAIRMAN WALLIS: Does temperature cycling make a difference?

CHAIRMAN SHACK: Time. Yes.

MEMBER MAYNARD: A number of transients, a number of different operational factors.

MEMBER CORRADINI: Repairs of the welds.

CHAIRMAN SHACK: Yes. Probably the biggest thing is the repairs and just how bad the stress state is at the weld. MRP-106 has some calculations for these particular welds that show that if you don't do any repairs in the welds, the stress state isn't all that aggressive. However, a weld without a repair is probably a beast you will never find.

MR. SULLIVAN: Another factor is that despite the limitations with predicting the inspections that are ongoing aren't going to be lock step like I just talked through. If a plant has an opportunity because it's pulled the core barrel to inspect the cold legs and the hot legs, they're not waiting until 2010 to do that work.

Wolf Creek, for example, has -- We found these laws as mitigated the pressurizer location with weld overlays and inspected the hot leg locations and the cold leg locations at least at the reactor vessel nozzles and they didn't find any indications. So some inspections are going to ongoing between now and when they have to for all these locations between now and when they have to complete this program. So there is some data coming in.

MEMBER BANERJEE: And these inspections are fairly accurate?

MR. SULLIVAN: They're --

MS. CSONTOS: That's a loaded question.

MR. SULLIVAN: They're much better inspections than were done prior to the beginning part of this decade. They're based on performance demonstration techniques as opposed to what we used to call amplitude-based. We believe that they're as good as can be made.

MEMBER BANERJEE: And that's the difference between these?

MR. SULLIVAN: The difference is that these under this inspection regime there are criteria in terms of detection and sizing that have to be satisfied with the inspectors to be qualified and the procedures are put through pretty -- The procedures themselves are put through rigorously demonstrations to make sure the procedures can satisfy that criteria and then the inspectors also have to be qualified to pass certain criteria in terms of detection as well as sizing.

MEMBER BANERJEE: It's like training a radiologist or something.

MEMBER CORRADINI: Not paid as much.

MEMBER BANERJEE: I understand.

MEMBER BONACA: For VC Summer, they found that if they augmented UT with any current they were more successful because they could identify the (Cough.) and then go with UT. Are they doing something similar here?

MR. SULLIVAN: No, I don't think in general they are, but in the VC Summer time frame which was 2000, they weren't using PDI-qualified examinations just in prior inspections. So they didn't see the flaws that apparently were there.

To bring this back to regulatory space, it's probably a lot less interesting, we obtained the grievance from licensees to the kinds of actions that I outlined in some of the previous view graphs. We are in the process of confirming those agreements with a kind of standard NRC practice of issuing confirmatory action letters.

And I alluded a couple of view graphs ago to this more advanced analyses that industry is doing, their finite element fraction mechanics analyses. They were described in a letter to us dated February 14th. We provided a response to them just Monday and we had, I think, a reasonably productive meeting with industry yesterday to talk about their project plan and to go over a number of critical points that basically define the framework, not the details, but the framework for these analyses and we're going to continue to interact with industry on this program to follow it through to its conclusion this summer.

We're doing a fair amount of additional analyses ourselves as Al alluded to. We're modifying our code, for example, so that it basically parallels the kind of software modifications that industry is doing. That will enable us to do a certain amount of checking of industry results and it will also allow our code to be used for benchmarking purposes against industry's code.

VICE-CHAIRMAN WALLIS: How big are these pipes?

MR. SULLIVAN: I believe the safety and relief nozzles are, at least at Wolf Creek, they were

8 inch OD.

VICE-CHAIRMAN WALLIS: And the surge line is bigger than that, isn't it?

MR. SULLIVAN: Yes.

VICE-CHAIRMAN WALLIS: What is it?

MR. SULLIVAN: The surge line is, I think, it's 14 inches.

VICE-CHAIRMAN WALLIS: Fourteen.

MR. SULLIVAN: Warren, can you clarify?

MR. BAMFORD: Not only 14 but there are some as small as 12 and some as high as 16, I think.

MR. SULLIVAN: And the spray lines can be as small as three as large as four generally.

MR. BAMFORD: Right.

VICE-CHAIRMAN WALLIS: And the probability of the 14 inch pipe breaking predicted by the experts is how much, 10^{-4} or 10^{-5} or something a year?

MR. SULLIVAN: I think it's something like 10^{-4}. Okay. I have a couple of conclusion slides that are in your package. But since this was a fairly short presentation, I would just be reiterating what I talked about a couple minutes ago.

MEMBER MAYNARD: Aren't we going to learn from the inspections that are going on in the spring? In addition to the industry analysis, aren't we get some additional information for what's found in the springtime here?

MR. SULLIVAN: We'll get a little bit of information. We talked about this on Tuesday which I think is why Dr. Shack is smiling and what we --

CHAIRMAN SHACK: My first question.

MR. SULLIVAN: What we discussed was that --

MEMBER MAYNARD: And a great question.

CHAIRMAN SHACK: Great question. You won't like the answer though.

MR. SULLIVAN: There are two reasons why licensees are mitigating these welds with weld overlays. One of them is because it provides a full structural replacement with the materials that are believed to be much less susceptible to PWSCC. But the second reason and it works hand-in-hand is that for the most part these nozzles are, I don't know what the percentage is, probably 85 percent of the time are not really inspectible anyway. The licensees cannot obtain the coverage which is defined in the ASME Code. So these new weld overlays provide a platform and a new boundary that is inspectible.

There are a handful. I think what we were thinking was something like three or so plants are able to do these inspections that are planning to do them between now and the end of 2007.

MEMBER MAYNARD: The rest are just overlay.

MR. SULLIVAN: Most of them are going to weld overlay anyway, but there are even some plants that are not planning to overlay, they just going to inspect which they recognize puts them in a little bit of risk because they could get into the outage, do the inspections they plan and find that they now have to line up a crew to do the weld overlays.

MEMBER CORRADINI: So I had one question that kind of goes to what you were saying. You said that they're going to plan to overlay and that improves, unless I misheard, inspectibility. Did you say that?

MR. SULLIVAN: What it does is it provides a platform so that they can get an inspectible volume. They actually can't -- It doesn't provide a platform to go and --

MEMBER CORRADINI: Platform meaning enough metal? I don't know what you mean by a "platform."

MR. SULLIVAN: I'm sorry. I'm using a confusing term. The reason I use "platform" is because it provides a flat surface for -- to ride along.

MEMBER CORRADINI: All right. Got it.

MR. SULLIVAN: That's why I was using that term. It doesn't mean that the new configuration is such that they can now insonify both the weld overlay and all of the original weld.

MEMBER CORRADINI: Just the overlay.

MR. SULLIVAN: And in most -- Unless there's a cast stainless steel they can insonify and look at the top 25 percent as well. That was a figure that was arrived at by industry as a desirable thing to do to see whether flaws are potentially propagating up through the original weld and maybe approaching the new weld.

MEMBER CORRADINI: Thank you.

MEMBER BANERJEE: So they are not all lining up a team to be ready to take action if they find something.

MR. SULLIVAN: Most of them are, but there is like what was said on Tuesday a handful and we pressed "handful" we said something like three. I actually have a document here that I could look through or I could --

MEMBER BANERJEE: The exact number is not important.

MR. SULLIVAN: Yes, it's less than a handful.

MEMBER BANERJEE: Okay. And in that case if they found something they would just have to have a prolonged outage.

MR. SULLIVAN: They would hopefully have a prolonged outage and they would land up having to line up an inspection or a welding crew and inspectors because the weld overlays have to be inspected and it's going to be very challenging if that happens because these teams, they're just going to be traveling from one plant to the other. I think their schedules are all completely booked up. So it would be really bad news for a plant if that happens.

MEMBER BANERJEE: Okay.

CHAIRMAN SHACK: Thank you, Ted. I believe we're going to have an industry presentation. Alex, are you going to give that?

(Off the record comments.)

MR. MARION: Good morning. My name is Alex Marion. I'm the Executive Director of Nuclear Operations and Engineering at the Nuclear Energy Institute and I have with me Mr. Dennis Weakland who is with Post Energy and he's chairman of the EPRI Materials Reliability Program Issue Integration Group.

I also have a team of some of our experts sitting in the back who will hopefully keep both of us out of trouble and anyway, we'll be prepared to handle any questions you may have. But let me just thank you for the opportunity to discuss industry actions that deal with the generic implications of Wolf Creek inspection findings.

This slide represents the four areas I intend to cover. We want to provide a little bit of background on the Industry Inspection Guideline MRP-139. We want to discuss briefly our initial response to the inspection findings from Wolf Creek, provide a brief overview of the finite element analysis that we are working with the NRC on and discuss ongoing meetings we've had with the staff.

Let me just say that the inspection program detailed in MRP-139 is a significant element of a more comprehensive, extensive industry initiative that was undertaken in 2003 to position the industry to be more proactive in terms of managing materials degradation. And this is a commitment that's been made with the industry chief nuclear officers via NEI and it's a serious commitment. As we went through evaluating the potential generic implications of Wolf Creek, we were through February at a point where we were having conference calls with the chief nuclear officers two times a week at a minimum. This was the chief nuclear officers representing all of the pressurized water reactors and also when we became more focused in terms of the 2008 plants, those interactions included the chief nuclear officers representing those utilities.

But MRP provides a structured process for inspecting pressurized water reactor primary system welds and it's built upon a safety assessment that's been provided to the NRC that has the deterministic and probabilistic approach. We assessed the margins related to the onset of leakage and critical crack sizes and we've considered previous industry regulatory guidance and operating experience on a worldwide basis.

And let me just clearly say that the findings of Wolf Creek do not fit, if you will, our experience base to date. The staff referred to that as anomalous. It's just unique and it's very different from anything else we had seen previously.

There is a review and approval process associated with deviations. When we initially established the schedule for these inspections we recognized that that's a very high standard, a very difficult schedule to implement and I'll talk about that in a little more detail with another slide later on. But there's an internal review process that addresses deviations. But from the standpoint of this inspection guidance it had been thoroughly reviewed not only through the advisory structure, the materials reliability program, but it was also reviewed by the chief nuclear officers because of the extensive resource commitment that was associated with implementing this guidance.

Just briefly, the guidance contains an inspection regime to manage degradation as we go forward. The intent was to establish a baseline of the condition of the butt welds consistent with ASME Appendix 8 demonstrated techniques and we initially focused the initial phase of the effort on the high temperature welds, specifically in the area of the pressurizer and as I said earlier, we've established extremely aggressive implementation schedules.

Let me just say the first phase for the pressurizer locations was identified as having to be completed by December 31, 2007. We could have very well picked April 2008, June 2008 or January 2009. We felt we had a legitimate technical basis to support those, but we chose 2007 and we recognized that not everyone could accommodate that and that's why we established the deviation process which is a very disciplined process to justify deviating from that implementation schedule and that process is analogous to what's allowed in NRC's Regulation 10 CFR 50.55(a) related to alternatives to meet the code requirements.

This slide represents the complete schedule of activities for implementing MRP-139. As you can see, this program extends through 2010. Initial phase, as I mentioned before, focuses on pressurizer locations and just to indicate if you look at these dates and consider 18-month and 24-month outage schedules and recognize that MRP-139 was issued in August 2005. This is March 2007. So we recognized that not everybody could meet December 31, 2007. As I said before, that's why we established the deviation process.

There was a little discussion in the staff presentation about the factors that contribute to primary water stress corrosion cracking and there are three factors. One is susceptible material and we all know we have that. The second is stresses during the manufacturing of the piping and the application of the welds and also to stresses induced by the operating conditions of a nuclear power plant and also the environment and the environment of course includes temperature and to some extent water chemistry.

In terms of the Wolf Creek pressurizer locations, the next couple slides just -- I provide a little synopsis of what happened at Wolf Creek. The examination that that utility was pursing --

VICE-CHAIRMAN WALLIS: Presumably this schedule is flexible. I mean you have four years of schedule here. But if you find something in the first year, this is going to presumably modify what you do in the second, isn't it?

MR. MARION: Absolutely. We're prepared to revise this schedule based upon inspection findings.

I just wanted to point out that the Wolf Creek examinations were consistent with what was recommended in MRP-139. I believe the staff indicated that the industry had provided a number of documents recently that captured our evaluation of the Wolf Creek inspection results. We also completed a survey and provided that to the NRC, I think, in February that captured the status of inspection activities to date and we have had a number of public meetings with the staff. As I mentioned before, we've had a number of extensive interactions with the chief nuclear officers to try to address or try to develop a consistent approach to dealing with this issue going forward.

CHAIRMAN SHACK: Alex, just on that question, is there a consistent approach whether people are going to be doing inspections before they do the overlays or if you're planning to do the overlay, you just do the overlay and do the inspection afterward to demonstrate that you have your insonification.

MR. MARION: I think Ted Sullivan gave you a really good explanation of what's involved. There are only three plants that we know of today that are planning to do inspections prior to any kind of mitigation activity. They'll pursue mitigation if the inspection indicates that there's a -- inspection results and some indication.

All of the other plants for the reasons that Ted described are going directly into mitigation with a structure weld overlay primarily because they can't meet the NRC requirements to do an adequate PDI-qualified or ASME Section 11.

CHAIRMAN SHACK: I thought Ted was saying there were three that were going to do inspections without necessarily committing to mitigation. I was sort of wondering whether people who were doing mitigation were just doing inspections so we would have a better idea, for example, of the incidence of cracking in alloy welds. It would be useful information.

MR. WEAKLAND: For most plants, you have an uninspectible geometry.

CHAIRMAN SHACK: Okay. It's just that.

MR. WEAKLAND: So these plants happen to have an inspectible geometry and it gives them more flexibility of when they may want to do mitigation or if they need to do mitigation. For plants with an uninspectible geometry, you really don't have much choice.

VICE-CHAIRMAN WALLIS: Are you going to make it inspectible when you put the overlay on?

MR. WEAKLAND: Yes.

VICE-CHAIRMAN WALLIS: So you might then discover some things that you couldn't see before.

MEMBER CORRADINI: No, because they can't see as far down, I guess.

MR. WEAKLAND: You only see the 25 percent of the existing.

CHAIRMAN SHACK: He can inspect the overlay. He can't inspect the original weld.

VICE-CHAIRMAN WALLIS: But you can't see all the way in?

MR. WEAKLAND: No.

VICE-CHAIRMAN WALLIS: So you'll never know until -- Not never, but you won't know for an awful long time what the state is of the original weld.

MR. WEAKLAND: That's true.

MEMBER ABDEL-KHALIK: So it's quite fortuitous that these things were first observed at Wolf Creek simply because they had a sort of an inspectible joint.

MR. WEAKLAND: You could take that approach. But I don't know if I could call fortuitous. These were indications. They are ultrasonic indications. We've dispositioned. It has given us reason for concern and why we want to maintain our aggressive schedule.

MEMBER ABDEL-KHALIK: But after 69 PWR fleet, there are only four plants according to what you're saying that have an inspectible geometry.

MR. WEAKLAND: No, there are more than that that I'm aware of. There are three that I know we're planning to inspect. Craig. Craig's very familiar with this information.

MR. HARRINGTON: Again, Craig Harrington with EPRI. We did work through the survey in November and December trying to understand everyone's plans, how inspectible they felt they were, whether they intended to do inspections before mitigation. There are -- It's three or four plants that have some number of welds this year that they are going to inspect in the spring and fall outages. That may be one or two welds. It may be all the welds, the six welds. It varies. Some of them they've already inspected.

CHAIRMAN SHACK: As I read the White Paper, I get two numbers. One says you get 31 nozzles that are inspected. The other says that 42 are inspected and I'm not sure why there's a difference. It may be the 31 really meet the fully coverage and the 42 mean you've looked at them and you have some fraction of coverage on the 42 minus 31. But it's about somewhere between 10 and 15 percent of the welds that we've looked at.

MR. HARRINGTON: I think that's an accurate representation. At the end, it is a relatively small percentage of the total population and it's scattered around plants.

MEMBER CORRADINI: That can be looked at.

MR. HARRINGTON: That can effectively meet

PDI exam requirements.

MEMBER CORRADINI: So let me ask the question differently. Of those that can be looked at, they all will be looked at.

MR. HARRINGTON: I don't know that you can make that statement.

MEMBER CORRADINI: Okay. I think that's Bill was going. I was just trying to understand.

MEMBER BONACA: And yet I think it would be important to understand if this is anomalous characterization of these cracks is really anomalous and yet if we don't inspect, we'll never know.

MR. WEAKLAND: There are some plants that have performed what would be considered non-PDI qualified examinations meaning that they did not get the extent of coverage to be acceptable under the code PDI requirements. I know for instance one of my plants is like that.

MR. MARION: One of the challenges here is that the inspection requirements changed. I think it was in 2004 NRC incorporated ASME Section 11 Appendix 8 which represented the most sophisticated inspection technique we refer to as performance demonstration initiative inspection protocols. And so that has a specific requirement relative to coverage and a lot of utilities can't meet that coverage requirement. So they can't do an inspection and take credit for it under NRC's regulatory expectations. That's part of the difficulty here.

VICE-CHAIRMAN WALLIS: I'm just trying to assess what's the probability that among these 30 or whatever they are non-inspected that there might be something like a Wolf Creek. It's not a negligible number, is it?

MR. MARION: We don't believe that's the case.

VICE-CHAIRMAN WALLIS: Why is it that they're all so sure that they're not like Wolf Creek?

MR. MARION: Well, we provided analysis to the NRC justifying this inspection regime indicating that we had sufficient time to execute or implement the inspections by the schedules that have been identified without compromising safety or compromising plant risk.

VICE-CHAIRMAN WALLIS: If you've inspected 17 percent the Chairman said or something and you found one, then what's the probability you're going to find one in the remaining 83 percent?

MR. MARION: I believe, Craig, that's something we're looking at as part of this evaluation of the generic implications, isn't it? Aren't we looking --

VICE-CHAIRMAN WALLIS: It seems to me to be fairly significant probability unless there's some other evidence.

MR. HARRINGTON: We have done some probabilistic analysis of how that might propagate into the rest of the plants. If we were to inspect every weld, what might we expect to find? Of course, it's a somewhat limited data set, but I looked at the numbers. It's 47 nozzles that we expect to have inspected prior to mitigation when we're finished with pressurizers. Thirty-one of those have been inspected to meet PDI requirements thus far. So it's not an insignificant population that's been looked at, but still trying to predict the whole --

CHAIRMAN SHACK: Bigger than Mr. Gallo takes anyway.

MR. HARRINGTON: That's true.

MEMBER ABDEL-KHALIK: You've made a point of making the statement that the findings at Wolf Creek do not fit the experience base. Now where did you get that and what is it that you're trying to say by making that statement?

MR. MARION: Our evaluations to date and

our understanding of primary water stress corrosion cracking does not fit, if you will, the indications that were found at Wolf Creek.

MEMBER ABDEL-KHALIK: So you're not saying that these indications are not real or impossible to find --

MR. MARION: Those are indications and we unfortunately do not have a sample of the metal to do a metallurgical analysis to definitely establish what kind of indications they were and what the size, depth, etc. was.

MR. SIMS: This is William Sims, Energy Operation. The expected indication is that it will be axial because of the higher hoop stresses. But going back to the question about inspections, all of these welds will be inspected after the overlay. We will inspect the weld overlay itself and at least 25 percent of the OD surface of the base material and the existing weld. So if there are some further issues out there, we should see them and that's PDI-qualified. You can actually see below the 25 percent, but it's not a qualified process after that point.

MEMBER ABDEL-KHALIK: Thank you.

MR. MARION: Okay. In terms of the advanced finite element analysis work that we're doing, our objective is to determine margin between leakage and rupture and the approach is to provide reasonable assurance that we have sufficient time between the onset of leakage and rupture. We had --

VICE-CHAIRMAN WALLIS: How does that support the staff's conclusion at Wolf Creek that quite a few of these were going to rupture very soon after leakage?

MR. MARION: I'm sorry. I'm missing.

VICE-CHAIRMAN WALLIS: I think that the staff's slides showed that in the Wolf Creek case they were predicting rupture very soon after leakage or simultaneously with leakage.

MR. MARION: Yes.

VICE-CHAIRMAN WALLIS: You're saying here that you're going to provide assurance that's sufficient time exists between leakage and rupture.

MR. MARION: Yes.

VICE-CHAIRMAN WALLIS: It doesn't seem to be quite consistent with what the staff was saying.

MR. MARION: Well, the staff analysis was somewhat conservative and they had to make some assumption given that we weren't able to fully characterize the indications that were found at Wolf Creek. And we feel that with this finite element analysis we can do an improved job of addressing some of the assumptions that are necessary. We're going to hopefully get NRC endorsement of our approach and methodology and we're reasonably confident that we can come up with some demonstration of additional margin between the onset of leakage and pipe rupture.

In terms of the analysis, the crack shape remains semi-elliptical as it grows through the weld thickness. This is the area of conservatism that we have. So as we go through refining the analysis, we think that we can allow the stress intense factored at each point along the crack and its development in terms of the shape of the flaw or the shape of the crack. We intend to evaluate the specific indications that were identified at Wolf Creek and let me just point out that one of the challenges we have is trying to get an understanding of what the depth of that indication was because the inspection technique was qualified for detection and sizing but not for depth. So there was an assumption of the depth of the flaw.

And I believe -- I'm trying to remember if Ted said it this morning, but it was stated at the Subcommittee meeting on Tuesday that the indications that we've seen in the locations are relatively consistent in depth sizing which is another unique trait compared to our experience base relative to PWSCC. So there are a lot of questions about what actually exists at Wolf Creek and that's one of the challenges that we need to work on with the staff in terms of how do we integrate that into this finite element analysis. We intend to perform sensitivity studies and we have a peer review effort under with the team to provide us input on dealing with some of the quantified assumptions that need to be made in conducting this analysis.

MEMBER KRESS: Alex, just what is the relationship between the stress intensity factor, the K, and the local shape of the curve of the crack?

MR. MARION: I'm an electrical engineer. So I'm going to have to defer.

MEMBER KRESS: Are they related to the curvature?

MR. MARION: I'm going to have to defer to one of our experts in the back. Please.

MR. RICCARDELLA: I'm Pete Riccardella. I'm not actually doing the analysis, but I'm a member of the peer review panel. The analyses that have been performed to date both by the NRC staff and the industry assume a fairly standard approach which is a semi-elliptical crack shape and that's just because that's mathematically convenient to analyze.

MEMBER KRESS: With the K constant all along the whole thing.

MR. RICCARDELLA: No. Actually, that analysis calculates 1 K at the deepest point of the crack.

MEMBER KRESS: The deepest point.

MR. RICCARDELLA: And 1 K, a second K, at the surface where the semi-ellipse intersects the surface and then propagates the whole ellipse based on the rates of those two points. Those two points turn out to be very, very conservative because you have high residual stresses on the surface. So that drives the K at the surface very high and then, of course, the deepest point, you have the through-wall crack propagation. You have a deep crack. So you're taking the two fastest crack growth rates and assuming that this whole ellipse propagates at the rate that those two points would tell you.

The way the industry, this new analysis, more sophisticated, is a finite element analysis which will look at the K at point for point along the crack surface and propagate each point as it would want to go based on the stress intensity factor correlation.

MEMBER KRESS: My question was what is the relationship that gives you the K at each point on the curve. What is that relationship?

MR. RICCARDELLA: That's based on a finite element model where you can go into the model and do what's called a J integral at each point and determine the K at each point along the crack surface. That comes directly out of the finite element analysis.

CHAIRMAN SHACK: There's no simple relationship.

MEMBER KRESS: This is a stress intensity factor.

MR. RICCARDELLA: Yes.

MEMBER KRESS: Isn't that determine by the crack shape at that point?

MR. RICCARDELLA: Yes. But the finite element model models the crack shape and so the K --

MEMBER KRESS: Yes, but isn't --

CHAIRMAN SHACK: He's thinking it's a purely local property.

MEMBER KRESS: I'm looking at it as the local property, yes.

CHAIRMAN SHACK: It's the kind of integral overall crack shape or local geometry and the overall stress field and unless you can really do influence functions in your head, it's very difficult to --

MEMBER KRESS: So why am I going to believe this new calculation?

CHAIRMAN SHACK: They're going to benchmark it.

MEMBER KRESS: With a calculation that's exactly like it.

MR. RICCARDELLA: No. Also with experimental work where it's available and field data where available.

MEMBER KRESS: Okay. You're going to have that in time to --

MR. RICCARDELLA: The experimental work already exists. We're going to compare it against experimental.

MEMBER KRESS: You have experimental that already exists.

CHAIRMAN SHACK: Some experimental work.

VICE-CHAIRMAN WALLIS: Does that go for one crack? There's not multiple cracks.

MEMBER BONACA: Are you looking at multiple cracks?

VICE-CHAIRMAN WALLIS: There's not a crack that grows, eats up another crack and joins with another crack.

MR. RICCARDELLA: One of the sensitivity

studies in the analysis program is to look at multiple cracks in this model, yes.

MEMBER ABDEL-KHALIK: I assume that this analysis requires some kind of an initial condition to be well-defined and if you indicate that there is uncertainty about the crack depth found at Wolf Creek, how is the initial condition for this analysis defined?

MR. RICCARDELLA: The initial cracks we will use a variety of initial crack sizes that will encompass with time reaching the Wolf Creek configuration and then we'll see how they continue to grow.

MEMBER ABDEL-KHALIK: So when the staff presented results indicating times between link and break, what sort of initial conditions did you assume in those analyses?

MR. SULLIVAN: We just used the initial conditions based on the measurements that were given to us by the Wolf Creek inspection personnel.

MEMBER ABDEL-KHALIK: But they're saying this is one of their biggest uncertainty in as much as all the measurements indicate that all the cracks have the same depth.

MR. SULLIVAN: Right. But that was the

best information we had to go on at the time.

MEMBER MAYNARD: On the uncertainty part of this, the cracks, I don't believe there's any uncertainty as to the cracks may be bigger. I talked to the people who did it and they're totally confident that what they were saying was absolute bounding. It could be considerably smaller than that, but not any bigger than what they had characterized as their fault from an uncertainty standpoint.

CHAIRMAN SHACK: But again because we're dealing with a sample from a population, you're going to have to make sensitivity studies that looked at range of these crack sizes and it wasn't clear from the Subcommittee meeting just how one was going to come to the acceptance criteria. I think -- I believe that the real hope is that when they introduce what seem to be reasonable elements, departures from non-axi-symmetry, that for a very wide range of starting conditions they're going to be able to demonstrate leak before break and I think that's the real hope from the analysis that as soon as you begin to include any kind of reasonable departure from axi-symmetry you'll demonstrate a leak before break margin despite all the other uncertainties that you still have. But again, I think you really won't know that until you begin to see some of the results of the analysis.

MR. RICCARDELLA: I think a significant aspect of this when we were talking about the semi-elliptical shape, where we talk about time between leakage and rupture, what really determines rupture is how much of the cross-sectional area is lost. So if you're assuming that's always semi-elliptical, you're making a fairly conservative assumption in terms of the amount of cross-sectional area that's lost if, in fact, the crack is shallow over most of its front and just deep over a short portion of it.

MEMBER ABDEL-KHALIK: You know, my concern is that you're sort of hanging your hat on this analysis and we don't even know the initial condition for which the analysis should be done. So I'm not sure how much doing this analysis will reduce the uncertainty as to what to expect during the two or three or four year period of this inspection program.

MEMBER KRESS: What -- Given a rupture type at this location, it looks like the conditional core damage should be what? About 10^{-3} per year?

CHAIRMAN SHACK: Yes.

MEMBER KRESS: That translates into a probability, say you have a year's time between now and shutdown, the 10^{-3} --

CHAIRMAN SHACK: Per plant.

MEMBER KRESS: Per plant. Now if you assume a conditional containment failure of 0.1, that's a 10^{-4} probability. Isn't that an acceptable LERF? It meets the QHOs because the QHO of 1 X 10^{-5} was meant for about 100 plants over 40 years. Now here we have less than 50 plants over a year's time/. Isn't that an acceptable probability for this same case assuming a rupture probability of one?

MEMBER BONACA: In the industry that wouldn't be.

MR. RICCARDELLA: And clearly the rupture probability in the next year isn't one.

MEMBER KRESS: Yes. Of course, it's not.

MR. RICCARDELLA: The 41 plants that we looked at in the statistics --

MEMBER KRESS: I'm trying to arrive at a reason for delaying shutdown inspection if I don't believe the calculations. The only other criteria I can use, I think, is risk. My question is is that an acceptable risk now. Now I know you don't want to have core damage.

MEMBER BONACA: You don't want to have a rupture.

MEMBER KRESS: I don't even want to have

a rupture.

MEMBER BONACA: We're looking at new reactors here.

MEMBER KRESS: But you're not going to have a rupture. You know it and I know it, but --

VICE-CHAIRMAN WALLIS: Well, I don't know it. There's a probability associated with it.

MEMBER KRESS: Sure.

CHAIRMAN SHACK: A CDF of 10^{-3} normally falls into our unacceptable region.

MEMBER KRESS: Yes, but that's 10^{-3} --

CHAIRMAN SHACK: Now you have to decide how much --

CHAIRMAN SHACK: But that's 10^{-3} for a plant that's going to operate for 40 years.

MEMBER BONACA: That's condition.

MEMBER KRESS: We've talked about short --

CHAIRMAN SHACK: He's thinking a rupture probability of one.

MR. RICCARDELLA: Yes.

MEMBER KRESS: We talked about short-term risk as it doesn't have to be the same long-term risk.

MR. MARION: We did a probabilistic analysis to support the time frames for this inspection program and I think Mr. Riccardella's organization did that.

MEMBER KRESS: You did one of those.

MR. MARION: And I think our values were on the order of 10^{-8}, weren't they, in terms of core damage?

MR. RICCARDELLA: Yes, but the NRC questioned some of the assumptions in the analysis. But clearly, the probability of a rupture in the next 18 months or so is not one. It's significantly less than that. And, Bill, to answer another question --

MEMBER KRESS: But we don't know what the probability is.

MEMBER POWERS: I guess I don't understand. I just heard somebody tell me that 20 out of 24 cases and things like that that there was no time between leak and rupture, I mean, for a variety of calculations. So why would I conclude that -- I mean, why do I know that there's not going to be a rupture?

MEMBER KRESS: I don't think we know the probability.

MEMBER POWERS: You said you knew it and that Jack knew it.

MEMBER KRESS: Intuitively.

MEMBER POWERS: Well, intuitively.

MEMBER KRESS: But I don't really know it.

MEMBER POWERS: So now I'm asking you how do you know that it's less one.

CHAIRMAN SHACK: Less than or equal to one.

VICE-CHAIRMAN WALLIS: Tom, you're losing credibility. Next time you say you know something I'm going to take it with a grain of salt.

MEMBER MAYNARD: Let me make a comment on that please.

MEMBER KRESS: I didn't base any of my conclusions on that. I said given a rupture in a standard risk. So I didn't use that information even though --

MEMBER MAYNARD: I believe that overall safety is better served by sticking to the schedule that is there for several reasons. First of all, moving the spring of `08 into somehow 2000 (sic), we're not talking about a significant amount of time. But by doing that, you're creating quite a perturbation to the whole industry and to the people who actually do the work, do the inspections, do the weld overlays and I'm not sure you get the same quality of work as when you do it with the --

MEMBER POWERS: I heard the same thing

prior to Davis-Besse. It was almost identical --

MEMBER MAYNARD: I'm sorry. I think there are some real considerable differences. At Davis-Besse, there was a indication of leakage and there were many other factors that fall into that. I believe that for these plants again, you're not gaining that much time and I believe that rushing it creates additional problems.

In addition, I believe that all these plants, if something were to happen, it falls within the accident analysis that's out there. We're not creating a new accident that's not covered by the current design basis accident, I don't believe.

MEMBER BONACA: Those accident have behind them an implication of frequency even in the current -- approach and that's an element that we don't understand. What's the probability that we don't know? That's the issue. So the consequences may be within the bound and I think it's more than anything else the benefit of the industry. Right now, we have plans for a lot of new plants. If you have a break in there, then those plants will fly out the window.

MR. MARION: Pete, did you want to add something to this?

MR. RICCARDELLA: Just on this question of the probability of an actual barrier. There was a probabilistic analysis that was presented in the White Paper that we presented and, you know, there were 49 data points in which nozzles of this type were inspected. The reason for the difference between 41 and 32, Bill, is that the 41 includes some overseas plants and includes some non-pressurizer nozzles like drain lines and things like that in which haven't been inspected and in which creaks were found.

Of those 41, over 20 were clean, had nothing. Another 10 or 12 had just axial cracks. And there were only a handful like six or seven that had circumferential cracks.

CHAIRMAN SHACK: I didn't think the number difference between seven and ten was all that large and to demonstrate that it's predominantly axial --

MR. RICCARDELLA: I'm not saying, but clearly, if you plot those, the Wolf Creek indications are in the tails of that distribution.

VICE-CHAIRMAN WALLIS: It's six out of 41. It's not insignificant.

MR. RICCARDELLA: But most of those six were smaller and the Wolf Creek cracks, if you look at them in terms of lost cross-sectional area, they were clearly in the tails of that distribution. So there is some evidence that even though you wouldn't say that it's an anomaly, it is in the tails of the distributions and then you look at what crack size would actually cause a failure and you can estimate some probabilities of a rupture occurring which are clearly on the order of 10^{-3}, I think, or less even if we take into account the most conservative assumptions. So you take the 10^{-3} and then the 10^{-3} core damage probability and you're in the 10^{-6} range I think.

MR. MARION: This slide just provides an overview of some of the parameters that are going to be evaluated in the calculation of this enhanced finite element analysis and we already touched on many of these.

In summary, I would like to say that or I will say rather that the materials initiative is successful to this particular point in time, recognizing that we are in an initial phase, if you will, of the inspections of primary systems welds and we are going to continue the inspection program through 2010 and make adjustments accordingly based upon the inspection results that are identified along the way.

MRP-139 provides an aggressive inspection baseline program. By the end of this year, 70 percent of the pressurizer dissimilar metal welds will have been inspected or mitigated. We are working with the NRC as we said previously on further analysis to show reasonable assurance that you will have a leakage prior rupture.

Our estimate is to complete the analysis by late June and we had a technical meeting with the staff yesterday to begin the initial exchange of information and discussion on some of the technical issues. We focused on the issues that were identified in a letter that we received from the NRC. It was a positive meeting. We're looking forward to working with the staff to complete this analysis and we'll be more than happy to brief this committee this summer when the results are available if you so desire.

In conclusion, we fundamentally believe acceleration of the implementation schedule that I've discussed in our earlier slides is unnecessary. The fact remains that given the operating experience and the data that we have on an international basis we've only had four very small leaks that have been identified.

From a risk point of view or risk perspective, we see no difference between inspecting now and the spring 2008 for the initial exams. We intend to monitor the spring 2007 inspection results in the spring as well as in the fall. And as Ted Sullivan indicated, the industry has implemented a very conservative enhanced leakage monitoring program as a compensatory measure to be in place until such time that inspections and mitigation activities are completed. This applies to the plants who have not, if you will, completed their activities to date.

That completes the presentation I have. We will be more than happy to any additional questions from the Committee.

MEMBER POWERS: It seems to me that the enhanced leakage monitoring is more of a key than the risk analysis here.

MEMBER KRESS: If one believes leakage before break.

MR. MARION: That's correct. Yes, as part of that program as Ted indicated, there are action levels that call for the utilities to basically evaluate and try to identify the source of unidentified primary system leakage within a certain time frame and if that cannot be done, then the plant is to shut down and do a bare metal visual inspection and that's rather extremely conservative and it goes well beyond the current requirements in the plant technical specifications, but the utilities involved in this effort have agreed that that's an important compensatory measure that needs to be put in place.

MEMBER ABDEL-KHALIK: And how are these changes codified?

MR. MARION: These changes to the leakage?

MEMBER ABDEL-KHALIK: Tech spec action items.

MR. MARION: They're not codified per se. The utilities have submitted letters to the NRC committing to implement that program and as Ted indicated in his presentation, the NRC probably over the next week and a half, two weeks, is going to provide a confirmatory action letter for each plant.

MEMBER POWERS: That's pretty codified right there and that's serious.

(Several comments.)

MR. SULLIVAN: And they were also captured in plant procedures. This is Ted Sullivan.

MR. MARION: Okay. Very good. Thank you very much.

CHAIRMAN SHACK: Thank you. We are a little bit ahead of schedule. Well, I'm not sure. We have time for discussion, but I think we've probably discussed as much as we have. There is some question as to whether a letter is required. Do you want to say anything about that, Ted or Michelle?

MS. EVANS: Yes. This is Michelle Evans. I'm the Division Director of Division and Component Integrity in NRR. I guess at this point we're not looking for a formal letter at this point in the process. We're interested in keeping you engaged over the next several months as the industry goes on with their analysis and we are engaged and we have the Office of Nuclear Regulatory Research also engaged in that process. So there is a possibility we would request a letter later in the summer. But at this point, we're not looking for a letter.

MEMBER ABDEL-KHALIK: When will this advanced finite element analysis be completed?

(Several answer "June.")

MR. HARRINGTON: The current schedule would have those results completed around the end of June.

MEMBER BANERJEE: Is there any experimental work going on at all?

MR. HARRINGTON: Experimental of what sort?

MEMBER BANERJEE: I mean, if this is an

unexpected finding is there any sort of -- I'm just trying to understand. Is it sufficient just to do analysis or should we be doing some experiments?

MR. HARRINGTON: We are contemplating and I think likely will fund some mock-up testing to try to generate additional relevant data on welding residual stresses in a virgin, unrepaired weld as well as repaired welds. That program hopefully will get under way shortly and would not generate results quite -- I mean, it would be a little bit past that analysis time frame, but late summer, we would start seeing results from that.

MEMBER POWERS: I think, at the Subcommittee, they indicated that there were experimental data that could be used to validate the modeling approach already in hand.

MR. HARRINGTON: There is some as was commented earlier. It's limited. It's a varied data set, but we are working to identify all the possible avenues of that kind of validation for the analysis.

MEMBER BANERJEE: One of the things that was said, I think, was the fact that circumferential rather than longitudinal was unexpected. Is this sort of what you would conclude from the available experimental data that it was unexpected?

MR. HARRINGTON: That statement is based on stress analysis. It's based on operating experience. The stresses would tend to drive a crack typically in the axial direction, but with weld repairs, you do get much more complicated stress patterns that could drive it at least locally in the circumferential direction. But the operating experience has largely been observation of axial flaws in these kinds of materials.

However, when we developed 139, the evaluation of just axial flaws and the presumption that that is the most likely condition would have led us to essentially little or not inspection program other than what was already there. The decision was made that notwithstanding those conclusions that it's maybe unlikely or not expected that we would see large circ flaws. That was the condition that we had to evaluate and that was the condition that we had to inspect for and, in fact, in MRP-139 a poor inspection coverage for axial flaws is not a particular concern. Poor inspection coverage for circumferential flaws is a failure of the inspection and a non-compliance with meeting the requirements and forces you to do more work. So despite the fact that we didn't expect it, the whole program is built around that kind of flaw.

MEMBER BANERJEE: I'm more trying to understand. Is the understanding that this arose due to some sort of a stress distribution that arises from welding and, if so, is there some way of being able to predict this and, if not, should there be an experimental program in place to understand what the stress distribution is?

MR. HARRINGTON: There has been analytical evaluations of those stress conditions. I think in BWR space they did some work on residual stresses from welding, welding repairs. There has been work over time, but in this whole problem as I think Ted and Al alluded earlier, maybe the most unknowable factor is the welding residual stresses. There is just way too many variables in how those welds were produced and there's an infinite number of combinations that you could evaluate either analytically or experimentally.

So we're working to try to find ways that we can bound that problem both analytically and possibly experimentally as well. But we're also dealing with the fact that left to the current schedule in about 14 to 16 months pressurizers are going to be done in this country and this will no longer be an issue because they will have already been either inspected per PDI requirements in those cases where it's practical to do that or they will have been mitigated.

MEMBER BANERJEE: How do you know first that it won't happen after the inspection unless you have some tool?

MR. HARRINGTON: There is a reinspection interval. This is not a one-time program. The inspection program does have a reinspection period that if you do not mitigate you continue inspecting on a fairly frequent basis.

MR. BAMFORD: (Off microphone.) Yes. Let me add to that. The overlay has another benefit besides adding additional metal. (On microphone.) This is Warren Bamford from Westinghouse. The overlay has another benefit that really hasn't been discussed this morning in addition to adding additional metal and that is it produces a clamping action on the pipe. So it causes the inside surface of the pipe to go into compression.

Even if there were a small flaw existing in the pipe, it would be in a compressive stress area and nothing would happen to it. So that's why it's really called a mitigation in addition to a repair. I think that's an additional action, an additional advantage, of the overlay process that hasn't been emphasized.

MR. HARRINGTON: On the current schedule of inspections which would finish around April of `08, we will have -- I can't remember the number offhand. It's over 90 percent of the welds on the pressurizers will have been not only inspected but mitigated either in most cases through a weld overlay, in a few cases through the mechanical stress improvement process which also accomplishes the same change in stress state on the ID surface that Warren just described.

MEMBER KRESS: I don't see how an overlay produces compression to a circumferential. I see how it would on an axial. That's a little more difficult to put compression on circumferential.

(Off the record discussion.)

MR. RICCARDELLA: There are a couple of effects and there's a lot of analyses. There's a document called MRP-169 that we've submitted that discusses the whole concept and a lot of analyses. But the key is you have to make the overlay fairly long. If you made it short, you're correct. You would have some tensile stresses. But by making it long, you get axial shrinkage and then you also get a thermal effect that goes on, too.

MEMBER KRESS: I can see how that -- You

don't have much length on the nozzle side to the pressurizer.

MR. RICCARDELLA: No, but we generally -- The length is set by what -- One of the requirements for length is how long it has to be to achieve the residual stress reversal.

MEMBER KRESS: But with respect to using existing data to benchmark the new model, the most sensitive influencing parameter seems to me like it's the residual stress distribution. I'm at a loss as to how you ever measure that, how you ever know what it was and when it comes to finding a bounding value, I think the bounding value will be fact dependent. I mean you have to change it with time or something. It depends where the crack is initially to get a bounding value. I don't know how you're going to work that, but maybe you know. Maybe you've given it some thought.

MR. RICCARDELLA: There has been a lot of analysis and testing of residual stresses under various conditions including repairs and we can just look at the distribution and --

MEMBER KRESS: I don't know how. I'm at a loss to measure residual stress.

CHAIRMAN SHACK: Having measured residual stresses and welds for a number of years.

MEMBER KRESS: What do you use? A strain gauge?

CHAIRMAN SHACK: Yes. You don't have much left of the weld by the time you're done.

MEMBER KRESS: Okay. You start cutting. Okay. It's Heisenburg Principle.

CHAIRMAN SHACK: It's not a nondestructive evaluation.

MEMBER KRESS: You have a Heisenberg Principle. Your experiment destroys the --

CHAIRMAN SHACK: I've looked at admissive welds. I've looked overlay welds. I've looked at butt welds and --

MEMBER KRESS: What do you look at when you cut it out?

CHAIRMAN SHACK: You're making strain measurements.

MEMBER KRESS: Strain measurements.

CHAIRMAN SHACK: Right. And as Pete says, they have been used to benchmark the analyses. The real problem with Sanjoy's question is I think we can actually predict residual stresses and welds reasonably well if you know what the boundary conditions are. The problem is that in many of these cases you really don't know how many. The records on the repairs are kind of sketchy. So there's a wide distribution, but it's not infinite.

MEMBER KRESS: It depends on how hot it got and how fast it cooled off.

CHAIRMAN SHACK: Yes.

MEMBER KRESS: And the constraints.

CHAIRMAN SHACK: The constraint are actually an extremely critical situation. The more highly constrained the weld is the bigger the stress is that you can make in it.

MEMBER ABDEL-KHALIK: Now the first and most significant conclusion in Mr. Marion's presentation is that acceleration of the implementation schedule is unnecessary. Is this conclusion independent of the results of the advanced finite element analysis?

MR. MARION: This is Alex Marion. That conclusion is based upon our understanding of primary water stress corrosion cracking in this location based upon the experience and the knowledge that we have to date. So it is independent of the analysis that we're performing.

MEMBER ABDEL-KHALIK: So is there any possible result that advanced finite element analysis can produce within the wide range of possible results that could cause you to change that conclusion?

MR. MARION: We're prepared to deal with the results that come out of the analysis and if they indicate that we need to make changes to that conclusion and changes to the detailed aspects of the inspection program we have in place, we will do so.

CHAIRMAN SHACK: I thought there was an agreement with you and the staff that if the results of the analysis were not considered acceptable that you would, in fact, accelerate the schedule.

MR. MARION: Absolutely. That commitment has been made by the utilities who have current plans for 2008.

MEMBER ABDEL-KHALIK: Will we have an opportunity to see the results of this advanced finite element analysis and the conclusion as to whether or not acceleration of the schedule is appropriate?

MR. SULLIVAN: I think we sort of have tentative plans for schedule further Subcommittee meetings if that's the level at which we do it.

CHAIRMAN SHACK: Yes. The answer is if we want to we certainly will.

MEMBER CORRADINI: Can I ask a question back to what Sanjoy was asking? Sanjoy was asking about research experiments on residual stress. I'm more interested in is the industry satisfied with the inspection method. That is, it would seem to me that you're going to have this continual aging problem with various components and a lot of it is things related to cracking and materials. Is that method of inspection that you're using now that will then, if I understand it correctly, be used with the overlays going out further because you're going to have to continually inspect this stuff? Are you satisfied with it? What is the industry -- Or are you working with the NRC in developing more enhanced inspection methods so you can actually tell what's there? Because my feeling is you're never going to know what your bounding conditions are, but you could develop more advanced methods to look at what you have as you continually age these plants because most of these will go into life extension. So what's the plan there and if this is not the venue for that, I'd like to include that on a discussion when we have this next meeting relative to the advanced analyses because to me, the inspection is the key and advanced methods to inspect.

MR. MARION: I agree with you about inspection being the key. The inspection methodology is an evolving process, if you will. We have vendors who are developing new probes, etc. The capability of those probes to detect flaws is being reviewed and evaluated in a program that we have with EPRI. So that methodology is evolving. But as of this particular point in time, I think the industry is comfortable with the technology that we currently have.

As a matter of fact, there's a new inspection probe that's being used this year called the "phased array" that's basically improving the inspection technique and that's being integrated into the overall process. And I can't say what it's going to be like in 2010.

MEMBER CORRADINI: I understand.

MR. MARION: But there will be some techniques that will be in play. But at this point in time, we're satisfied with what we currently have.

MEMBER CORRADINI: I guess to follow on what Said and Sanjoy said I would like to add something like this. If we're going to have another presentation about this, I would like to know more about looking forward.

CHAIRMAN SHACK: Inspection technique.

MR. MARION: That would have to be a

completely separate discussion because I'm not sure we could give it adequate coverage in half an hour or something like that. But we would be more than happy to support that.

MEMBER MAYNARD: Have there been any discussions or plans if somebody else finds a circumferential crack indication of anything different that might be done as far as talking about taking a sample if a plant finds that or has there been any discussion on that?

MR. MARION: That's one of the options that, of course, that's being considered. One of the activities we have in place is to do a lessons learned through each inspection cycle. Now we had an effort to capture lessons learned from the fall 2006 inspections and that's being integrated into our activities going into the spring. At the end of the spring, we're going to capture lessons learned and try to integrate that into the fall. A lot easier said than done, but we recognize that we need to do that.

As my information indicates, I believe there's only plant that's planning to do inspection this spring and we've had discussions with the personnel of that plant to make sure they understood what the options were depending upon what they find.

Dr. Shack, if I may. In terms of the letter from this Committee, I was kind of surprised at the staff request and I recognize this Committee is not here to serve the industry, but it would really help if we could get some kind of an indication from the Committee as to the reasonableness of the approach that we're taking on this finite element analysis. We're not asking for review and approval. We just want some indication that this makes sense, if we can get that in something.

VICE-CHAIRMAN WALLIS: I think we'd have to see the finite element and more details of the analysis itself and how it treats the temperature and the chemistry and things like that. I don't know at the moment how good this finite element analysis is.

MR. MARION: I'm not asking for that. I'm asking for the approach that we're taking, does that make sense, details notwithstanding.

CHAIRMAN SHACK: What they're getting rid of is this artificial constraint that crack always grows as an ellipse.

VICE-CHAIRMAN WALLIS: But do you know how to predict crack growth with this environment?

MR. MARION: I believe we do.

CHAIRMAN SHACK: I think that we have data to demonstrate that.

VICE-CHAIRMAN WALLIS: I think there's a lot of scatter in that.

CHAIRMAN SHACK: Those are uncertainties that have to be addressed.

MEMBER BONACA: Buy the path is the correct path.

CHAIRMAN SHACK: I think it's a substantial improvement to have a realistic crack shape growth rather than the artificial. Whether it turns out to be conservative or non-conservative is a different question. But it's certainly an artificial constraint that the crack growth is an ellipse.

VICE-CHAIRMAN WALLIS: This is affected by history. We have a lot of in-flows and out-flows in the surge line and temperature changes. Does this influence this crack growth?

MEMBER BONACA: Yes.

VICE-CHAIRMAN WALLIS: Quite a few things that can influence the crack growth.

MEMBER POWERS: And it's on the list.

CHAIRMAN SHACK: You get a large degree of scatter. But again, I think whether they can demonstrate this in the face of all the uncertainties they have is an open question because I think it's a

-- I personally think it's an interesting approach.

VICE-CHAIRMAN WALLIS: It's interesting but --

CHAIRMAN SHACK: We'll be considering.

MR. MARION: All right. Thank you.

MEMBER ABDEL-KHALIK: But without presenting the details, I'm not sure the Committee can give an informed opinion as to the validity of the analysis.

MEMBER BONACA: It wouldn't be that.

MEMBER ABDEL-KHALIK: And absent the results of the analysis, I'm not sure the Committee can give an informed opinion as to whether or not the current schedule is appropriate.

CHAIRMAN SHACK: Matter for discussion. Yes. Any further comments at the moment? Okay. We'll take a break until 10:30 a.m. Off the record.

(Whereupon, the foregoing matter went off the record at 10:19 a.m. and went back on the record at 10:32 a.m.)

CHAIRMAN SHACK: On the record. Our next topic is proposed revisions to the Standard Review Plan Sections covering Sections 15.0, Accident Analysis and 15.9, BWR Core Stability and I guess that's you, Sanjoy.

MEMBER BANERJEE: Right. We heard about both of these standard review plans at the Thermal Hydraulic Subcommittee Meeting last week and 15.9 is going to go first because it's a little bit, I think, shorter in terms of what the discussion will be in this presentation and then we'll follow up with 15.0.

Now 15.9 really is addressing BWR stability issues and it was previously covered under SRP 4.4, Thermal Hydraulics Design. The objective is to provide guidance to reviewers to ensure compliance with GDC 10 and GDC 12 related to stability and specifically, it will address acceptance criteria for these what are called LTS Systems, suppress stability and related generic issues. It's specifically also will exclude ATWS which is covered under 15.8.

So with that, the Subcommittee really didn't identify any major generic or other issues. But we'll let Dr. Huang and March-Leuba tell us a little bit about it.

DR. HUANG: This is Tai Huang from Reactor Systems branch and I like Sanjoy mentioned in query about a story of these standard review plans 15.9 BWR stability and this is the new section of the NUREG-0800, Standard Review Plan, for review of SECY analysis report on nuclear power plants. Previously, the stability was mentioned in the Standard Review Plan 4.4 and only one term, so-called thermal hydraulic stability evaluation in the area of review and one paragraph in one of the review criteria. So that's only two areas you know the stability in the previous SRP 4.4.

And today, this SRP 15.9, a new section of this standard review plan, we were going to have this applicable to these operating plans, new plan and also extended operation domain. And with today's BWR stability, you have a potential of monitoring the acceptable fuel design limits and also with the effect of day-to-day operational BWRs. As you know today the BWR operation, they're going to have more operating domain and then also the fuel design is different. So the detail we're following in that the slides on that we're going to explain that later.

As far the regulatory requirements, GDC 10 for the reactor design and also the GDC 12 suppression of the reactor oscillation bolts are mostly important in that regulatory requirement to the base and why we need this 15.9 as today for the BWR stability is there is a long term solution that has the dedicated protection system function today developed and available. And stability can have significant impact on the operation because you have an exclusion reason, bigger or smaller, depending on your design conditions and you have to have a specialized calculation required to determine how big this exclusion reason as you design. Specific guidance provided for issues identified result in operating reactors. For example, there are long-term solutions already results in what data. We're going to explain that and generic criteria that are applicable to new fuel and extended operating domain and new reactors are provided in this 15.9.

And as you know in our long period of experience and an effort between the NRC and industry, this slide shows the history of BWR events back in 1970 in Vermont Yankee events and tests. And following that in 1986, there's a Generic Letter 8602 and following that 1988 is LaSalle Events and they keep going after LaSalle Event, there's the NRC Bulletin 88-07 that highlight that the funding for the power oscillation from LaSalle's two units.

And later on 1988, there's a Generic Letter Part 21 come from GE to show that MCPR may be violated if 10 percent APR is used as criteria for manual scram.

And keeping going to the 1991 to 1993, the effort between the NRC and industry to develop these long-term solutions. So there's a generic topical report from Owner's Group NEDO 31960 and also there is a supplement and then 1992, there's a WNP-2 Event and then the staff had a team to inspect the site and they wondered what's going on there. So there is an Information Notice 92-74. You can find out the detail of what's going on there.

And then up to 1994, there is a Generic letter 9402 and that's to require a long-term solution for each BWR reactor. There's INPO SER 07-00 about in the 1994 time frame and this tells us that from the previous instability event and the lesson learned.

And then because the generic application for long-term solution, so they said GE Part 21 DIVOM issue came out there because the generic development is a generically a DIVOM curve. But the reactor core is quite different, different operations, so the generic curve may not be applicable. So the Part 21 shows the plant-specific DIVOM should be provided for plant-specific application.

And then 2003 there is Nine Nile Point-2 Event. And there is the long-term Option 3 parameters insensitive. This is a lessons learned from Nine Mile Point-2. And then there is Perry Event 2004. So this is the time frame and then the history to show the effort between the NRC and industry.

And following that, I will have Jose to explain the need for these.

MR. MARCH-LEUBA: Good morning. I'm am Jose March-Leuba. I'm a consultant to the staff on issues of instability.

I wanted to start with this slide which we spent last week probably ten minutes discussing and the lesson I wanted to get to you is that BWR fleet has stability. They are aware of stability. They deal with it day-to-day and it really affects operations on the day-to-day.

What I show here is a power-to-flow operating map. Here we have a circulation line and this is APRM flow scram. This type of figure is contained on the COLR report in every plant and they all have this region in red. That region in red which is the most prominent thing on the map when you look at it, it's because of instability. The region in green is where one of these long-term solutions, Solution 3, and can cause you scrams. So the operators are really aware of the stability and this is an improvement of over 15 or 20 years ago when they didn't even know stability was a problem.

So this is actually to justify also why we have a complete new SRP 15.9 as opposed to one paragraph in 4.4. The review that COPR was mostly density-wave instability which when you talk about the stability of power, that's what we're worried about. That's the one that has real potential of causing SAFDL violations.

And there are three modes of instability in density-wave. You have the core-wide, the regional and the channel. In the core-wide, the whole core moves up and down and it's the one that you would be expecting to have when you have an oscillation in flow, an oscillation in fraction and an oscillation in power, all of them in phase.

On the regional mode, however, half of the core goes up and the other half goes down. You have what is called power channel oscillation. So you have a slushing from side to side. The problem with regional mode, that's the one that causes all these long-term solution effects is that the scram system is an average of a number of LPRMs which are distributed through the core and you average the left side with the right side. Whenever you have a large oscillation, you really don't see LPRM oscillation. The calculations show that before even you have a very large oscillation in the local channels, you will not reach the scram set point or by the time you reach the scram set point, you certainly have violated CPR.

You can have a single channel oscillating thermal hydraulic event by itself. But that is really considered to be an accident and it has happened a couple of times in foreign reactors and it can be happening if you have a channel that is not properly aligned and you have leakage at the entrance from the channel.

The SRP also recognizes there are other types of instabilities besides density-wave. The most important one is the control system instabilities in which case a controller goes out of tune and the way to solve that one is to send a technician and to fix it. And the SRP also recognizes that there are design-dependent instability modes, for example, for passive ESBWR. You would worry about the start-up and achieving low pressure.

We also spent probably 15 minutes on this slide last week. This again shows the power-to-flow map circulation line and here is the 100 percent power, 100 percent flow operating point which is what's called the original license thermal power and this is the normal 100 percent roll line.

Most reactors pre-EPU have been operating not at this point but at this point because you are allowed to have some flow maneuverability to account for burn-up and -- mostly burn-up. So you can control reactivity with increasing the flow and you still maintain 100 percent power. So most reactors were allowed to operate at this point.

When EPU came along, what they did is they extended the role line all the way to here, so that essentially the operating conditions power-to-floor ratio remained an EPU at about the same conditions as you were before pre-EPU. So it was just an extension. Now what problem they're finding the EPU plants is they don't have any flow window to compensate for the burn-up day-to-day and most EPU plants have to change control rods almost every other week which happens is they're operating here and on the weekend, they have to go down in power where they can move control rods and go back in power again. So what they're trying to move to and you will see this next month is something called MELLA+ in which they regain the operating flexibility on flow so that they can compensate with burn-up without having to remove control rods.

Another advantage is the more you move to the left the higher your spectrum is and you can gain some plutonium production that gives you more time to refuel. So it's good for everybody economically speaking.

The red line shows the stability bounding and this is a representative line of constant decay ratio equal to one. If you were to the right of this line, any operating point here, power-to-flow here, you are stable. If you are on that side, you are unstable and there are lines of constant decay ratio to this side. For example, 0.8 would be like this. The decay ratio 0.6 would be like that.

On the left side, then a limit cycle, once you become unstable, a limit cycle develops and you have lines of constant amplitude of the limit cycle as you move into it. So the farther you move into the unstable region, the larger your limit cycle is going to be.

MEMBER CORRADINI: Can I ask a question back to that?

MR. MARCH-LEUBA: Yes.

MEMBER CORRADINI: So if I go to the right of the red line as you said 0.8 --

MR. MARCH-LEUBA: 0.6.

MEMBER CORRADINI: 0.6, whatever, it just means the damping becomes more enhanced if I generate an oscillation.

MR. MARCH-LEUBA: Correct. Well, if you perturb it externally.

MEMBER CORRADINI: If I perturb it with some sort of forcing function it will die away quicker.

MR. MARCH-LEUBA: Correct.

MEMBER BANERJEE: But based on linear analysis usually, right?

MR. MARCH-LEUBA: On the right side is linear analysis. On the left side is not linear.

MEMBER BANERJEE: You know, there are many situations where finite amplitude analyses show instability whereas linear analysis doesn't.

MR. MARCH-LEUBA: That is correct. If you have a perturbation that's large enough, you can have -- And we're going to spend -- As I told you last week, this should be a semester, not a 50-minute presentation and indeed this line becomes a --

MEMBER CORRADINI: Are you teaching the course?

MR. MARCH-LEUBA: I've done it before. I've talked for two weeks once and I talk fast.

CHAIRMAN SHACK: Long story. I was afraid of that.

MR. MARCH-LEUBA: I have a blackboard and I know how to use it.

MEMBER APOSTOLAKIS: You are better than we are.

MR. MARCH-LEUBA: In the interest of time, let's get moving and if you have any questions, please I love questions.

There are two types of instability events. One, you can reach the unstable region by increasing the power or reducing the flow. When you increase the power, you do it two ways. You either pull control rods or you have a sump cooling transient. Both of these things are low in nature and therefore these types of instability events result always in very small amplitude of oscillation which are reversible. If you pull the rod and the oscillations are started, you insert the rod and the oscillations go away and that has happened.

(Off the record comments.)

The type of instability that we really -- that the long-term solution is trying to prevent is the flow reduction event in which you're operating up here and suddenly you lose your recirculation pumps and you end up down there, to the instability area and then you will have a large amplitude limit cycle which can indeed produce oscillations that can give you a CPR violation.

Because of that, a couple of decades ago right after the LaSalle Event which was a flow reaction event, the industry and the staff started a very large effort in producing what is called the long-term solutions and a number of solutions were developed back then which are categorized in two types. One of them is prevention in which you limit the operating domain so that you can not be unstable. You will never operate at a low flow which is low enough so instability will develop and that's called Option E1A. And then you have the detect and suppress solutions if oscillations are developed and the detect and suppress solutions are Option II and Option III.

Last week, I have Option 1D as a prevent one and after our comments, I make it as a mix. Option 1 is a mixed one in which you protect one instability mode by region, the original, and then you do have a flow by a scram which is a detect and suppress. All these options were developed by the BWR Owners Group and they are publicly available. Many will probably change hands and you have to change a Solution 1A to a III, but it's publicly available.

Because we are moving into this expanded operative domains like MELLA+, some of these options may not -- Actually, we know Option III does not work for MELLA+ and therefore the venders are getting into proprietary, new options like DSS/CD for General Electric which has already been approved and enhanced Option III which is under review and this will be proprietary.

The problem with the new operating domains as you see if you operate now in the MELLA+ corner and you lose your recirculation pumps you end up much further into the instability domain and you cross it during the pump run-back. So you have several effects which affect the makeup on Option III inapplicable.

We did have a lot of fun last week and we did talk for three to four hours about this. It was very lively and they told us today to take the Subcommittee word for ours, that they didn't have any problems after those three hours. But I wanted to reinforce to the Subcommittee that we listened to your suggestions and we have made some changes the SRP.

One of the problems the Subcommittee had was the definition of "reasonably prompt" as applied to operator actions, how do you define that and we have replaced that in the final SRP with as accomplished within the two minutes that allow for operator action in the demonstration calculations. So if the operator can do the actions required of him within two minutes which is the amount of time we assume for the calculations, then this is okay.

VICE-CHAIRMAN WALLIS: What is the consequence if he doesn't?

MR. MARCH-LEUBA: If he cannot do it, then it's not an approvable long-term solution. Then you cannot take credit for operation action. Then you have to put an automatic action.

VICE-CHAIRMAN WALLIS: But suppose you have a reactor and he doesn't do it. Suppose he waits for three minutes. You have this run-back or whatever you have.

MEMBER KRESS: You have oscillations.

VICE-CHAIRMAN WALLIS: Oscillations.

MR. MARCH-LEUBA: Potentially you have a large oscillations and you --

VICE-CHAIRMAN WALLIS: Is there fuel damage?

MR. MARCH-LEUBA: You will have a CPR violation. But in the laboratory domain we assume fuel damage but there really is not. There is a significant margin. Beyond that because of the nature of the oscillations, there's periodic dry-out and re-wet, dry-out and re-wet every two seconds. So getting to dry-out --

VICE-CHAIRMAN WALLIS: In terms of a PRA, you would be predicting fuel damage and you would be predicting core damage.

MR. MARCH-LEUBA: It will depend on the particular analysis. It assumes CPR 1 equal fuel damage and that's GDC 10 tells us. The industry has tried to go beyond that.

VICE-CHAIRMAN WALLIS: We get to look at this when we look at MELLA+, don't we? We're going to do that in April or something.

MR. MARCH-LEUBA: April 16th, I believe. We'll revise that again.

MEMBER MAYNARD: Now is this is a new operator action or is this an existing operator action that has to be depleted quicker?

MR. MARCH-LEUBA: Because this is an SRP which happened to come, a revision of the SRP, it's a new SRP, in the middle of new reactor emphasis on the staff, on the agency. We have tried to make an effort to make it applicable to future cases and as such, we have placed some criteria what would apply to long-term solutions for a future reactor. And that's where this comes along. So whenever Areva or whoever submits a new long-term solution if they take credit for the operator in that solution it had better be within two minutes.

MEMBER BANERJEE: Does this also do something -- We haven't heard about MELLA+, but are you trying to cover some eventuality there?

MR. MARCH-LEUBA: Yes, because we have done the MELLA+ review.

MEMBER BANERJEE: Right.

MR. MARCH-LEUBA: We are documenting the staff position that has been taken on this SRP so we can do it in the future and the industry knows what our position is. The SRP is good for two things.

We did have a lively discussion again on the term "approved methodology." The SRP said thou shall use approved methodologies when you do analysis and it did -- if we don't do that in reality because some times it is not an approved methodology that can do the analysis that is required. So we went in through those cases. We intended to handle them as an exceptions and we clarified on the SRP with this sentence, "In cases where an approved methodology is not available, the staff may accept the use of other methodologies based on the results of analysis." So there is some flexibility for the staff to do an analysis that needs to be done and there is no methodology approved. And we certainly corrected some typographical errors.

DR. HUANG: This is the summary of this presentation. The staff concludes SRP 15.9 provide adequate guidance and criteria on long-term solution for operating reactors, new reactor and future design changes and operating domain changes. So that's our conclusion of this presentation.

MEMBER BANERJEE: Just one point we had brought up which related to ESBWR. The matter of flow regime instabilities which you said that they had actually done some detailed studies with fine nodalization which we had requested and shown that this wasn't an issue. Right? And we haven't seen that and I don't think we need to see it. We just want to be assured though that those eventualities would be covered under the SRP in the sense that the reviewer would ensure that there was reasonable assurance of that type of instability being excluded.

MR. MARCH-LEUBA: The SRP addressed the generic and reminds the reviewer that --

MEMBER BANERJEE: All instabilities should be.

MR. MARCH-LEUBA: Yes. Density wave has been analyzed to death and we know the solution and that's most of the SRP describes and it reminds the user, the SRP reminds the user, whether it be the industry or the reviewer, that all these things are possible and you have to look at them.

MEMBER BANERJEE: And this may require some fine nodalization studies to assure yourself.

MR. MARCH-LEUBA: Absolutely.

MEMBER BANERJEE: And I think we haven't seen that from the vendors yet.

MR. MARCH-LEUBA: You have not seen that because the SER for ESBWR is due at the end of this month.

MEMBER BANERJEE: All right.

MR. MARCH-LEUBA: And I don't know when the schedule is. I think you'll see it in the June time frame, I believe.

MEMBER MAYNARD: Just from a regulatory standpoint from what I understand this doesn't impose any new requirements on licensees. This is a way of evaluating and approving various solutions to maybe some of the issues that they're dealing with. It's not really imposing a new requirement on an operating reactor.

MR. MARCH-LEUBA: The SRP does not impose any requirements whatsoever.

MEMBER MAYNARD: And I understand.

MR. MARCH-LEUBA: In particular 15.9, what it does is documents what the staff has already been doing for the last 20 years.

MEMBER ABDEL-KHALIK: Just for the record, I have looked at 15.8 inasmuch as it deals with the BWR ATWS stability issue and for that particular issue, 15.8 is adequate.

MR. MARCH-LEUBA: Yes.

MEMBER BANERJEE: There is a broader issue as to whether we should review it separately which you will speak to the whole 15.8.

MEMBER ABDEL-KHALIK: Later on, we will come to that.

MEMBER BANERJEE: Thanks both of you for a valuable presentation. So I think, Bill, should we move on to 15.0 then?

CHAIRMAN SHACK: Yes.

MEMBER BANERJEE: Thanks a lot. I think the next presentation will be on 15.0 and Mr. Miranda will make it. Briefly, this is a revision of a 1996 document, again in 0800 and has objectives of clarifying various event categories and acceptance criteria. It classifies events into two categories, AOOs and postulated accidents. Only two and it stipulates that it shouldn't propagate from AOOs to postulated accidents. ATWS is in a separate class here.

MEMBER BONACA: But it creates the AOOs in two categories.

MEMBER BANERJEE: No, it doesn't. It's supposed to, as you will see, the sort of novel parts of it which caused us a lot of controversy and discussion was one that you don't have to consider AOOs coincident with single failures. Secondly, in coming to the sort of guidance it looks at the principle, if it can be called a principle, but a principle of constant risk and we'll let Mr. Miranda talk about that.

So the Subcommittee really felt that the first issue was really an important one and we want to really see what the main Committee thinks about it. Okay. I think that will be interesting.

MR. MIRANDA: Thank you. My name is Sam Miranda. I'm a technical reviewer in NRR, Reactors Systems branch, and this work is the result of the work of other reviewers as well as myself in Reactors Systems branch, namely George Thomas and Gene Hsii and

Lambrose Lois and Summer Sun.

Chapter 15.0 is the Introduction to the Chapter 15 SRP sections which deal with the various events of Chapter 15 and we're going to talk about the AOOs, the Anticipated Operational Occurrences and this first bullet here is the definition taken from the GDCs from Appendix A of 10 CFR Part 50. We see that AOOs are "conditions of normal operation which are expected to occur one or more times during the plant lifetime." And that is the definition we want to apply in the SRPs. I'll talk a little bit more about this later.

MEMBER APOSTOLAKIS: These -- You have to have at least other things, don't you?

MEMBER BANERJEE: They have.

MR. MIRANDA: We have some examples.

MEMBER APOSTOLAKIS: This is just a guidance how they define it. Yes?

MEMBER BANERJEE: Yes.

MR. MIRANDA: We want to include also in the introduction Chapter 15.0, the Acceptance Criteria for the AOOs. If we're going to define accidents in various categories, we want to put in the acceptance criteria that correspond to those categories.

And another item from the GDCs, in fact

several GDCs, an AOO is required not to cause fuel damage. The way they state it is "an AOO shall not cause acceptable fuel design limits to be exceeded" and the way we interpret that requirement is that if acceptable fuel design limits are exceeded as indicated by D&B ratio, then that fuel is judged to have failed.

So we want to apply the GDC definitions of AOO and postulated --

VICE-CHAIRMAN WALLIS: As we discussed, all this under the review plan is full of "shalls," "shall not exceed." It doesn't say anything about 95 percent probability. Are you going to address that somewhere? All these are absolute prohibitions. "Thou shalt not exceed" something. It doesn't say anything about probability of exceeding it. Are you going to address that today?

MR. MIRANDA: I can tell you that in the subsequent chapters of SRP that they go into more detail as to what --

VICE-CHAIRMAN WALLIS: What "shall not" means.

MR. WERMIEL: Sam, let me give it a try. Dr. Wallis, this is Jared Wermiel. I'm the Deputy Director of the Division of Safety Systems in NRR.

When we use the word "shall" in the standard review plan, we are taking criteria that would come directly from a requirement and that implies to us either a GDC or something in the regulations. When we use the word "should" we are establishing the staff's criteria as applied to that particular aspect, but it's not directly drawn from a requirement of a regulation or a general design criteria.

VICE-CHAIRMAN WALLIS: That's not my question though. When you say "shall not exceed," that implies it shall never exceed and I understand that the staff allows LOCA analyses to use to the so-called 95/95 method.

MR. WERMIEL: There are specific criteria in 10 CFR 50.46 that talk about use of realistic analysis for design basis LOCAs.

VICE-CHAIRMAN WALLIS: With very high probability.

MR. WERMIEL: And we defined "high probability" as 95/95 confidence.

VICE-CHAIRMAN WALLIS: All right. But this SRP says "shall not."

MEMBER BONACA: (Inaudible.)

VICE-CHAIRMAN WALLIS: All the "shall nots" appear throughout this whole SRP.

MR. WERMIEL: I guess without some context for the use of the word "shall." Sam is talking about AOOs, anticipated operational occurrences.

VICE-CHAIRMAN WALLIS: "Shall" appears all of this place.

MR. WERMIEL: I hope we're using "shall" as I said in the context of a requirement drawn from the regulations.

VICE-CHAIRMAN WALLIS: I don't think that's the case on page seven but we'll get to that if we get to that. That was one of the questions we raised at the Subcommittee. I don't see it on the slides. That's why --

MEMBER BONACA: Yes, because here the criterion would be D&B. So the question is how you apply the criterion D&B and looking at 95/95. Where is it written? That's the question. Is it written in following sections? This is the introduction.

MR. MIRANDA: Yes, this is just the introduction and the following sections address all of that and they indicate, for example, that "fuel has considered to have failed if it doesn't meet the 95/95 D&B arm limit." In fact, 95/95 D&B arm limit has to correspond to acceptable fuel evaluation model which has been reviewed.

VICE-CHAIRMAN WALLIS: That does not imply that you can predict with 100 percent certainty whether or not these limits will be exceeded.

MEMBER BONACA: No.

MR. MIRANDA: This is a requirement.

VICE-CHAIRMAN WALLIS: It implies that you can enforce it.

MEMBER BONACA: But it defines later on in a different section what it means.

VICE-CHAIRMAN WALLIS: Okay. We'll get to that later on.

MR. MIRANDA: What you see so far, the bottom bullet here, is taken straight from the GDC. This is the language they use.

MEMBER BANERJEE: It's a question of how you interpret that language, I guess.

VICE-CHAIRMAN WALLIS: It's a bit like the Bible. "Thou shalt not do various things."

MEMBER APOSTOLAKIS: The GDCs were written an long time ago.

VICE-CHAIRMAN WALLIS: I know, but they have to be interpreted sometime.

MEMBER APOSTOLAKIS: Before rationalism.

(Off the record discussion.)

MR. MIRANDA: And finally, we're going to take this opportunity with this revision to simplify and clarify some of the items in the SRPs, especially the acceptance criteria.

This is a summary of how we got here.

MEMBER BONACA: So you divide the AOOs into two groups, water frequency and frequency.

MEMBER BANERJEE: But there is no distinction made between those if they are combined.

MEMBER BONACA: They are, of course, in the same. This is why I'm pointing it out because for PWRs, you don't do that. The infrequent events you're allowed to have some fuel damage.

MR. MIRANDA: That's right and that is not the requirements. That came from ANS standard that was written in 1973 and it was withdrawn in 1998. And the SRPs had not recognized infrequent events. About the closest we came to that was in Reg Guide 1.70. So what we're doing in this revision is we're returning to the regulations to the original definitions.

MEMBER APOSTOLAKIS: Of what used to be moderate frequency and flow frequency now is AOOs.

MR. MIRANDA: That's right.

MEMBER ABDEL-KHALIK: So what would be the current requirements for steam generator tube ruptures? They started out as Condition 4. They changed to Condition 3. And if you say you don't recognize the ANS classification, what is the current acceptance criteria for steam generator tube ruptures with regard to fuel damage?

MR. MIRANDA: With regard to fuel damage for tube ruptures since it's considered to be a Condition 3 event which was what used to be a Condition 3 event, it would now be considered an AOO and there would be no fuel damage permitted.

MEMBER BANERJEE: That's how I understood it.

MEMBER ABDEL-KHALIK: And that is the current requirement?

MR. MIRANDA: Yes.

MEMBER BANERJEE: Does this just put into the SRP what is current practice already?

MR. MIRANDA: Yes. As a matter of fact, it does because if you look at the SRP currently, the 1996 version, you will find nowhere in there any reference to Condition 2, 3, or 4 events or infrequent events. Events in the SRP from `96 are either incidence of moderate frequency or limiting faults.

So we're just formalizing what we already have. It's not really a change and it's not a relaxation by any means.

MEMBER APOSTOLAKIS: What is this?

MEMBER CORRADINI: That's the crazy font.

MR. MIRANDA: What? This?

MEMBER APOSTOLAKIS: Yes. This slide.

MEMBER CORRADINI: This is an eye chart test.

VICE-CHAIRMAN WALLIS: Very strange font.

MEMBER CORRADINI: It's a crazy font.

MR. MIRANDA: You should be able to read it in your handouts. But it doesn't matter. I'll go through this and I'll tell you why it's up here and how to get where I go from here.

(Off the record comments.)

MR. MIRANDA: First of all, we begin in 1971 with the GDCs and there are a number of GDCs like this. I have picked Criterion 10 and this GDC reads, "The reactor core and associated coolant control and protection systems shall be designed with appropriate margin to assure that specified acceptable fuel design limits are not exceeded during any condition of normal operation including the effects of anticipated operational occurrences." So the bottom line there is an AOO cannot, shall not, may not, actually shall not exceed specified acceptable fuel design limits during any condition of normal operation which is part of the definition of an AOO.

In Reg Guide 1.70, 1972, it was issued and that recognized incidence of moderate frequency, but did not provide acceptance criteria. The acceptance criteria come along in 1973 with the ANS standard for PWRs which is issued on August 6th and there -- now this language comes from this standard, it says, "A single Condition 2 incident shall not cause consequential loss of function of any barrier to the escape of radioactive products." So a Condition 2 incident as defined in that standard is a condition of moderate frequency, is a condition that may occur during a calendar year of operation. So it's a subset of AOOs.

In 1975, the first addition of the SRP was issued and in there we have a problematic requirement, actually it's a criterion, a problematic criterion which we wish to address with this revision and this criterion says, "An incident of moderate frequency in combination with any single active component failure or single operator error shall be considered and is an event for which an estimate of the number of potential fuel failures shall be provided for radiological dose calculations." Then the ellipsis there refers to Section 4.2 which deals with fuel evaluation models.

MEMBER ABDEL-KHALIK: Why is this problematic?

MR. MIRANDA: Because we want to remove it. We want to take this out. We discussed this in the Subcommittee meeting.

MEMBER ABDEL-KHALIK: Yes, I understand. But I think I'd like to understand the logic of why it is problematic and why would you want to remove it and whether or not removing it actually reduces margin.

MR. MIRANDA: Okay. That's coming up in the next few slides.

MEMBER ABDEL-KHALIK: Okay.

MR. MIRANDA: And there the conclusion is "There shall be no loss of function of any fission product barrier other than the fuel cladding."

VICE-CHAIRMAN WALLIS: That's different from -- Seventy-three says that loss of function of any barrier and then 75, if there's a single failure it allows you to have fuel damage.

MR. MIRANDA: Seventy-five allows --

MEMBER BANERJEE: Only the cladding.

VICE-CHAIRMAN WALLIS: Fuel cladding damage.

MR. MIRANDA: It allows you to have fuel cladding damage but it allows you to have that if you have the combination of an AOO and single failure.

VICE-CHAIRMAN WALLIS: All right. The combination.

MEMBER BANERJEE: And it also says "limited number of fuel clad..."

MR. MIRANDA: That's right. That's also a problem.

MEMBER CORRADINI: Maybe this was covered in Subcommittee, but just to clarify. So the 75 language is not a Condition 2 AOO. What is it?

MR. MIRANDA: We believe that that's a postulated accident and that's going to come up in the next couple of slides.

MEMBER CORRADINI: So it's not a Condition 3 AOO?

MR. MIRANDA: Condition 3 doesn't exist. It's an AOO.

MEMBER BANERJEE: On the ANS.

MR. MIRANDA: It's either an AOO or a postulated accident.

MEMBER BANERJEE: This has nothing to do with the ANS.

MEMBER CORRADINI: I understand.

MEMBER CORRADINI: But if you go back to Slide 4.

MEMBER CORRADINI: I just wanted to understand --

MEMBER BONACA: The sub-category there, I mean, in past experience if you had an accident Category II you never accepted fuel damage even with a single failure.

MR. MIRANDA: Define single failure.

MEMBER BONACA: I'm sorry.

MR. MIRANDA: We need to define what single failure is.

MEMBER BONACA: Single failure of the component.

MR. MIRANDA: Excuse me?

MEMBER BONACA: Single failure of the component. It was single failure, right, when you do the analysis?

MR. MIRANDA: There are two definitions of single failure and that's coming up in another slide.

MEMBER BONACA: I'm just trying to understand. I thought there was a differentiation between Category II and Category III. But in Category III you would allow some fuel damage if you have a single failure also assumed. There were single failure. Category II you would not.

MR. MIRANDA: Okay. Single failure as is

most commonly defined and it's also in the GDC definition section, A single act of failure is defined as "a failure of a component in a protection system that's required to mitigate an event." And it's a design requirement actually. The protection system is required to perform its intended function despite its worst single act of failure.

MEMBER BONACA: So you four channels. You never worry about that. That would be -- You never assume failure. Unless you go to an ATWS, you never assume the failure of the RPS.

MR. MIRANDA: You do assume failures. For example, if you have a fluid system like an ECCS, for example, and you have an accident, a LOCA or a steam break, your worst single failure would be one train of ECCS. So when you do your analysis, you take the degraded performance of the ECCS. Now you're just using one train and you show that even with the degraded performance you achieve acceptable results and that's the way single failure is normally defined. It's part of the design criteria for the protection systems.

A single failure can also be an initiating event. It could be something like you're operating at full power. Everything is fine and then all of a sudden, a turbine stop valve closes. So now you have a loss of load accident and the single failure is your valve.

MEMBER BONACA: But it's the accident. It's not the --

MEMBER CORRADINI: The AOO.

MEMBER BONACA: It's not a single accident failure.

MEMBER BANERJEE: But I guess what the bone of contention here is is this combination of that with something like a stuck open relief valve or something. Now with the current way the staff was interpreting it, you would be allowed some limited number of fuel cladding failures as long as no other barrier failed and you're trying to remove that requirement now because in part it's ambiguous. I mean, what do you mean by "limited number"?

So there was a lot of discussion on this issue. Maybe we should just let him continue because I'm sure that the Committee will have discussion on this issue as well. We never reached any sort of agreement within the Subcommittee.

VICE-CHAIRMAN WALLIS: I'm not sure the Subcommittee fully understood this at the time. So it may take awhile.

MEMBER BANERJEE: Yes, it may take awhile.

MR. MIRANDA: I've done a little bit more thought on this since last week and I have taken your advice, Dr. Wallis, to show that this is a redundant requirement.

VICE-CHAIRMAN WALLIS: Okay.

MEMBER BONACA: I know for one -- I'm saying the confusion I have is from past experience when you look at Category III for PWRs that included steam line breaks. If you have a steam line break, you're allowing some damage, some fuel damage, even assuming worst single failure and accidents in the Category II typically are really pretty frequent events and you don't want to have any fuel damage. You want to be able to restart the plant even if you have a single failure and that's the way it's always been interpreted at least for PWRs.

MR. WERMIEL: You're absolutely right.

MEMBER CORRADINI: Can you repeat that, Mario? I thought I caught it. Can you just repeat it again? I'm sorry.

MEMBER BONACA: What I was saying is that under AOOs you have two categories. They were coming from the ANSI standards and there was one incident of moderate frequency. Now those are pretty frequent events and like load reject, you may have loss. So you want to be able to restart the plant without any fuel damage even if you have a single failure of a component.

Okay. Now for infrequence events, that was a category that included steam line breaks which is a much more rare events. It still is considered frequent enough that it may happen in the life of the plant because you may have a stuck open valve that causes the same kind of event or a similar event for that one. However, less frequent, you were allowed to have some fuel damage again assuming a single failure. So there was a different treatment that we've seen between ANS Category II and the ANS Category III.

MR. MIRANDA: Okay. We're still having a problem with the definition of single failure. I would say that any time you actuate a protection system you have to assume in the analysis the performance of that system in the presence of a single failure.

MEMBER BONACA: "The worst single failure" it says. The regulation has always said "the worst single failure" --

MEMBER APOSTOLAKIS: And independent of the initiator, right?

MEMBER BONACA: I'm sorry.

MEMBER APOSTOLAKIS: Single failure has to be independent of the initiator. The initiator itself cannot count as a --

MEMBER BONACA: And you were supposed to realize the worst single failure.

MEMBER APOSTOLAKIS: That's my understanding.

MR. WERMIEL: We don't disagree with that. That's absolutely correct. For AOOs and for accidents, we always assume the worst single failure concurrent with the event.

MEMBER BONACA: And that's why you did the sensitivity analysis and that gave you an understanding of the systemics.

MR. WERMIEL: Correct.

MEMBER BONACA: What was the worst thing that you had to do and you could --

MR. WERMIEL: But what Sam is trying to get to though is language in the standard review plan that we're trying to remove that seems to be ambiguous in that it seems to imply that for events that we would classify as AOOs where fuel damage is not permitted it would seem to allow that and that language we believe is inappropriate because the situation that you speak of, Dr. Bonaca, where we have a steam line break and fuel damage is permitted is classified as an accident.

VICE-CHAIRMAN WALLIS: Accident.

MR. WERMIEL: It's not an AOO.

MEMBER BONACA: That's right.

MR. WERMIEL: So we have a criterion for limited fuel damage within specified acceptance criteria.

MEMBER BONACA: If you have an accident, would you put it then in Category IV, Limiting Faults?

MR. WERMIEL: We would, yes, but we only have two categories. We only have AOOs and we have accidents or limiting faults.

MEMBER BONACA: The reason why I'm asking this question too is that we just reviewed this technology neutral --

MR. WERMIEL: Framework, yes.

MEMBER BONACA: -- framework that they're using the traditional ANS criteria of the incidence of moderate frequency, AOOs, than infrequent events and they don't call them AOOs and then they use limiting fault.

MR. WERMIEL: Unfortunately, we are dealing with a standard review plan that was intended for application by reviewers to the operating fleet and we had to cover as best we could with the language that we had the situation that was used when those plants were designed and built.

With the new reactors, we understand that there will be this new framework and that there may be some deviation. Remember. You are allowed to deviate from the criteria of the standard review plan. For example, I think when you talk about the ESBWR or you meet with the ACRS for that standard design you will find three categories of events. You will find infrequent events. You will find a middle category and you will find accidents.

So they have implemented this criteria differently and since you're writing a rule applicable to that design, there is no problem with that provided the staff can agree that the categorization makes sense and fits into the criteria that it would believe to be appropriate. But the current fleet was really designed with the two categories in mind.

MEMBER BANERJEE: I guess the argument put forward to the Subcommittee was that there was a basis in the regulations for these two categories. But there wasn't a basis in the regulations for the intermediate category. That's how I understood it.

MR. WERMIEL: And that's correct. There isn't that I'm aware of anywhere in the GDC where you don't have either permission for exceedance of a fuel design limit or non-permission. It's only one or the other in the way the GDC is currently worded and that's how the categorization was basically developed for the current operating plants.

VICE-CHAIRMAN WALLIS: The categorization in the SRP seems to be based on frequency.

MR. WERMIEL: That's the primary input.

VICE-CHAIRMAN WALLIS: Is the decision greater or less than 10^{-2} or something? Or what is the borderline?

MR. WERMIEL: You can calculate it based on the -- It talks about that's the intent for the life of the plant.

VICE-CHAIRMAN WALLIS: When the plant is relicensed two and three times. I mean, what is the life of the plant?

MR. WERMIEL: These days it's 60 years for those that have received a renewed license.

VICE-CHAIRMAN WALLIS: And this makes a difference. This is how you decide whether it's one or the other.

MR. WERMIEL: I think we decided

primarily on the categorization that's in the standard review plan and that's based on operating experience.

VICE-CHAIRMAN WALLIS: Ah. So it's a vague sort of thing. It could change from one to the other as experience develops.

MR. MIRANDA: We have an example of that with the tube rupture.

VICE-CHAIRMAN WALLIS: Yes. Sure.

MEMBER ABDEL-KHALIK: At the end of the day, though, if your recommended change were to go through, would the licensee still be required to perform analyses for incidents of moderate frequency in combination with any single act of failure?

MR. MIRANDA: We wanted to delete that. We want to --

MEMBER ABDEL-KHALIK: I'm hearing two different things.

MR. WERMIEL: The answer is yes. Absolutely, they would. For any event, an AOO or an accident, you always assume a single act of failure in a mitigating system and it's the worst single act of failure in the mitigating capability. We always assume that.

MEMBER BONACA: That was the foundation to understand the systemic. In absence of PRA or whatever, you were doing this analysis to understand the sensitivity to different components.

MEMBER ABDEL-KHALIK: I think it's important for the record to reflect that the answer that we just heard because that's inconsistent with the indications that we heard in the earlier presentation.

MR. MIRANDA: No, it isn't and if we can go on, I'll show you why.

MEMBER BONACA: Let's go on.

MEMBER BANERJEE: Let's proceed, yes.

MR. MIRANDA: Okay. This is the statement that we want to remove from the SRPs and here we see "an incident of moderate frequency in combination with any single act of component failure or single operator error." So first of all, we have to deal with the definition of "incident of moderate frequency" and that is a Condition II event and with this revision, it could also include Condition III events.

And "in combination with any single act of component failure," single act of component failure generally means a failure in a protection system. But the way it's used here it means another initiating event, another AOO, another Condition II or III event because it's equated, for example, with a single operator error which is another AOO. So what they're doing here is they're combining AOOs. They are taking two events at the time, two independent failures.

MEMBER BANERJEE: But what about the stuck open safety or relief valve which is, I guess, the one that's -- one of the things that are of concern here?

MR. MIRANDA: The way I've seen that used and I think you're referring to Three Mile Island that's --

MEMBER BANERJEE: That's a more complex chain. I'm not.

MR. MIRANDA: But the key there is it is a chain. The stuck open relief valve is a consequential failure. It results from another failure.

MR. WERMIEL: Sam, let me try. Let's take Three Mile Island for example. The initiating event was a loss of feedwater. That's an AOO. That event should have led to no fuel damage because our criteria assuming a single act of failure in the mitigating system would not have permitted it. What happened during the event? The PORV stuck open. Now you have an event that started as an AOO becoming an accident.

VICE-CHAIRMAN WALLIS: So it's not an acted failure. It's just another event.

MR. WERMIEL: What Sam is trying to say is if you believe that is an act of failure then you should have not allowed fuel damage to occur and what we're saying is no. We want to clarify the language that we wouldn't take a consequential failure or -- I'm using the wrong word. A second independent occurrence that could actually be called an event concurrent with the initial AOO because then you would be allowed fuel damage and it wouldn't fit into the AOO category. That's an accident.

VICE-CHAIRMAN WALLIS: What's the difference between occurrence or a second event and a single failure?

MR. WERMIEL: The single failure criterion in the GDC talks about mitigating systems.

VICE-CHAIRMAN WALLIS: But the problem is the mitigating system. It releases pressure and it closed. So it failed, didn't it?

MR. WERMIEL: Yes.

VICE-CHAIRMAN WALLIS: A failure of a mitigating system.

MR. WERMIEL: All we're trying to say is such an event should not be considered an AOO. You would categorize it as an accident and apply different criteria.

VICE-CHAIRMAN WALLIS: If you have an AOO, you supposed to consider failure of a mitigating system.

MR. WERMIEL: Correct.

VICE-CHAIRMAN WALLIS: So I don't understand the logic actually.

MR. WERMIEL: The PORV isn't part of the mitigation for a feedwater transient.

MEMBER ABDEL-KHALIK: But that comes in because the current SRP says "in combination with any single act of component failure."

VICE-CHAIRMAN WALLIS: "Any single."

MEMBER ABDEL-KHALIK: Which means the licensee has to do a series of sensitivity calculations to identify.

MR. WERMIEL: Don't misunderstand me. The licensee has analyzed for any such, all these, events that we're talking about. If I had an feedwater transient and the PORV stuck open, the capability for the plant to cope with that given a single act of failure on top on it is still there. But what Sam is trying to say is the criteria for AOOs doesn't apply to that kind of an event. The criteria for accidents does and that means limited fuel damage. That's all we're trying to say.

MEMBER APOSTOLAKIS: What you're saying is that as they do the sensitivity analysis they find that they cannot cope with this. So that's not AOO anymore. It has to be moved to another category.

MEMBER BONACA: Limiting faults. I'm trying to understand. You're talking about accidents, but yet all you put out there was two categories.

MEMBER APOSTOLAKIS: He's moving to the --

MR. WERMIEL: It would move into the other category. Such a situation where you have a feedwater transient and a stuck open power operated relief valve moves it into the other category. That's correct. That's the staff's interpretation. It always has been.

MEMBER BANERJEE: But now you also have a requirement that an AOO should not escalate into the other category.

MR. WERMIEL: That's correct.

MEMBER BANERJEE: I'm just trying to grapple with this complexity in terms of what happens if the AOO leads to something which moves it into the other category.

MR. WERMIEL: Sam has an example that he and I have talked about in the past. What we do is we ask the licensee when we find such a situation to deal with it, to find a way to preclude that occurrence from happening. In other words, if you have to fix the size of the aux feed system to prevent a particular another event from happening on top of the initial AOO, in other words, make it bigger, add more flow, something like that, then maybe that's what they need to do.

VICE-CHAIRMAN WALLIS: Let me ask you. If TMI PORV had not stuck open, was it an AOO or was it an accident?

MR. WERMIEL: It was an AOO. It was a simple feed --

VICE-CHAIRMAN WALLIS: Two things happened. They had loss of feedwater and then the aux feedwater didn't work.

MEMBER BONACA: That wasn't even assumed anyway.

VICE-CHAIRMAN WALLIS: That was assumed as a failure.

MEMBER BONACA: Because PORV was never --

VICE-CHAIRMAN WALLIS: So the aux feed failure would be one of these single failures in an AOO case?

MR. WERMIEL: No. The auxiliary feedwater system is designed and intended to be available --

VICE-CHAIRMAN WALLIS: It was not available at TMI.

MR. WERMIEL: Then it was not.

MR. MIRANDA: It was not available due to an operator error.

MR. WERMIEL: And there were reasons for that.

MEMBER APOSTOLAKIS: What did you say, Mario, just now?

VICE-CHAIRMAN WALLIS: I don't understand at all.

MEMBER APOSTOLAKIS: Did you say it was not analyzed?

MEMBER BONACA: The PORV was not analyzed because it was not considered a component.

MEMBER APOSTOLAKIS: An active component.

MEMBER BONACA: And so therefore it was never analyzed because it was not a mitigating system of any --

MR. WERMIEL: Dr. Bonaca, that's not entirely true. TMI had an analysis for a small break loss of coolant accident which is what you have with a stuck open PORV.

MEMBER APOSTOLAKIS: An initiator.

MR. WERMIEL: Yes, indeed.

MEMBER BONACA: -- as an consideration failure.

MR. WERMIEL: As an accident, yes.

MEMBER CORRADINI: I guess I'm -- Somehow this is, unless I misunderstood, a classification issue.

MR. WERMIEL: That's all it is.

MEMBER CORRADINI: But Said asked an important question that I want to re-ask because I thought he asked regardless where you stick the IIIs, now the IIIs have become IVs, so the greens are blues and whatever, are you required to do the analysis in all conditions because I don't know how you phrased it but I heard a yes? So it seems to me then nothing has changed from what is required by the licensee to analyze what I call operational transients, AOOs, versus what one will now classify as only accident.

MR. WERMIEL: Nothing has changed with regard to the assumptions that are made in either case and that assumption includes the limiting act of failure in the mitigating system.

MEMBER BANERJEE: If we let Sam speak, he's going to show us that the current criterion that is redundant, right?

MR. MIRANDA: That's right and all we're

saying here is that what we want to eliminate, what we want to take out of the SRPs, is this notion of looking at AOOs two at a time and AOO is analyzed and it's shown that it does not violate acceptable fuel design limits. Taking two AOOs at one time according to the SRP will permit some level of fuel damage.

MEMBER BONACA: The language however is confusing because AOOs has always been consider the initiator.

MR. MIRANDA: That's right.

MEMBER BONACA: "Failure to assume" means any possible single failure that the system --

MEMBER APOSTOLAKIS: In addition.

MR. MIRANDA: That's right.

MEMBER BONACA: Because you have a number of systems coming, mitigating systems, and you are assuming the failure of one or the other. There are others. When you talk about AOOs, it implies you're assuming two independent.

MR. MIRANDA: That's correct.

MR. WERMIEL: That's what we want.

MR. MIRANDA: That's right. And that's what we want to address here.

MEMBER APOSTOLAKIS: But coming back to your point earlier, you said that the valve of the pressurizer was not considered as a failure because it is not part of a mitigating system.

MEMBER BONACA: The interesting thing was this, that when you were realizing another pressure transient it was always felt that the PORV was a relief function of some type. It gave you some relief because it opened up and kept your pressure below the limit. Therefore, it was no model because it wasn't viewed as -- It was simply a model. The only place it was modeled was for a small break LOCA as an initiator.

MR. MIRANDA: Yes.

MEMBER BONACA: And that was a fundamental flaw in the approach that wasn't in the accident analysis that if something was viewed to be something that helps you and in this particular case it was helping you maintain pressure below the big pressure limit, then you would not model it and it gave you a mind set that said that you never consider it as a single failure, for example, if you lose the loss of feedwater.

MEMBER APOSTOLAKIS: But according to this, it should have been considered because any single act of failure.

MEMBER BANERJEE: But this is what they

want to remove, right?

MEMBER APOSTOLAKIS: Right. But at that time it was enforced.

MEMBER BANERJEE: It was enforced.

MR. MIRANDA: Okay.

VICE-CHAIRMAN WALLIS: You're going to show us it's redundant.

MEMBER BANERJEE: Which is why we spent hours talking about this as you can imagine.

MR. MIRANDA: Okay. Single failure.

CHAIRMAN SHACK: You have to 12:00 noon today.

MEMBER BANERJEE: I know.

MR. MIRANDA: The issue is the definition of what a single failure is.

MEMBER BANERJEE: Once you have it, I think that's it.

MEMBER CORRADINI: We won't.

MEMBER APOSTOLAKIS: Let the guy move on.

MR. MIRANDA: The single failure, the traditional definition, is what we find in the GDC and this is a single failure in a protection system and it's a design requirement. The protection system has to perform its function despite a single failure.

MEMBER BONACA: Can I just simply

interject again? Your language, I mean you're talking protection system. There is only system that could be called a protection system, reactor protection system. You're referring to ECCS. You're referring to ATWS system. They are mitigating systems.

MR. MIRANDA: Protection system with a small "p." Yes.

MEMBER BONACA: That's what confusing me.

MEMBER APOSTOLAKIS: Call them safety functions.

VICE-CHAIRMAN WALLIS: I don't understand the term -- A relief valve is a protection system against over pressure.

(Several speaking at once.)

MR. MIRANDA: That's right. If it's safety qualified, yes.

MEMBER BONACA: All I'm trying to say is that there is a language that has been established for 40 years --

VICE-CHAIRMAN WALLIS: I'm just going to throw up hands and say you guys must know what you're doing.

MR. MIRANDA: This slide indicates that there are two ways you can look at a single failure and since the previous slide doesn't tell you what a single failure, it's a single act of failure, any single act of failure. Normally, you would expect to interpret that as the single failure in a protection system. But the way it's used in that paragraph indicates to us that it's an equivalent of an AOO. It's an initiating event. A single operator error is also an initiating event.

VICE-CHAIRMAN WALLIS: It's something beyond your original intent when you define "single failure."

MR. MIRANDA: It's also a single failure in terms of an AOO.

MEMBER APOSTOLAKIS: But my understanding was a single failure was not an initiating event.

MEMBER KRESS: That's correct.

MEMBER APOSTOLAKIS: A single failure criterion, it is not an initiating event. It's a postulated addition of failure that you have to postulate and demonstrate a few things.

MEMBER KRESS: Yes.

MEMBER APOSTOLAKIS: So this is a new interpretation to me.

MR. MIRANDA: It's not new, if you look at Chapter 15.

MEMBER APOSTOLAKIS: The way it was

interpreted?

MEMBER MAYNARD: We're mixing a lot of different languages here.

MEMBER CORRADINI: Right.

MEMBER MAYNARD: It is confusing. I'm following it but it is very difficult because we are mixing like Mario said on reactor on the protection systems and single failures. We're kind of jumping in several different areas.

MEMBER BONACA: But the question is when we say "single failure" do we ever mean a failure that actually initiates an AOO? In my mind no.

(Chorus of no's.)

MR. MIRANDA: No, except in this paragraph .

MR. WERMIEL: Yes, I agree. We didn't mean that. However, our understanding is that people have interpreted this language that we want to remove differently than what you just said, Dr. Apostolakis.

MEMBER APOSTOLAKIS: Right. But it seems to me --

MR. WERMIEL: This has been the traditional interpretation because this comes right out of the GDC.

MEMBER APOSTOLAKIS: Right. So the second bullet is their unusual interpretation.

MR. WERMIEL: It's not that unusual. It's unusual and it's not right.

MR. MIRANDA: If you look at Chapter 15, take any accident that's described in Chapter 15, the first or second paragraph usually says something like "The following is an analysis of the loss of load event and loss of load event can be caused by..." and it's operator error, closing of the turbine stop valve, tripping of the condenser and so on. They have various causes for that event. These are the initiating events and only these are single failures. It's a single failure of a component, usually a control system component or a valve.

MEMBER APOSTOLAKIS: Yes, it is a single failure but it's not "the" single failure the regulations are referring to. That's the point.

MEMBER ABDEL-KHALIK: Let me give you an example.

MEMBER BONACA: But the single failure is you have loss of feedwater or you have --

MEMBER ABDEL-KHALIK: Let me give you an example. You have loss of feedwater. That's an anticipated event. If everything works out okay, the plant will shut down. No damage. Okay. You have loss of feedwater and you have one of the aux feedwater pumps fail. That's an assumed single failure. Correct.

(Off the record comments.)

MEMBER APOSTOLAKIS: Correct.

MEMBER ABDEL-KHALIK: That is not an initiating event. That's the assumed single failure.

MR. MIRANDA: And that would be in the analysis.

MEMBER ABDEL-KHALIK: In that particular case given the redundancy in the aux feedwater system, again the plant will demonstrate that there is no fuel failure.

MR. MIRANDA: Right. Exactly right.

MEMBER ABDEL-KHALIK: But the licensee is required to assume many other single failures and identify the worst single failure that can possibly happen in combination with a loss of feedwater and for that particular combination that licensee is required to show that only limited fuel damage occurs.

MEMBER APOSTOLAKIS: Right.

MEMBER ABDEL-KHALIK: Now you want to remove that requirement and in my mind, that is a loss of margin.

MR. MIRANDA: I can give another example.

MR. WERMIEL: It isn't the loss of margin at least not in my mind because those other failures that you speak of have been analyzed in other events or under other categories. It's been accounted -- And that's where Sam gets into this idea of the redundant criteria. It has already been accounted for in the analysis of other events or other accidents.

MEMBER ABDEL-KHALIK: If one would start with a clean sheet of paper, there is no way for a licensee to identify those events that you're talking about according to your classification.

MR. WERMIEL: There is because we have the standard review plan which talks about those events and those accidents that we believe form the basis upon which the plant should be designed.

MEMBER BONACA: Let me expand on what Said said. Okay? So you assume the loss of -- You assume they have loss of feedwater and then you assume that one of their trains of feedwater doesn't work. That's why you have redundant systems. If you had, for example, a design just as an example where you have a common header by any reason and you will have these two trains possibly isolated, you would have to assume the failure of both trains because they would be controlled by a single valve.

(Off the record discussion simultaneously.)

MEMBER BONACA: That's what you would have to do. So you would find that your design is so poor that somehow you had a valve out there in the header and that valve can close and deny all those -- and you would have to assume -- So again, it doesn't matter if you analyze that kind of condition in a different event for the loss of feedwater that is the limiting condition that you have to assume.

MR. MIRANDA: I don't want to change any of that. No.

MEMBER CORRADINI: Can I just get a clarification because Said asked a very particular question and I want to make sure I understood the answer. His point is that what you're going to remove is you're going to remove the licensee to do this sort of analysis and your answer is back is true, but the licensee would have done that analysis for another reason anyway.

MR. MIRANDA: Yes.

MEMBER BANERJEE: Where would he have done it?

MR. WERMIEL: I'll go back to my example. I had loss of feedwater transient and the power operated relief valve on the primary side sticks open. He would have analyzed the sticking open of the primary relief valve as part of the analysis for small break loss of coolant accident and he would show mitigation capability for that event given a single act of failure. But he wouldn't combine that event with the feedwater transient at the same time.

MEMBER BONACA: That's an initiator, but at TMI what you had you had an accident and all ended up in a LOCA.

MR. WERMIEL: Correct, and the LOCA has been analyzed.

MEMBER BANERJEE: But you are looking at different sequences here, right?

MR. WERMIEL: The problem that I have with this entire discussion is I wouldn't know how to decide what combination of events and things like that I want to combine.

MEMBER ABDEL-KHALIK: But that's the job of the licensee.

VICE-CHAIRMAN WALLIS: The whole problem. That's the whole problem.

MEMBER ABDEL-KHALIK: Because the regulation says any single failure. So the licensee has to do sensitivity analyses, look at all the single failures and then come up with the worst single failure and that's the one for which they should show these criteria for that.

MR. WERMIEL: In the Appendix A, the single failure criterion is defined in the definitions and it talks about a single failure in the mitigation systems. It doesn't talk about an unrelated single failure concurrent with an event.

MR. MIRANDA: I would like to give you two examples to illustrate the difference between what we're talking about.

MR. WERMIEL: It's clear.

MR. MIRANDA: First of all, the traditional definition of single failure, look for example at a steam line break. A steam line break requires the operation of several protection systems. You need a reactor trip, for example. The reactor trip, there's a single failure in the reactor trip that assumed the reactor trip nevertheless occurs because it's designed to work that way.

We have a single failure in the safety injection system. Say we lose one train of the safety injection system. We have safety injection nevertheless at a lower rate perhaps. Nevertheless we have it because it's designed that way. So here you have an accident with two single failures assumed in two different protection systems and that's the way it's analyzed.

What we're trying to eliminate here in this SRP revision is the requirement to consider a completely unrelated failure. For example, I've just seen recently a submittal by a licensee operating a combustion engineering plant where they take two events they have following this provision, following this SRP criteria and what they did there was they looked at a loss of off-site power event and they said the loss of off-site power event will produce a very low D&BR. It's one of the events that will reduce thermal margin considerably.

And then they combine that with a rod withdrawal at power event because that's another event that will reduce thermal margin considerably. The two events are unrelated but they assume that they occur simultaneously. Physically, it's not even possible because --

MEMBER BANERJEE: And what do they come to the conclusion with?

MR. MIRANDA: They concluded that the loss of off-site power combined with a rod withdrawal at power still meets the fuel design limits in this case.

MEMBER BONACA: The example you made, it is just a gross application of that. I mean, I've never seen it before.

MR. MIRANDA: This happens a lot. We see combined AOOs like this a lot usually from combustion engineering plants by the way where they combine AOOs and the AOOs are completely independent, unrelated and in this example I gave you not even physically possible.

MEMBER BANERJEE: But why do they do that? There must be a reason, right?

PARTICIPANT: To get this language.

MR. MIRANDA: That's right.

MEMBER BANERJEE: No, there is a reason -- Are they trying to do something like bump it up a category so they can allow fuel failure? What is the real -- There must be a reason. Nobody is an idiot.

(Laughter.)

MEMBER BANERJEE: Let's assume they're smart guys.

MR. MIRANDA: They expect the NRC staff to be looking for analyses such as this. In this case, they didn't need to bump it up. If they had to, if they had some fuel failures, they would have been able to take some. In this case, they didn't have to. But they submitted this analysis because they figured we expected to see it.

MEMBER BONACA: I still take objection with your language. You gave us the example of steam line break. You talk about protection systems or two protective actions. The first one is the protection system, the RPS. They have a scram. If you take the failure of the scram, you're going to ATWS. It's a different category and you don't want to even look at it.

MR. MIRANDA: But the point is you can't the failure of the scram. To get a failure of a scram, you need a common mode failure to get to ATWS.

MEMBER BONACA: Then you said there is another protection system which is the self-injection system. Initially, it was called the mitigating system and not protection. Protection is the RPS. That's traditional language. I'm only saying I hope that in the SRP you are not changing language which has been established for 40 or 50 years now and everybody has been operating with it, I mean, just because it's confusing.

MR. MIRANDA: Okay. But you get the --

VICE-CHAIRMAN WALLIS: Have you shown this redundance yet?

MR. MIRANDA: No.

VICE-CHAIRMAN WALLIS: That's what you were going to show me.

MR. MIRANDA: No, I'm still getting there.

VICE-CHAIRMAN WALLIS: That's what I'm waiting for.

MEMBER BONACA: All right. Let's go.

VICE-CHAIRMAN WALLIS: If it's redundant, I don't care whatever this argument -- all that's going on here. If it's redundant, throw it out.

MEMBER BONACA: We are trying to clarify.

MEMBER BANERJEE: I think it's hard to prove it's redundant.

VICE-CHAIRMAN WALLIS: It's hard to prove it's redundant.

MEMBER BONACA: If the clarification is obfuscation because you're using a different language, we are not accomplishing the objective of what we have. We're just clarifying, right?

MR. MIRANDA: Yes.

MEMBER BONACA: Okay. Go ahead.

MR. MIRANDA: When I talk about protection systems, I'm talking about any system that's used in response to an event to protect the plant and it could be a reactor trip or it could be ECCS.

MEMBER BONACA: -- the language --

MR. MIRANDA: The first bullet is from the GDCs and we saw this before. Finally, it says "Fuel design limits are not exceeded during any condition of normal operation." That's the GDC. And we know that an AOO is a condition of normal operation. Therefore, we know that the combination of AOOs, two independent, random AOOs is not a condition of normal operation. So we could say "a condition that is not of normal operation may cause fuel design limits to be exceeded." Are we agreed?

So when we say a condition that is not of normal operation that may cause fuel design limits to be exceeded is exactly the same as the requirement, the first bullet. It's the same statement only it's in the contra-positive. We just take the second condition, normal operation. We negate it, put it at the front, "a condition that is not of normal operation" and we negate the first proposition, "fuel design limits are not exceeded." Now they may be exceeded. It's the contra-positive. If A is B, then not B is not A.

MEMBER ABDEL-KHALIK: Let me give you a specific example again. Let's go back to the example I talked about. You have loss of main feed and then following that the single failure is failure of a single aux feed pump. Okay?

MR. MIRANDA: Right.

MEMBER ABDEL-KHALIK: This is an un-event. The plant is designed. You have three aux feed water pumps. The response, there is no damage.

MR. WERMIEL: And that's an AOO.

MEMBER ABDEL-KHALIK: Let's say you remove this requirement and the designer would interpret this as "Okay. I don't need redundancy in aux feed water pumps." He's starting from a white sheet of paper. He has only one aux feed water pump and therefore you lose your main feedwater pump. If you were to lose the aux feedwater pump then this becomes a total loss of feedwater event. Right?

MR. WERMIEL: Yes.

MEMBER ABDEL-KHALIK: Which is analyzed as a Condition III or as an accident, total loss of feedwater, a feed and bleed event.

MR. WERMIEL: No.

MEMBER ABDEL-KHALIK: It is not?

MR. WERMIEL: No.

MEMBER ABDEL-KHALIK: Total loss of feedwater is not analyzed.

MR. WERMIEL: No.

VICE-CHAIRMAN WALLIS: One generator.

MR. WERMIEL: No. There is no provision that I am aware of that credits "feed and bleed" for a loss of feedwater event.

MEMBER ABDEL-KHALIK: If you had only -- My concern -- Let me tell you that the bottom line --

MR. WERMIEL: I hope not anyway.

MEMBER ABDEL-KHALIK: Hold on. The bottom line for my concern is by doing this you're sort of removing one of the incentives for equipment redundancy.

MR. WERMIEL: No, I disagree because Sam was trying to say and I'll say it again there is nothing in what Sam is talking about that negates the requirement of the GDC for redundancy, single failure capability in the mitigation systems. Nothing.

MEMBER APOSTOLAKIS: What is it that we are removing when you say we're removing this?

MR. WERMIEL: It's the language that Sam had up on one of your very first slides, I believe, Sam.

MR. MIRANDA: Actually, it's the bottom bullet right here. "The combination of two AOOs may cause clad damage." That's the piece.

MEMBER BONACA: But you said something

else which was important before that they would be independent, unrelated AOOs. That's a fundamental issue.

MR. WERMIEL: But that's the point. The point that Sam is saying is the interpretation of the language that we would like to remove has been that -- And he gave you the example of the combustion engineering plants that you have these two independent AOOs that are not only unrelated but sometimes can't even physically happen being interpreted as part of the licensing basis for some plants. We want to clarify that.

MEMBER ABDEL-KHALIK: But that's an interpretation which is inconsistent with the language that says "an incident of moderate frequency in combination with any single act of component failure..."

MR. WERMIEL: Okay. I'll go back to Sam's example. If I take that language on the CE plant, I've had this feedwater transient, let's say, and I now have -- Let's think. You gave the example even better. They were totally unrelated events.

MR. MIRANDA: The example I gave which is one I just saw yesterday was a loss of off-site power in combination with a rod withdrawal at power.

MR. WERMIEL: Right. You can't have a rod withdrawal at power and a loss of off-site power because you can't withdraw the rod if you have no power.

MEMBER BANERJEE: But let's say that's the sort of exception, a silly one, but in order to avoid people doing some, let's say, silly analyses, you're removing a criteria which I guess we don't understand all the implications of it. This is what I think what you're encountering. If the implications were very clear and let's say that what you said that most likely this will get analyzed in some other way, then if it is analyzed in some other way the issue that's troubling is does it matter what the sequence is of how that happens because you said that it will be analyzed as a small break LOCA or something.

Now does that mean that if the PORV is open as just as an example due to some AOO being an initiating event, is that equivalent to analyzing it as a small break LOCA with a single failure? Maybe it is. But one has a different sequence from the other and I don't know if that sequence matters.

MR. WERMIEL: Remember what the "criteria for an AOO" includes and that's the frequency of the occurrence of what we're talking about. I indicated to Dr. Wallis that there's some experience base that supports the frequency. A sudden opening of the PORV in and of itself it creates a small break LOCA and I don't think a sudden opening of the PORV is an anticipated operational occurrence. I don't think under the normal life of plant we would expect or anticipate that a power operated relief valve would just suddenly open. That should not happen. So that would not be considered an AOO. That would be classified as an accident.

MEMBER BONACA: As an initiating event.

MEMBER BANERJEE: That's what I was going to say, initiating.

MR. WERMIEL: Initiating events are accidents or AOOs.

MEMBER ABDEL-KHALIK: But an operator action that would render aux feed unavailable is a single failure.

VICE-CHAIRMAN WALLIS: It happened at TMI. It just was that the valves were not closed.

MR. WERMIEL: And we hope that we've dealt with that particular problem through other ways because the criteria, the general design criteria, are specific to the systems designs themselves. The operator is governed by procedures, by technical specifications, by other things and we believe those control his or her actions sufficiently so that those kinds of events are unlikely.

VICE-CHAIRMAN WALLIS: About three hours on this at the Subcommittee meeting. I don't think we've clarified things very much.

MEMBER APOSTOLAKIS: But it seems to me that what they're saying is not that obscure. If you go to slide 9, it says "remove the language which states that combined AOOs may lead to fuel clad damage." And I was told earlier that there is a list of these AOOs somewhere.

MR. MIRANDA: Yes. It's in Chapter 15.0.

MEMBER APOSTOLAKIS: So that's very clear, is it not, that you can't take two of those and say that's an AOO?

MEMBER BANERJEE: But that's not what they're saying. They're saying --

MEMBER APOSTOLAKIS: But that's what they're removing.

MEMBER BANERJEE: No.

MEMBER ABDEL-KHALIK: They are removing more than that.

MEMBER BANERJEE: More than that.

MEMBER APOSTOLAKIS: And what is the

additional language?

MEMBER BANERJEE: It doesn't have to be an AOO.

VICE-CHAIRMAN WALLIS: Slide 6.

MEMBER BANERJEE: Any single failure is being removed.

MEMBER APOSTOLAKIS: But that's not what he said.

MR. MIRANDA: No.

MR. WERMIEL: No. The single failure in the mitigating system is not being removed.

MEMBER APOSTOLAKIS: Yes. That's my understanding.

MR. WERMIEL: It can't be. It's in the general design criteria.

MEMBER APOSTOLAKIS: Right.

MEMBER BONACA: Right.

MEMBER APOSTOLAKIS: So you are still doing the sensitivity analysis that Said mentioned.

MR. WERMIEL: Yes.

MEMBER APOSTOLAKIS: But this specific thing of assuming two AOOs being also anticipated operational occurrence is not allowed.

MR. WERMIEL: That's right.

MEMBER APOSTOLAKIS: It's very simple.

MEMBER ABDEL-KHALIK: Where is that sensitivity analysis identified in the SRP as someone is reviewing?

MEMBER APOSTOLAKIS: It's part of the GDC.

MR. WERMIEL: When you read the criteria associated with any anticipated operational occurrence or any accident, it talks about the criteria under which those events are to be analyzed and Dr. Apostolakis characterized it as a sensitivity analysis. I would characterize it as the assumptions that go into the development of that particular analysis. Included with that are things like loss of off-site power, single failure, a number of things.

MEMBER APOSTOLAKIS: Slide 6 is not removed. Is that correct?

MEMBER ABDEL-KHALIK: Slide 6 is removed.

VICE-CHAIRMAN WALLIS: Is removed. That's what they want to remove.

MEMBER BANERJEE: That's what they want to remove.

MEMBER APOSTOLAKIS: I thought --

(Several speaking at once.)

MEMBER BANERJEE: We wouldn't have been arguing so long if they were not trying to remove that.

VICE-CHAIRMAN WALLIS: They want to remove this.

MEMBER APOSTOLAKIS: That's why I'm confused. I thought in slide 9 they state what is an AOO. That's what they're doing.

MEMBER BANERJEE: They are removing that.

MEMBER APOSTOLAKIS: And they just told us that the GDC requirement of assuming an act of failure is not removed.

MR. WERMIEL: What we're saying, Dr. Apostolakis, is in order to make it clear that we're categorizing events into these two categories, this language we believe confuses that categorization. We want to take it out. Along with the assumption of those two categories is the assumed single act of failure in the mitigation system for those events and that includes AOOs and that includes accidents.

CHAIRMAN SHACK: I can't find in the new guidance statement that says anything about any single act of failure in the mitigation.

VICE-CHAIRMAN WALLIS: That's right. I looked at that.

MR. WERMIEL: If you go to the SRP section that talks about it, I believe you'll find reference to the appropriate GDC.

CHAIRMAN SHACK: That's what I'm trying to look for.

VICE-CHAIRMAN WALLIS: Where is it?

CHAIRMAN SHACK: I can't find it. If you can guide me to it, then that might settle this whole discussion.

MR. WERMIEL: It had better be there.

CHAIRMAN SHACK: But it isn't apparent to me where it is. It has to meet the requirement of the GDC for AOOs and maybe buried in that is the single failure requirement. But I would like to see a specific statement that says consider a single factor in any mitigating system.

MEMBER ABDEL-KHALIK: Right. When you're reviewing look for this.

MEMBER CORRADINI: That makes sense.

MR. WERMIEL: If it's not there, we'll add it in and that's a promise because that's always been the assumption.

MR. MIRANDA: Every STP section has a statement in there that says "The reviewer shall look at the mitigation systems that are accredited in the analysis."

CHAIRMAN SHACK: Can you tell me the page in this particular section?

MR. WERMIEL: Yes, find it.

CHAIRMAN SHACK: That's what I'm looking for.

MR. WERMIEL: If it's not in this section, perhaps it's in the section associated with a particular AOO. Do we have an SRP section for one AOO handy? We don't?

MR. MIRANDA: I don't have --

MR. WERMIEL: I will take that as a look-up. We will make absolutely sure, positively sure, that every accident and every AOO --

(Off the record discussion.)

CHAIRMAN SHACK: Certainly this is an overall section. This seems like the place where it ought to be.

MR. WERMIEL: That language ought to be in there, too. I agree.

CHAIRMAN SHACK: And maybe it is, but I can't find it.

MR. WERMIEL: I have my SRP scribe here and I will make absolutely sure that he goes back and checks 15.0 and every associated section in Chapter 15.0 and there's a bunch of them to assure that the mitigation system single act of failure, worst case single act of failure.

VICE-CHAIRMAN WALLIS: It doesn't seem to be here.

MR. WERMIEL: Worst case because that's what the GDC says is not lost.

MEMBER APOSTOLAKIS: Exactly.

MEMBER ABDEL-KHALIK: If you explicitly include in that SRP, I'm happy.

(Off the record comments.)

MR. WERMIEL: We will do it.

VICE-CHAIRMAN WALLIS: I have a different question here. In this SRP, it talks about Condition III events. I thought they had been abolished.

MR. WERMIEL: Which?

VICE-CHAIRMAN WALLIS: I thought II and III were all combination together.

MR. WERMIEL: I thought we had done that. Did we miss something?

MEMBER APOSTOLAKIS: II and III are.

MR. WERMIEL: Which SRP are you looking at?

MR. MIRANDA: Yes, which one is that?

VICE-CHAIRMAN WALLIS: On page 6, it talks about Condition II and Condition III events and they're quite different.

MR. WERMIEL: Did we miss something?

CHAIRMAN SHACK: Yes. It's reflecting back on what licensees may have in their own categorization.

VICE-CHAIRMAN WALLIS: Acceptance criteria, Conditions II and III.

MR. MIRANDA: We're also saying in this Chapter 15.0 that licensees that have used this categorization in the past, Conditions II, III and IV events, if they wish to continue using it, they may. We're not going to try to back-fit them.

MEMBER BANERJEE: Right. We discussed that. Yes.

(Off the record comments.)

CHAIRMAN SHACK: Gentlemen, we do have a problem in the sense that we have interviews scheduled at lunchtime.

VICE-CHAIRMAN WALLIS: Right.

CHAIRMAN SHACK: I guess the question is do we need to continue this discussion after lunch or is this something that we need to hear the language.

MEMBER APOSTOLAKIS: The question in my mind is all we need to see the SRP after the revisions.

CHAIRMAN SHACK: Yes, and if you can look at it over lunch and find the language for us.

MR. WERMIEL: I found some.

CHAIRMAN SHACK: Okay.

MR. WERMIEL: In Section 15.0, page 9, the second full paragraph from the top of the page.

VICE-CHAIRMAN WALLIS: Where are we here? Where do I find it?

MR. WERMIEL: I'll quote from the document. "The reviewer ascertains that the applicant has evaluated the effects of single act of failures" and there's a reference "and operator errors." And that "the licensee's application contains sufficient detail to permit independent evaluation of the adequacy of systems as they relate to the..."

VICE-CHAIRMAN WALLIS: This is part of Section B, Analysis Acceptance Criteria for Postulated Accidents. It's not AOOs that he's talking about.

MR. WERMIEL: Ah-ha. If we need to add similar language to cover AOOs we'll do that.

MEMBER APOSTOLAKIS: I think after lunch --

MEMBER BANERJEE: That would remove a lot of our concerns.

MR. WERMIEL: And you know what? It should be clear that that language applies to both, accidents and AOOs.

MEMBER APOSTOLAKIS: Come back after lunch and tell us exactly what sentence you would add where.

MR. WERMIEL: Sure.

MEMBER APOSTOLAKIS: That's going to work.

MEMBER ABDEL-KHALIK: I think that will do it.

MR. WERMIEL: We will do that.

MEMBER APOSTOLAKIS: Okay. Great.

MEMBER BANERJEE: It will make us all happy.

MR. WERMIEL: We'll do that.

(Off the record comments.)

MEMBER BANERJEE: This was the point we were at at the end of the Subcommittee meeting. All they needed to do is add that language.

VICE-CHAIRMAN WALLIS: You tried very hard, George.

MEMBER APOSTOLAKIS: Glad I could be of service.

(Laughter.)

(Off the record comments.)

CHAIRMAN SHACK: We're going to recess for lunch until 1:30 p.m. Off the record.

(Whereupon, at 12:08 p.m., the above-entitled matter recessed to reconvene at 1:31 p.m. the same day.)

CHAIRMAN SHACK: We can come back into session.

Sanjoy, do you want to continue our discussion of the standard review plan?

MR. BANERJEE: Sure. I think the staff were going to come back with some wording suggestions. So --

CHAIRMAN SHACK: Or at least point out to us where the wording was.

MR. MIRANDA: After the last meeting with the subcommittee, I made some changes to SRP Chapter 15, Part 0, and the changes are in the copy that you have now, and they are indicated in italics. There's also a strikeout on page 7 in response to Dr. Wallis' observation that something in there was a definition and not --

MR. BANERJEE: Maybe you could just briefly lead us through this.

MR. MIRANDA: Sure.

MR. WALLIS: So these are all at the end rather than being in context? They're all at the end, the changes, aren't they?

MR. MIRANDA: Well, if you look at page 8 --

MR. BANERJEE: What about 15.2? Some strikeout there. Are these significant?

MR. MIRANDA: No, they're not. I put those in just to make it more clear, that this is in reference to what I mentioned this morning, that licensees that have condition two, three, and four events in your licensing basis, they continue to use those.

MR. BANERJEE: Okay, right. Carry on.

CHAIRMAN SHACK: Is there language you wish to point out that covers the concern that we were discussing this morning, I guess, is where we were really hung up.

MR. BANERJEE: Yeah.

MR. WALLIS: Also, AOO is defined as an accident which doesn't result in sufficient damage to preclude resumption of plant operation.

MR. MIRANDA: Yes, and that's also in --

MR. WALLIS: That's a much better definition than all of this frequency stuff. It's a workable definition.

MR. MIRANDA: And it's noted in the GDCs as well.

MR. WALLIS: I didn't see that before. I like the way you put that in.

MR. MIRANDA: Thank you.

On page 9, under assume protection system actions, the new text is in italics. It says, "The performance of each credited protection system is required to include the effects of the most limiting single active failure. This verifies satisfaction of the GDC criteria that required protection systems to adequately perform their intended safety functions in the presence of single active failures."

MR. ABDEL-KHALIK: But that's under Part B. That's under Part B, which starts on page 7.

MR. WALLIS: It has to do with accidents, doesn't it?

MR. ABDEL-KHALIK: Right.

MR. WALLIS: That's accidents. How about the AOOs?

MR. BANERJEE: Yeah, I thought you were going to add something under AOOs. That was sort of the --

MR. WALLIS: There's nothing in the AOO section that talks about this additional failure.

MR. BANERJEE: Section A rather than B.

MR. MIRANDA: There was another reference to it. I'm trying to find it.

MR. BANERJEE: Well, at 15.10 there is the review of verifies that the applicant has specified --

MR. WALLIS: That is still accidents, isn't it?

MR. BANERJEE: Yeah, it's still on the accidents and has included the effects of single active failures. So that's page 10 towards the middle in italics.

MR. WALLIS: It's very confusing because you have capital B as a heading, and then you have Subsections little I, and then you have -- then it goes to three. Is that part of Subsection B or is that a new thing?

And then there's Subsections A and B in Part 6 and so on.

MR. MIRANDA: Frankly, I have to admit that I don't know how these things are numbered. They've been changed so many times, and we've had at least six people involved in making these changes, but --

MR. WALLIS: Okay. So they aren't subsections of B.

MR. BANERJEE: No.

MR. WALLIS: No, they are separate things.

MR. BANERJEE: Yeah, under four and six, I guess.

MR. WALLIS: It is clear that four applies both to accidents and to AOOs?

MR. MIRANDA: That was my intention. It applies to protection systems. It has always applied to protection systems. We talk about single active failure. We are talking about a failure in a protection system and, therefore, it applies --

MR. APOSTOLAKIS: Not a protection system. Safety system.

MR. MIRANDA: Safety system.

MR. BANERJEE: Yeah.

MR. APOSTOLAKIS: Protection system is a specific system.

MR. BONACA: Right, right, and by the way, this is all in the text, however. Page 15.09-9 talks about protection systems.

MR. BANERJEE: It's in the text, but I mean, as you pointed out, the usage is more related just to the SCRAM systems.

MR. BONACA: SCRAM systems?

MR. BANERJEE: Yeah.

MR. BONACA: The other system is the communication systems.

CHAIRMAN SHACK: The typical protection system functions include trips, closures, ECC.

MR. BONACA: That's why there is the issue, I mean, because there is a definition there.

CHAIRMAN SHACK: But I guess if you read the headings carefully enough, the heading 2(a) and (b) and then the heading 3 and 4; so four does apply to everything.

MR. ABDEL-KHALIK: But just to avoid any confusion, it would be easier if you explicitly state that, this sentence in italics. If you start that sentence by saying, "In evaluating the response to both AOO and postulated accidents," comma, "the performance of each credited protection system is required to include," et cetera.

And that would be totally unambiguous.

MR. MIRANDA: Before the words "the performance of each credited system," put that in.

MR. ABDEL-KHALIK: Before that so that evaluating the response to both AOOs and postulated accidents, comma.

CHAIRMAN SHACK: That addresses your concern?

MR. MIRANDA: Yes, it does. Thank you.

MR. BANERJEE: And I guess on page 10 for use in mitigating transient or accident conditions you really mean mitigating AOOs and postulated accident, just to be very clear. Just before that stuff in italics on page 15.010.

MR. MIRANDA: Okay. For use in mitigating transient or accident conditions.

MR. BANERJEE: Yes. You use the word AOOs and postulated accidents, don't you? I mean, just to be --

MR. MIRANDA: Mitigating AOOs, false postulated accidents.

CHAIRMAN SHACK: And just to keep the terminology consistent throughout the documents, right.

MR. BANERJEE: Yeah, so that there's no ambiguity.

MR. MIRANDA: Okay.

MR. BANERJEE: So would that satisfy the committee then?

MR. WALLIS: We're not going to revisit what was taken out and why?

MR. BANERJEE: Well, effectively they're saying that they took out something which was ambiguous.

MR. WALLIS: That's redundant or ambiguous.

MR. BANERJEE: Yeah.

CHAIRMAN SHACK: But I think the paragraph that's in addresses our concern that we didn't wan tot lose when that paragraph disappeared.

MR. WALLIS: Well, why did we spend so long this morning?

CHAIRMAN SHACK: Well, let's not discuss history here because the paragraph was not there.

MR. APOSTOLAKIS: Because entropy increases.

MR. BANERJEE: Well, this is the first time we've seen the changed wording. So shall we then conclude?

CHAIRMAN SHACK: I think we can conclude this section. I think everybody is happy.

MR. BANERJEE: All right. Thank you very much. Very helpful.

CHAIRMAN SHACK: And we want to move on to our next topic, which is final results of the chemical effects head loss test related to the resolution of the PWR sump performance issues, and I'm going to have to ask Mario to chair this portion of the meeting since I have a conflict of interest that Argonne has been involved in work in this area.

And, Graham, you're going to lead us through it, I assume.

MR. WALLIS: I think so, although Sanjoy chaired the meeting.

MR. BANERJEE: I'm quite happy to have Graham lead us through this.

MR. WALLIS: I thought that would be the case.

Well, you're aware of the sump issue, GSI-191. It's several years old. Over the last few years RES has conducted research in various areas. This has been reported to this committee, and we have written several letters about it, which you may recall.

Now, last year we were told that research would stop around the end of the first half of the year. So the end of the spring, and what remained was to write up the formal reports of that research.

Now, we had seen the results of the research and we had already discussed it, and in looking at the final reports, it seems ot me that most of the major points we'd already discussed in our letters, but there are a few areas which we haven't heard about, and we're going to be informed about these today. There has been further activity.

I believe it's the feeling of the subcommittee that these activities sufficiently extensive or complete to warrant a letter from the committee at this time, and that was, I think, also the inclination of the staff at the subcommittee meeting. And of course, we can decide that at the appropriate time.

So I'd like to invite the staff to go ahead and make their presentation.

MR. SHAW: If I may, Dr. Wallis.

MR. WALLIS: Yes.

MR. SHAW: Let me begin. My name is Tony Shaw. I'm the Branch Chief of the Mechanical and Structural Engineering Branch in the Office of Research.

This research work was conducted in my branch. This is a follow-up from last week's briefing to the Thermal Hydraulics Subcommittee, and the purpose of today's briefing is to give the full committee an update of what we have done on research related to resolution of Generic Safety Issue 191.

And most of the material like you mentioned before was briefed in front of the committee earlier several times, and so today we'll focus on the update of the research activities you have that your full committee may not have heard before. So we'll do that.

And we're not requesting a letter from the ACRS. This is really for information for the full committee.

Today's briefing will consist of several parts. Mr. Erv Geiger will kick off to provide overview of all the research associated with the information of the informed resolution of GSI-191.

He will follow by discussion of the surrogate test being conducted at Argonne National Lab. That's Dr. Shack's support. That's to test a surrogate material that Westinghouse is proposing to use in their test regarding that head loss in sump.

That will be followed by Bill Krotiuk. His test run at PNNL, again, regarding head loss on a sump screen, as well as the enhanced head loss correlation he has developed based on the most recent data, including those data generated from PNNL.

And at the end we will discuss in more detail the peer review process and the PIRT process we have employed with regard to the sump research, and that as directed by the subcommittee last week, we would like to focus the majority of today's time on a peer review. We expect to spend at least half of the total time focused on peer review. The rest of the time will be occupied by Erv Geiger and Bill Krotiuk[s review.

So with that I would like to turn that over to Erv Geiger.

MR. GEIGER: Thank you, Tony.

Hi. Erv Geiger. I'm with the Office of Nuclear Regulatory Research, and I would like to thank the committee fore giving us this opportunity to discuss the results of our research for GSI-191, and we'll also inform you of some additional testing we had done since we had last provided a presentation.

Some background. The GSI-191 was established to assess the potential for debris in the containment to be Grade ECCS and containment spray system performance during loss of coolant accidents.

And as part of that effort two ECCS performance degradation issues were identified for investigation, and they were to decrease in the available MPSAs for the ECCS/CSS pumps due to debris accumulation on the screen and also some work integration of components due to --

MR. WALLIS: Now, the second one of those, have you done any work on downstream effects recently?

MR. GEIGER: Well, the one that we had done was the throttle valves.

MR. WALLIS: That's right, but I think the committee was very interested in effects on the core or the other components inside the reactor vessel.

MR. GEIGER: I understand that's of great interest to the committee. However, research at this point has not been commissioned to do research. I think ACRS is conducting --

MR. WALLIS: We had recommended it in our letter.

MR. GEIGER: NRR is conducting it. NRR is conducting quite a bit of work on that as a separate effort, and I think they will be presenting that in a later presentation.

MR. SHAW: Dr. Wallis, this is Tony Shaw again.

I believe that topic will be part of the discussion that Rob Tregoning will offer. The issue came up through the peer review, and it will go through the PIRT process. So Rob will --

MR. WALLIS: Well, the peer review --

MR. SHAW: He says it's not correct.

MR. WALLIS: He says no?

MR. TREGONING: Rob Tregoning, Office of Research.

The issues that you raised, there was some separate study that was undertaking, some scoping calculations done by Research as well as an effort in coordination between industry and NRR. We don't have that on the agenda for today, but I'm presuming in May when NRR comes back that that will be a point of discussion.

Mike wants to follow up.

MR. SCOTT: This is Mike Scott, NRR.

We do plan to talk to you in May about how we're doing on that issue, but there is a topical report on the subject that we're to receive in May. So we probably won't have too much to tell you in May. At a later meeting we'll have more to say.

MR. WALLIS: Well, I think what we have learned is the RES does not have an active program on this subject.

MR. GEIGER: Correct.

MR. WALLIS: Thank you.

MR. GEIGER: Then subsequently chemical effects was identified as a potential ECCS performance degradation phenomenon. So we did some research on that.

So the objectives of the research were to determine if chemical reaction products could form in a representative sump pool environment and examine independently the effects of chemical precipitates or particulates in combination with insulation fiber on the sump screen.

Examine the variables affecting the debris bypass of sump screens and study effects of those bypasses on the throttle valve clogging. And then we characterized the transport of coatings in water.

We had presented much of these research results in detail in several ACRS presentations in 2006, and the effort resulted in 11 NUREG CR reports, and there are two NUREG reports and there are two technical letter reports not on this topic.

The detailed GSI-1 research presentations, I guess, that have been made previously and the current presentation is going to focus mostly on recent work that had been completed since the last meeting.

MR. WALLIS: Now, you've written lots of NUREGs.

MR. GEIGER: I'm sorry?

MR. WALLIS: I say you've written lots of NUREGs --

MR. GEIGER: Yes.

MR. WALLIS: -- on separate topics. Some day it might be good to have a NUREG that throws it all together and says this is the state of our knowledge, which is useful, not just what's being done, but extract from it what is actually of use for solving the problem.

MR. GEIGER: Well, there's a great deal of detail in a lot of these reports, and as you noted, the reports are very detailed and perhaps there would be some value. I agree there could be some value in summarizing the results of all that research into this. That may be something we may look at.

MR. WALLIS: And think about that, right.

MR. GEIGER: Yes.

MR. SHAW: May I add something? This is Tony Shaw again.

We do have -- Erv is in the process of drafting what we call RIS, a research information letter, REAL (phonetic). We'll send to NRR.

MR. WALLIS: That will fulfill this function then.

MR. SHAW: That's exactly right. It will summarize everything, a brief description of each research project and the reports.

MR. GEIGER: Okay.

MR. APOSTOLAKIS: We can't read that. That's okay.

MR. GEIGER: I'm not sure why. That's

interesting.

MR. APOSTOLAKIS: We have a file copy. Don't worry about it.

MR. GEIGER: Okay. Well, I'm sorry.

So the significant findings of our research, I guess the important issue to remember is that the major accomplishments are that we did demonstrate that gelatinous precipitates could form in the sump pool during LOCA.

MR. WALLIS: Gelatinous? There were precipitates, but is the word "gelatinous" appropriate here?

MR. CORRADINI: Is that a fancy word for "gooey"?

(Laughter.)

MR. CORRADINI: Well, I've seen that word used.

PARTICIPANT: Sticky?

MR. GEIGER: Non-Newtonian? I'm sorry.

MR. WALLIS: Well, a lot of them seem to be particulates. I'm not sure how gelatinous they were.

CHAIRMAN SHACK: I mean, the aluminum oxyhydroxides could be relatively characterized as gelatinous. The calcium phosphates --

MR. WALLIS: The calcium phosphates are not.

CHAIRMAN SHACK: -- as we heard are not.

MR. WALLIS: And small quantities of precipitates whether gelatinous or not --

(Laughter.)

MR. WALLIS: -- pose significant head loss.

MR. GEIGER: I think where it came from is that what was identified as the PMI. We saw some gelatinous material. What was this?

MR. WALLIS: Well, I thought that, in fact, Argonne didn't see anything, but it still clogged the screen.

MR. GEIGER: Well, that, too.

MR. BANERJEE: Invisible.

MR. GEIGER: Well, not without magnification. If we had magnification we might have seen something.

Okay, and then the head loss testing with CALSIL also demonstrated that particulates deposited in and throughout the fiber bed could cause a pressure drop.

Coatings are concerned, and we demonstrated that coatings really did not transport under the velocity conditions that we studied. So that could be applied somewhat depending on the plans, too.

MR. WALLIS: As long as they're big enough.

MR. GEIGER: Yes. There were chips, not particulates.

MR. WALLIS: Right.

MR. GEIGER: We would think that particulate falls in a separate category.

And the screen bypass experiments demonstrated that NUKON and CALSIL, even reflective metal insulation could actually get through and bypass sump screen. We tested between 1/16 inch and 1/8 inch opening sizes, and all of those depending, of course, on the size and the characteristics of how the insulation was broken up, but there was quite a bit that bypassed, and some of these could actually accumulate in the throttle valves which were close tolerance, like the throttle valves. That potentially could cause problems.

So our accomplishments and the path forward. Right now the planned GSI-191 research projects are complete. Those are the ones that have been pretty much in the works for the last couple of years.

The research results are being used in making regulatory decisions. For instance, evaluations of the industry testing on the sump screens, and the industry activities are being monitored to identify any new issues that come up as a result of their testing.

And work is continuing on the evaluation of the NUREG 1861 peer review comments, and Robert Tregoning will go into more detail on this later in his presentation, and staff will identify any future research needs to insure an acceptable resolution to GSI-191 as they may come up during the testing and maybe as an outcome of the --

MR. WALLIS: When you say that you mean that you're waiting for NRR to identify these needs or --

MR. GEIGER: Well, we're looking at what may come out of the NUREG, the peer review comments if we need to go there.

MR. WALLIS: So this is based mostly on the peer review of these new research needs?

MR. GEIGER: Peer review, and also in discussions with NRR. They had indicated that depending on where the industry testing needs, there may be a request for additional research.

MR. WALLIS: Okay. So you'll be responding to something?

MR. GEIGER: Yes, we'll respond to that. Right now we're not out looking at -- because we're not looking at the tests and so on. So we're not aware of what the outcomes are.

MR. APOSTOLAKIS: Can you give me more information on these regulatory decisions that you are making? Evaluating somebody's testing is not really a regulatory decision, is it? I mean, are you asking the industry to do anything?

MR. GEIGER: Well, the industry is -- as an outcome of some of this testing we have done and also the testing they have done, they have identified certain issues that are for sump clogging, potentially clogging sumps or head loss testing, a loss of head loss on the MPSH.

So what they have done is they're looking at -- they're taking measures to mitigate those.

MR. APOSTOLAKIS: Sure.

MR. GEIGER: So there may be buffer replacements. There may be requests for not using any buffers. There are a number of issues. So that's where we are using. We're going to -- some of this information will inform the decisions to their requests.

MR. APOSTOLAKIS: So if they propose a remedy, then you will use these results to evaluate whether that makes sense.

MR. GEIGER: Yes.

MR. APOSTOLAKIS: So you're more in a review mode then.

MR. GEIGER: We're in a review mode, and it's basically NRR looking at all of these tests because they are actually looking at a large number of the vendor tests and identifying issues as to how much, you know, settlement, how much transports and what the clogging issues are.

One of the things is that there are so many variables in sump screen designs now, you know. They're not all perforated plates now. They have many different designs. So just attacking any one or researching further on any one design may not solve the other problems, but there are some generic issues here that would address all of these.

So I guess NRR could speak more to that, but that's pretty much how much I know about it right now. Okay?

MR. ABDEL-KHALIK: Have the results of

this research affected the methodology of any accident analyses?

MR. GEIGER: I don't have any information to address that. I'm not sure if it's inputting NRR.

CHAIRMAN SHACK: They're putting in new hardware.

MR. GEIGER: Yeah, they're all putting in -- well, right now what it -- well, one of the items they're doing is everybody is putting in larger sump screens, and they're looking at how much debris actually accumulates on those sump screens and they're doing pressure drop calculations pretty much based on their specific plan chemistries.

MR. BANERJEE: But they're also evaluating what to do to control the chemistry.

MR. CORRADINI: But to get to Said's point, so they put in new hardware. They then have to assess how much gets stuck on the hardware. Then they must have to do different LOCA analyses for the recirculation phase to decide how much --

MR. ABDEL-KHALIK: And modify the analysis of record.

MR. SCOTT: This is Mike Scott, NRR.

If I could try to respond to that, it is correct to say that the industry has been made aware of the conclusions that have been derived from these various NUREGs. They're all publicly available on our sump performance Website, and we have discussed them with the industry.

It would also be correct to state that the results of the various research projects that are documented in these NUREGs have been considered and are being considered by NRR staff in our ultimate review of the generic letter responses, as well as in the audits that we are now in the process of doing.

Whether the industry has incorporated or let me say the extent to which the industry has incorporated the NUREGs will be more visible to us as we continue to observe testing, continue to do audits and review the generic letter responses. At this point we're not fully sure how far that has gone.

MR. CORRADINI: Can I translate that? So they've been --

(Laughter.)

MR. CORRADINI: I'm trying to understand it. That's very extensive. I'm just trying to understand.

So to the extent that you've done the research, you've made it publicly available, it's unclear how individual utility licensees are going to use it to either put in either new hardware or evaluate how that hardware performs.

MR. SCOTT: Okay.

MR. CORRADINI: Is that what I heard?

MR. SCOTT: Well, there's more than one answer to that. First of all, the hardware has largely been put in or is being put in in terms of much larger strainers, and that was done with the knowledge up front that the issues were not fully resolved. And all of the utilities who put in their hardware knew that there was a chance that they would be making additional changes if the problems to be discovered later or to be evaluated later bore out the need for that.

And in particular, chemical effects has been a major issue, and chemical effects testing is only now starting to be performed by the vendors as a whole.

You mentioned utility specific. I would say it's more vendor specific. Each vendor has a method that they sell to their customer utilities. Now, each utility's configuration is different, but they're probably going to buy the methodology that each vendor provides.

Now, what we haven't fully evaluated yet is those methodologies, particularly as related to chemical effects. The information has not been made available to us yet. It's just now being made available. So they have presumably used some of this information, but I can't validate for sure that they have.

MR. POWERS: I can assure you that they have.

MR. WALLIS: Well, can I ask a different question? He asked if industry is using this information. Are you using this information other than in sort of a qualitative sense knowing which questions to ask industry? Are you making any predictions with NRR about the performance of these screens?

MR. SCOTT: Are we making predictions? No, I would not say --

MR. WALLIS: Using the results of the research to predict anything, yeah.

MR. SCOTT: I would not say that our method involves predicting the performance. Now, as you may recall, Dr. Wallis, from last week's discussion, NRR evaluated the research reports, and we developed a document where we described the uses that we were putting them to. I wouldn't say that we're using them to predict because that has not been part of the process.

MR. WALLIS: No, but you're learning which questions to ask and what to look for and that sort of thing.

MR. SCOTT: Those documents are informing those questions, yes.

MR. ABDEL-KHALIK: But eventually at the end of the day the analyses of record will reflect this additional knowledge and wisdom that has been gained by this process that may impact the methodology and/or the results of the analyses.

MR. SCOTT: We are continuing to develop review guidance in certain areas, and these documents will inform that development. So they will ultimately be incorporated as appropriate by the staff in our review of the submittals that we get from the industry.

MR. MAYNARD: There's nothing that requires the utilities or even the staff to use the NUREG results. There are other things that are available. So we still have to demonstrate compliance with the regulations and the rules. The NUREGs provide information and provide methodologies or things that could be used, but it's not the only thing that has to be used by the staff or by the licensee, right?

MR. SCOTT: That's certainly correct. Each licensee will need to show to us that they have satisfactorily addressed this issue. They can use whatever method they want as long as they can justify it. That's true.

MR. GEIGER: I think what it boils down to is that we're not designing the resolution for the licensees. It's up to them.

So our follow-on presentations, as previously mentioned, there's a technical letter report where we did some follow-up studies at Argonne National Laboratory to examine WCAP surrogates and also sodium tetraborate solutions.

And we did complete our pressure drop calculation methods for pressure drop across sump screens, and then we're going to present, I guess, our approach to the resolution of the peer review comments.

With that I'll go on to the next. Are there any questions?

MR. WALLIS: Thank you very much.

Is this the time to ask Dr. Shack to put on a different hat and move up to the front?

MR. GEIGER: Yes, if Dr. Shack would please come up.

Okay. We did some additional follow-on testing on a WCAP surrogate, and sodium tetraborate buffer to develop some more knowledge in the area.

MR. POWERS: Is it fair to ask what a blacksmith knows about sodium tetraborate?

MR. WALLIS: Well, I was tempted to ask for his qualifications, but I think we can pass over that.

MR. GEIGER: The background, we did some surrogate testing, and some licensees are conducting a sump screen head loss testing using the Westinghouse recommended procedures for producing these surrogates.

And also for the buffer testing, the ICET and head lost testing indicated that sodium tetraborate appeared to be a less problematic buffer than some of the other buffers like sodium hydroxide and trisodium phosphate under certain sump environments. Not all of course.

So some licensees may elect to change these buffers to sodium tetraborate.

MR. WALLIS: You say some licensees are using Westinghouse surrogates.

MR. GEIGER: Yeah, not everybody.

MR. WALLIS: Presumably those are the ones who have chemical effects which would be covered by the surrogate. Are there any that were using different surrogates?

MR. GEIGER: Should I speak, Mike, or do you want to address that?

MR. WALLIS: I just wonder if the Westinghouse surrogate has some faults, let's say.

MR. LU: this is Shanlai Lu from NRR.

MR. WALLIS: Alternative surrogate to be used?

MR. LU: Actually that's the entire whole thing is being even studied by the industry at this point, and they may use the W --

MR. WALLIS: It's being reevaluated?

MR. LU: Yes, some of the WCAP, the surrogate (unintelligible) are mounted so large, and they cannot label it with (unintelligible) loss beta. So they are looking into that.

MR. POWERS: I have certainly heard that the surrogate grows the wrong phase of either aluminum hydroxide or oxyhydroxide.

CHAIRMAN SHACK: I'll discuss that a little bit.

MR. GEIGER: So the objectives of the surrogate testing were to evaluate the head loss performance of the WCAP surrogate precipitate relative to precipitates generated during the earlier NRC sponsor testing for chemical effects head loss, and then the buffer testing was just to examine the solubility of the aluminum in --

MR. WALLIS: And the question that we asked of the subcommittee is what's the confidence with which we can say that any of these surrogates or precipitates represent what happens in a sump.

MR. GEIGER: And I know we discussed that before, and I think in thinking more about it, the way it looks, what we have proven, you know, we had intended to run these tests longer, but what we had proven was that even if we had any precipitates, aluminum precipitates of aluminum, if you used even a little bit above the saturation limit -- I'm sorry -- not the saturation limit, but if these precipitates would occur, you would immediately have high head loss across the screen.

So although we didn't prove that, yes, these were identical to or very similar to what you would expect if the precipitate generated over a 30-day period or whatever. What it did demonstrate is that if anybody, in fact, did use these Westinghouse precipitates.

As soon as they ran their test, if they had a fiber bed under sum screen, they would experience head loss.

MR. WALLIS: Well, when we get to the peer review we'll find that the chemists had lots of comments about all kinds of chemical things which could be going on in the sump and all kinds of different sorts of precipitates, and whether you were getting the right precipitate and so on.

So it would seem that at least those peer reviewers had a lot of questions about the reality of some of these surrogates.

MR. GEIGER: That may be, but if you just look at, I guess, the practical point, if any vendor is testing the surrogates, as soon as they put in a little bit of surrogate, it's going to affect their test program. So they're going to have to go look for something else to do. I mean, that's where it comes out to what did we prove, is that if you use Westinghouse surrogates, you're immediately going to show that you're affecting your head loss.

Whether we fully understand how or whether their tests are going -- you know if they're realistic or not, what we can say is that they, in fact, show that if you have a fiber bed with this aluminum precipitate -- so they may look at then alternate testing, which I understand they are, to, I guess, use other methods for predicating or maybe developing the precipitates over a longer period in the sump itself.

But I think there are other approaches they will have to follow.

I think Dr. Shack is going to go over the test results.

CHAIRMAN SHACK: I just want to discuss some of the work that we did at Argonne, following up on some of this work.

Just a quick background, again, to address Dr. Wallis' question. Again, you know, you'll hear more from the peer review, but, again, the ICET-1 or the ICET series of tests at Los Alamos were an attempt to get a reasonable complexity of the environment. I mean, you know, they simulated sort of prototypic amounts of the various materials.

You know, we're certainly not complete, but it's a rather complex chemical environment, is what it was, and from those tests we identified a number of products that could affect head loss. One important class of those products are these aluminum hydroxides, oxyhydroxides. We won't worry too much about the exact chemical form that they're taking in.

And one of the results that's interesting to this, you know, the tests at Los Alamos were intended to be somewhat conservative. The amount of dissolved aluminum that you're going to have in solution will, of course, depend on the area of aluminum that you have and the volume of the sump that you're dissolving into.

The values used in the ICET test probably weren't bounding. There may be a few plants that actually have higher values, but they have a higher aluminum-to-sump volume ratio than many of the plants that you're going to have. So they're fairly conservative from there.

So we would expect most plants to have lower dissolved aluminum levels with the corresponding buffers than we found in the ICET tests where we found 350 ppm of dissolved aluminum in the sodium hydroxide environment and 50 ppm of dissolved aluminum in the sodium tetraborate environment.

Now, when we ran our first series of head loss tests at Argonne, we found that 350 ppm of aluminum and a sodium hydroxide environment as we cooled the environment down, we dropped Jello on the bed and got very, very high head loss. If we did it even with 100 ppm of dissolved aluminum in that sodium hydroxide environment and we cooled down, we got very high head loss.

So that doesn't indicate that you can't live with the sodium hydroxide thing, but at least for these aluminum to volume ratios you were getting large head losses.

MR. CORRADINI: Can I ask you a clarification?

So you mixed it to the solubility limit of the aluminum? I don't understand. The 350 ppm was just a chosen number?

CHAIRMAN SHACK: That was what came out of the chemical test at Los Alamos. When you cooked this thing at 160 degrees for 30 days, which represents the sump environment, they dissolve aluminum up to the 350 ppm level.

As we cool it down, we, in fact, will reach a solubility limit, and we'll form a precipitate, but you know, these are the dissolved aluminum levels that we got out of the ICET tests.

MR. CORRADINI: So under the cooking recipe, that's not at its limit. That's not saturated yet.

CHAIRMAN SHACK: That's not saturated, no. You can get a lot of aluminum into these solutions.

The interesting thing, again, from our first series of head loss tests with the 50 ppm of aluminum, which we think is conservative for many plants, we ran for 11 days at 70 to 80 degrees, and we produced no measurable increase in head loss. We at the last moment upped that dissolved aluminum level to 100 ppm and our head loss immediate rose up. So somewhere between 50 and 100 ppm of aluminum with the STB we got head loss.

So there was interest in looking back at with this anomalous test can we repeat these results because it sort of impressed.

And, again, as Erv mentioned, industry has proposed a surrogate approach where you prepare the aluminum oxyhydroxide separately. In the Argonne loop, our loop doesn't look anything like a sump screen. You know, ours is really to look at the potential for essentially local chemical effects on a fiber bed to induce head loss.

If you really want to do a prototype test, you have to do a different kind of geometry. They can't wait 11 days, you know, circulation in their large flume. so they have to come up with surrogates, and what they proposed to do was make a conservative assumption that all of the dissolved aluminum would end up as a precipitate and they would add that much precipitate to the solution conservatively bounding the result, and you know, if they could demonstrate that they could live with that they could live with that, they would be home free.

There are a number of questions here. They form their solution or their precipitates from acidic solutions at high concentrations. Would they have properties to the actual precipitate which forms in a basic solution at a much lower concentration?

MR. WALLIS: And of course, the peer reviewers, amongst other things, said that there might be all kinds of small particles in the sump that could act as nucleation centers and things like that.

MR. CORRADINI: Yes.

MR. WALLIS: Which you don't have.

MR. CORRADINI: You recall with that 50 ppm of aluminum in the sodium tetraborate, we tried to make that precipitate. We added nanoparticles. I mean, you know, our solutions are dirty anyway. You know, this is a lab loop. We toss in the NUKON, which has, you know, got crap all over it. We then added nanoparticles to try to get it to precipitate. We bumped the pH down a couple of tenths of a unit to try to make it precipitate. It just wouldn't come out. So there was something there.

Our follow-on test program says that we're going to prepare these surrogates as the industry proposed and test their head loss properties to see if they were comparable to the kind of head losses we got with our more realistic precipitate products.

We wanted to do another head loss test with this 50 ppm of aluminum and the sodium tetraborate to do it and to slowly increase our concentrations above the 50 ppm just to get a better feel for the margins that you have.

And we wanted to look at the solubility and precipitation of these products from aluminum sodium tetraborate things in small tests just to get a better understanding of when we did get precipitation.

MR. ABDEL-KHALIK: So what limits the maximum concentration of aluminum in the STB case to 50 ppm? Is it just time?

CHAIRMAN SHACK: No, it reaches that limit in about 15 days, and then it doesn't seem to go up in the ICET-5 test. Whether there's -- again, there doesn't seem to be precipitate forming at those temperatures in the tests. Whether there's a passivation reaction that occurs on the surface of the aluminum, you k now, it's not clear, but, again, we're looking at a very empirical sense that we have a very large aluminum-to-volume ratio, and it's just limited at that, at 15 days, and it sat there for about 15 days at about that level for the 30-day test time.

The surrogate product that we formed, again, from the ICET tests, we knew that one of the characteristics and one of the reasons we got such high solubilities with the products were amorphous forms of these. The aluminum hydroxides come in a variety of forms. The amorphous forms have solubilities that are orders of magnitude higher than the crystalline forms.

Now, again, in order to do the analysis of the form, we couldn't quite -- the surrogate if we followed their recipe gave us a solution that was too fine and too dispersed for us to do the analysis. So we couldn't actually find out whether their particles were crystalline or not.

So what we did was we buggered it. You know, we violated the rules for making the surrogate, but as we tried to go down, the chemical reactions were giving us crystalline forms as we tried to go more and more to the surrogate limits. We could still see the crystalline forms here, but because the particles were so small we couldn't really do it, but we think that we're getting a crystalline product.

This whole thing turned out to be kind of moot because when we went off and ran the first head loss test, we took the amount of precipitate that you would get if you just essentially took five ppm of the dissolved aluminum and assume that that precipitated out of the solution. So we're not arguing that five ppm of aluminum would do this, but say if 50 ppm were the solubility limit and you dissolved 55 ppm into solution and five came out, that was the amount of surrogate product we had.

Here's our head loss test. We start here at time zero. We add the NUKON, and so we get this little sort of .2 psi pressure drop across the NUKON bed.

Here is where we added the surrogate, and it takes about 15 seconds to get from the place where we added the surrogate for the surrogate to reach the bed and the head loss just went up.

MR. WALLIS: A factor of 30 or something.

CHAIRMAN SHACK: The limit of the loop, and again, you know, we don't see any particular bed forming on top of this.

MR. WALLIS: But if the pressure drop went up by a factor of 30 and the flow rate went down by a factor of 30, that's a factor of 1,000 in resistance.

CHAIRMAN SHACK: You know, and again, we've only reached the limit of the head loss capability of this test. We don't know what the real increase in head loss was. But, again, I think the conclusion from this is that you don't want to reach the solubility limit. You know, if you begin to precipitate stuff, you don't need a model to tell you how the chemical product is going to --

MR. WALLIS: If you have a fiber bed covering the screen.

CHAIRMAN SHACK: Yes, if you have a fiber bed.

MR. POWERS: You're telling me we should take the trisodium phosphate out and put EDTA in, right?

CHAIRMAN SHACK: Now, if we go to the sodium tetraborate loop test, again, we're back here with our 50 ppm of aluminum, which, again, we think is a conservative amount for most plants. We were running at 80 degrees this time, and the lowest temperature we can run depends on the weather at

Argonne at this point.

If we were running it now, we could do a lot better, but at this time 80 degrees was about our limit.

We ran for 22 days at 50 ppm and nothing happened basically. We couldn't see any increase in head loss. You can see the temperature going up here as we add aluminum to essentially beef up the ppm, we first raise the temperature so that we don't form a precipitate immediately on doing it. We raised the temperature, add a little bit of dissolved aluminum to get it up five or ten ppm and then bring the temperature back down.

We went to 60 ppm and if there's any increase in head loss here, it's very small. At about 70 ppm, we begin to see the head loss increase even at 120. As we come down to 80 degrees or so, we see the head loss going up. Again, as we go to 80 ppm at high temperature we still see it going up. We come down to 100 and it's going up. And we come down to 80 and it's going up.

So somewhere between 50 and 80 ppm we've reached the solubility limit here and precipitated enough product to make a substantial decrease in the head loss.

When we look at the measurements from the solution, the amount of solution that we've actually removed and formed a precipitate on the bed corresponds to something like three to seven ppm, which is not too far from the five ppm that we did with the surrogate. So if the surrogate isn't an exact replicate, it's not a bad one, but the message is that it doesn't really take very much of this precipitate to give you a big head loss. You don't want to precipitate stuff.

MR. WALLIS: Is the message also that sodium tetraborate is somewhat better than some of the other buffers?

CHAIRMAN SHACK: Sodium tetraborate, again, for a given aluminum-to-sump volume ratio with the sodium tetraborate buffer, you don't seem to dissolve enough aluminum, and you keep it in solution, which is where you'd like to have it, and so from that point of view it does seem somewhat benign.

I don't want to talk too much about the small scale sodium tetraborate tests. Again, Dana asked what a blacksmith is doing with the chemistry here, and this blacksmith is very puzzled by many of the things that go on because one of the amazing things here is the amount of supersaturation we can get in these solutions.

You know, from a pH and a chemical standpoint, why the sodium tetraborate is really different from the sodium hydroxide solutions isn't clear to me. We have boric acid in both cases. You know, we can argue about boron complexing of the aluminum, but there's plenty of borate in the sodium hydroxide solutions, too, because we've got, you know, 4,000 ppm of boric acid added. You know, there are sodium atoms. The pH is about, you know -- but for some reason, whether it's solubility or the precipitation kinetics are just slow, the stuff doesn't come out.

We have, you know, sort of 85 to 90 ppm in the bulk solution here, and out of that only three to ten ppm is actually removed from solution. So, you know, a lot of it is staying in the thing.

When we did our long term tests, we think the long term equilibrium concentration of aluminum in these sodium tetraborate solutions at 80 degrees F. is about 50 to 55 ppm. So if you wait long enough with an 85 ppm solution, it should precipitate out. But, again, we're talking 30-day kind of time intervals, and it seems to stay saturated for that length of time.

And, again, my conclusion is whether this is a true difference in solubility or somehow we just have a difference in sluggishness of precipitation, we don't really know.

Our basic conclusions here is that when we have a fiber bed present, you don't have to precipitate very much in the way of these aluminum oxyhydroxides to get a big head loss. So you have to avoid reaching the saturation limit.

Again, for aluminum area and sump volume ratios equal or less than that into the ICET; we don't think that you're going to get amounts of precipitate that will cause significant head loss in sodium tetraborate buffered solutions for temperatures 70 degrees or more over the time of interest.

MR. WALLIS: That's an interest indication, but presumably to prove it out, you would need a somewhat more lengthy research program or something? You've got indication that that's the case, right?

CHAIRMAN SHACK: We've got two tests. We've doubled the database.

MR. WALLIS: That's right. Doubled? In this case you've taken zero and had one, haven't you, in the case --

CHAIRMAN SHACK: No, no. We had the earlier head loss test with the sodium tetraborate that gave us roughly the same result, that we could live with 50 ppm.

MR. WALLIS: Oh, okay.

CHAIRMAN SHACK: We ran it for 11 days that time. We've run it for 22 now.

MR. WALLIS: So you have doubled it, I guess.

CHAIRMAN SHACK: We have doubled it.

MR. WALLIS: But there's no uncertainty evaluation.

MR. POWERS: You call out aluminum oxyhydroxide. Do you really see those?

CHAIRMAN SHACK: Pardon me?

MR. POWERS: Do you really see oxyhydroxides?

CHAIRMAN SHACK: No.

MR. POWERS: Aren't you just seeing hydroxides?

CHAIRMAN SHACK: We don't know what we really see.

MR. POWERS: I think you really just have hydroxides in there. I don't think you get warm enough to get oxyhydroxides.

CHAIRMAN SHACK: The Westinghouse people think that we -- we said that it was aluminum hydroxides when we did it. The Westinghouse people said it oxyhydroxides. I figured that sort of covered everything.

MR. POWERS: Well, one of the reasons that you get peculiar precipitation kinetics is that in a basic solution aluminum wants to sit in a tetrahedral coordination, and the oxyhydroxide goes into an octahedral coordination.

CHAIRMAN SHACK: But, again, both the sodium tetraborate and the sodium hydroxide solutions, you know, they're slightly basic.

MR. POWERS: Yeah, but when you change coordination spheres, that's why you get sluggish precipitations.

MR. GEIGER: Thank you very much.

I knew we'd run into trouble with the schedule if I asked Dr. Shack to present this, but I guess we have one hour for the next two presentations. So Krotiuk will.

MR. WALLIS: That doesn't mean that you have to spend an hour.

MR. GEIGER: No, no. Well, what I was saying is that I think of primary interest is the peer review. So what we're going to try to do is hurry up so that we can dedicate more time to the peer review.

MR. WALLIS: That's fine. Please go ahead.

MR. KROTIUK: I'm going to be talking about some testing and modeling that has been done to look at the pressure drop across the re-bed (phonetic) that has some accumulation of fibers and particulates, and it's a situation that exists for -- we're looking at a situation that does not have any chemical reaction.

A lot of this information has bene previously presented, and so I'm just going to try to highlight the areas where the information has not been previously presented.

First, let me just talk about the head loss testing. The head loss testing was done at PNNL, and it was intended to characterize the pressure drop for various debris, types and distributions and to determine the effects of fluid temperature on head loss.

And what we tried to do also is that we tried to introduce better diagnostic techniques, in other words, to measure bed thickness and pressure drop and mass accumulation in the beds themselves, and ultimately we wanted to use this information to develop an improved calculational method for pressure drop.

This work is complete, and it has been published.

Just to summarize the testing that was done, basically there was a large tests loop where the testing was performed with temperature control, and we had an optical triangulation technique to measure the bed height during the testing. We also pressurized the loop to maintain gas in solution so that we did not have any two phase flow type of conditions, and we also introduced a filtration system to make sure that what we had in the debris bed was not added to or changed as we were doing testing.

There was a secondary loop that we had that was a benchtop loop, and it enabled us to do testing much more quickly, to give a sensitivity type of information that we could then use in developing the test matrix that was actually used for the large test.

The test matrix itself was constantly changing with input from the benchtop loop and just assessment of the data as it went along.

We performed a fair number of tests, as

indicated here. We had tests using a screen and a perforated plate alone without the accumulation of any debris. We performed CALSIL only tests where CALSIL was deposited on the plate or the screen.

NUKON only test fibers, and a combination of NUKON and CALSIL, which was a very interesting area.

And then we did very little tests, but we did some tests with coatings.

I'll just go to the conclusions of the testing. One, with all of the testing that we did, we did find that the NUKON only debris head loss tests were relatively repeatable. In other words, if we had two tests that had the same loadings of the NUKON only debris, the pressure drops that we would measure for a given velocity through the bed was very close and repeatable.

That was not the case with the NUKON-CALSIL beds because after we had the fiber bed made, which was the NUKON, and we the CALSIL, about the same amount for different tests, we would sometimes get different results. And so that seemed to indicate that the pressure drop was affected by the CALSIL or the particulate distribution in the fiber bed.

Regarding CALSIL only tests, we tried to perform a number of them in both the benchtop loop and the large loop, but we were never successful in creating a complete CALSIL only test bed.

Just further conclusions. We did find that the pre-preparation did influence pressure drop, in other words, how we prepared the fibers and the CALSIL particulates, how we ground it up and introduced it into the loop.

The more important thing though was even more than the debris preparation, was the loading sequence. We did find that if we used a pre-mixed mixture of NUKON and CALSIL we obtained pressure drops that were lower than what we would get if we, say, introduced NUKON and then built a fiber bed and then introduced the CALSIL after.

MR. WALLIS: On that topic, PNNL said that the range that they could get with the different ways of putting the same stuff in was three orders of magnitude. That comes right out of their report.

It wasn't clear to me, thinking back at your subcommittee presentation, that your theory ever predicted such a wide change in the range and possibility, depending on the arrangement of the bed.

Three orders of magnitude is an enormous range for the same constituents.

MR. KROTIUK: And the way I tried to introduce that with the modeling was that it was differences, but it probably wasn't of that order of magnitude.

MR. WALLIS: It was quite mysterious. It was actually when they put the CALSIL in first, and it sort of went part way around the loop and then came back.

MR. KROTIUK: Yeah. The worst case is when they added the CALSIL in first and sort of got a mixture going in the loop. Then they built a fiber bed, and then the CALSIL deposited on the surface or within the fiber bed; that was actually the highest pressure drop.

let me address the modeling.

MR. WALLIS: That's all right. Just by the way.

MR. KROTIUK: Right. One thing, because we had the optical triangulation measurements of thickness, we did see the bed contract and relax with changes of approach velocity, and generally, for most cases, the pressure drop decrease would increase temperature of the fluid, which is consistent with the classical theory.

MR. WALLIS: Not always.

MR. KROTIUK: Not always because, again, the pressure drop would be affected, especially the NUKON-CALSIL. It was primarily for the NUKON-CALSIL beds because the distribution of the CALSIL within the fiber bed itself could affect the pressure drop.

Now, let's just go to the head loss modeling, and basically what I used was the data from the PNNL testing and data from other tests also, the LANL and some of the Argonne testing to come up with a model that would try to be able to predict pressure drop, and this is published in the NUREG.

Okay. Let me just go over the model a little bit. The hypothesis of my model was this. I used a classical form of the performance media equation with some modifications and changes that's documented in the NUREG, but basically what I tried to say is that for a case where we had a bed that was composed of one kind of material, in fiber or particulate, that we could use a single homogeneous control volume to calculate pressure drop across that debris bed.

If the bed was composed of two types of materials, for instance, fibers and particulates, then I postulated that you could have various types of configurations. One is that you could have a homogeneous mixture of particles and fibers within the bed. You could have a situation where the fibers are on one part of the bed and you have particles mixed with fibers on another part, and I'll call these sort of a saturated condition. It's not really correct, but that's my terminology.

And then there could be a situation where you have particles mixed with fibers and then particles that are deposited on top of the particle fiber portion of the bed. And what I tried to do is develop a methodology whereby I could develop a lower bound and an upper bound pressure drop calculation, and basically what I found is that if you used a homogeneous approach for a particle fiber bed that you had your lower limit for pressure drop, and the hard part was to try to come up with a methodology to calculate the upper limit.

And I came up with a two volume approach whereby I actually did pressure drop calculations, say, for instance, in this case where I had the pressure drop calculations across the saturated particles in the fiber bed and then across the fiber bed itself.

The expansion and contraction of the bed itself was considered. Initially I assumed an irreversible process and then subsequently everything else was elastic.

And let me just quickly go over the conclusions. One is that the one volume model, the homogeneous model, was always successful in producing a comparative or maybe conservatively higher pressure drop for NUKON only tests, and I looked at the PNL testing, some ANL testing, and some LANL testing, and generally that conclusion was always present. The methodology was good for a bed composed of one debris type.

For the NUKON-CALSIL tests, the one volume approach, homogeneous mixture of NUKON-CALSIL, always predicated a lower limit for the pressure drop.

The methodology that I developed to calculate the upper limit using the two volume approach for a NUKON-CALSIL bed only worked about 75 percent of the time in being to predict comparative or conservatively higher pressure drops. It predicted lower pressure drops for about 25 percent of the tests that I had looked at.

And I found that the discrepancies primarily existed for cases where the CALSIL layer on top of the fiber was very thin, and the methodology that I developed to predict this thickness of the

CALSIL was very sensitive in that range, when you had low masses and low thicknesses, and that if you had small errors in your determination of that thickness, you could have substantial differences in pressure drop calculations.

MR. WALLIS: You got this layer by some kind of an unusual correlation.

MR. KROTIUK: Yes. It was completely an empirical correlation.

MR. WALLIS: There should be some accounting. We suggested that you simply put all of the particles on the top.

MR. KROTIUK: Yes. Okay, and I looked at that. Okay? If you want, I'll just say what happened when I looked at that.

MR. WALLIS: It will be interesting if you have some results.

MR. KROTIUK: Yes, I looked at a fair number of cases, and basically what I found, if you assume that it's all the CALSIL on the top of the fiber bed, that you definitely did bound all the test results.

MR. WALLIS: But a much higher pressure drop.

MR. KROTIUK: But much, I mean,

significantly higher, by orders of magnitude such that, you know --

MR. WALLIS: It's a bit like what we just saw with aluminum at Argonne.

MR. KROTIUK: Right. It just went up, you know. A measurement may have been, say, ten feet of water and we were predicting now 180 feet of water.

So I looked at it, and that's what I've so far concluded, and that's as far as I've taken it.

The methodology that we developed was successful in predicting bed thicknesses that were comparative to all of the test data for all of the tests that were looked at, and the calculation method generally predicts the higher pressure drops at the lower temperature, which is consistent with the classical theory.

MR. WALLIS: As a result of viscosity.

MR. KROTIUK: That's because of viscosity, changes in the fluid. Okay?

MR. WALLIS: And this work is finished now.

MR. KROTIUK: At this point, yes. I'm looking a little bit more at the suggestion, but it's primarily done, yes.

MR. WALLIS: So if industry were to use

something like this or to try to use something like this, presumably it would require some fairly extensive validation or something like that? Maybe an improvement of this exponential correlation.

MR. KROTIUK: Yeah.

MR. WALLIS: So there's more work required before it's something you can rely on.

MR. KROTIUK: As I said before in the subcommittee meeting, I'm not really totally happy with that empirical correlation, but it's the best I could come up --

MR. WALLIS: Well, it shows that something better can be done than the existing perhaps.

MR. SCOTT: This is Mike Scott.

If I can add also, as you all may recall, we've informed the licensees in our SE that the head loss correlations are only to be used for scoping. Now, we didn't of course have this one at the time, but the earlier 6224 was only to be used for scoping, and that the screen sizes are to be based on testing.

MR. WALLIS: Yes. Thank you.

Are we ready to move on?

MR. KROTIUK: Yes.

MR. WALLIS: Okay. Thank you very much. Are there any questions from the committee, any more?

(No response.)

MS. TORRES: Good afternoon. My name is Paulette Torres. I represent the Office of Research. Next to me is Mr. Robert Tregoning, and we are both going to present the results of the peer review of Generic Issue 191 chemical effects research.

The main objective of the peer review, the first one was to review the technical adequacy of research activity related to the chemical effects on PWR sump pool environment. These research projects addressed by the reviewers include the integrated chemical effect testing conducted at Los Alamos, the ICET follow-up testing and analysis also conducted at Los Alamos, the chemical speciation provision conducted at the Center of Nuclear Waste Regulatory Analysis, and the chemical head loss testing conducted at Argonne National Lab.

The second objective, which was to recommend research improvements and identify important technical issues for consideration, was added to the peer review when it became obvious early in the process that many of the issues being raised were outside the scope of the previous and ongoing NRC research program. The second objective during the initial peer review scope made the review more comprehensive.

MR. APOSTOLAKIS: How much time did you give them to review this? How much time did they have to review these documents?

MS. TORRES: A month.

MR. BANERJEE: Enough, enough.

MS. TORRES: Yeah, they started around --

MR. APOSTOLAKIS: There is never enough.

MR. BANERJEE: They did a great job.

MR. TREGONING: We have a kickoff meeting last October. We gave them initial documents starting in last August. We had them write a preliminary report last November, and we had a follow-on meeting in March, and then their final reports were due to us in May or June. So about nine months.

MR. WALLIS: Well, how much of that time were they paid for is the real job. If they were paid to do two hours' work in nine months, that's not a very big report. Presumably what matters is how many hours did they put in.

MR. APOSTOLAKIS: That's right. Calendar time really doesn't mean much, but if Professor Banerjee says they did a good job --

MR. BANERJEE: You will stick.

MR. WALLIS: Well, George, the peer review is about twice as thick as the report itself.

MR. APOSTOLAKIS: Why is it so difficult to get -- how much time did they actually spend? You don't know that unless you go to --

MR. TREGONING: Well, it varied by the reviewer. We had five different reviewers, but I think you can see by the nature and the quality and the depth of the report that some of them spent quite substantial amounts of time, including running analyses, scoping calculations. You know, so these were very extensive peer reviews.

MR. APOSTOLAKIS: They were paid.

MR. TREGONING: Of course.

MR. APOSTOLAKIS: Don't say of course.

MR. TREGONING: Of course.

MR. APOSTOLAKIS: Some organizations don't pay.

MR. BANERJEE: Well, my impression of it was -- in fact, I read the peer review very thoroughly, and my impression was that it was above and beyond the call of duty on some of their parts. Not all of them; two or three of them.

MR. TREGONING: I'll say when we got the peer reviewers together, there was quite a bit of synergy, and they fed off each other, which is not uncommon, and as ideas got bounced back and forth, you know, there's a big of one-upmanship, and a guy would want to go back and do some calculations to see if his issue was --

MR. WALLIS: They certainly hear an awful lot of different names of various crystal forms of all sorts of substances.

MR. APOSTOLAKIS: Okay. Thank you.

MR. POWERS: This is just showing off on the part of chemists. So yeah.

MR. BANERJEE: Some of them were chemists.

MS. TORRES: The Office of Research had recommendations for the peer reviewer selection from NRC staff, laboratories, the ACRS itself. The peer review consisted of five members, and they provided a range of technical expertise, such as filtration, analytical and experimental chemistry, corrosion, electrochemistry, and gel formation.

The group possessed diversity of experience. They were selected from nuclear and chemical industry, the academia, and national laboratories.

NUREG 1861 satisfied the first objective discussed earlier, which was review the technical adequacy of RES activities related to chemical effects in PWR sump pool environment. The NUREG 1861 was published December 2006. It describes the chemical effects peer review assessment process and summarizes each reviewer's significant findings.

The final assessment reports from each peer reviewer are compiled as appendices to the NUREG report, and the review is not a consensus review. Each reviewer was asked to provide an individual evaluation based on their particular area of expertise.

The PIRT process was used to satisfy the second objective, which was recommend research improvement and identify important technical issues for consideration. The same issues contained in NUREG 1861 were evaluated using the PIRT process to provide a balanced evaluation and ranking of the issues for further consideration.

MR. WALLIS: -- is a different report, is yet another report?

MR. TREGONING: Yes.

MR. BANERJEE: It is not completed yet, or is it?

MR. TREGONING: That's correct. It's not completed.

MS. TORRES: A summary of the PIRT process will be discussed by Mr. Robert Tregoning.

MR. TREGONING: Thank you, Paulette.

There's always a question about why you do a PIRT and when you do a PIRT. Quite often you may do a PIRT when you're embarking on a new technology area, like the Trisco fuel assessment.

Here we actually did the PIRT somewhat midstream, but actually the timing was, I thought, particularly good because we had done a body of work. We had learned some various important lessons, but we had a number of open questions and issues. Plus we were transitioning in this mode where we wanted to evaluate what issues might remain, and as we continued to work with the industry to move forward, we wanted to make sure that we were comprehensive in our assessment.

So that was one reason for doing the PIRT. The other reason, as stated on this slide, early on in the peer review process a lot of the comments that we were getting from the peer reviewers were well outside the scope of the original NRC sponsored research. So really the idea behind the PIRT was to use the process to identify and rank some of the issues being raised by the peer reviewers with respect to the post-LOCA chemical effects.

As Paulette mentioned, the peer review itself --

MR. WALLIS: This first bullet, actually that's right. The peers raised points which hadn't yet been addressed by the NRC. So it's clear that the scope of the sump column is broader than has actually been addressed by your research program to date, or appears to be from the peer review, anyway.

MR. TREGONING: The issues for consideration are certainly broader. I would agree with that.

And as you read, of course, when you do peer review, these were all intended to be independent peer reviews. So the PIRT process we wanted to use to bring at least some sort of consensus, not true consensus, but at least get some ideas of what the group together thought about importance and --

MR. WALLIS: After doing their review.

MR. TREGONING: This was in parallel.

MR. WALLIS: In parallel.

MR. TREGONING: They had done a substantial -- we did the PIRT at the last meeting we held. So they had reviewed all of the reports for about six months, and they had completed their preliminary assessment reports.

But it was about the time when they were preparing their final documents. That's why a lot of the issues you see in that peer review 1861 document, many of the same issues were raised and discussed in the PIRT, if not all of them.

So the PIRT really provides a natural way to characterize, identify, and rank the issues that some of them raised individually within the NUREG.

So the objective of the PIRT, and again, we really had a broad objective as you do in most PIRTs, is we were looking for all chemical phenomena which could lead to deleterious ECCS performance and also possibly damage reactor fuel due to inadequate heat removal in the post-LOCA environment.

I at least want to cover the PIRT evaluation criteria because I think it's important to know what the reviewers were looking at, and these evaluation criteria really mimic many of the phenomena that need to be addressed within GSI-191, the sump clogging issue.

But the difference here is the focuses on the chemical phenomena that would most likely affect these various things, both sump clogging --

MR. WALLIS: As long as they don't clog the sump until they become physical.

MR. TREGONING: Right, yes.

MR. BANERJEE: But it's the chemistry that leads to the physics in this case, right?

MR. TREGONING: I knew you would haggle with my definition here.

MR. WALLIS: Well, you can't forget the physical.

MR. TREGONING: Of course not, of course not. But the notion here that I wanted to stress, there's a lot of the physics that has been considered throughout this process.

MR. WALLIS: Affected by the chemistry.

MR. TREGONING: Of course. So what we really wanted to focus on was how the chemical environment and chemical considerations might affect an interplay with the physics that are involved. But I couldn't get all of that on one line on the slide.

So, again, we're looking for sump screen clogging effects, things that might degrade downstream component performance, diminished heat transfer, or affect structural integrity.

MR. POWERS: I was curious what you mean by "affect structural integrity."

MR. TREGONING: Things like large scale corrosion of support structures.

MR. POWERS: Those are very dramatic chemical effects

MR. TREGONING: Well, yeah, and to be honest, given the time scale, to be honest, none of the issues really -- that was a minor one. In fact, just for information, that was initially not one of the evaluation criteria, but the PIRT peer reviewers wanted to add that one themselves. So just to make sure they were comprehensive.

MR. POWERS: That would do it.

MR. TREGONING: Of course. So when we did the PIRT, to categorize the issues, we broke the post-LOCA cooling into four distinct time periods. Four time periods we used to represent different operational phases within the post-LOCA environment and also identify time scales associated with important chemical phenomena.

So the four that we looked at were the debris generation phase, which lasts about zero to 30 seconds during the blow-down event; ECCS injection; a direct ECCS injection, I should add, which again 30 seconds to about the onset of recirculation, which is variable depending on the plant, but 20 minutes is a typical number that you see there.

And then short term and long term ECCS

recirculation. Now, there was no reason to break up short term and long term ECCS recirculation. However, we know a lot of the margins that licensees have to deal with. They're minimum right at the onset of recirculation.

So we wanted to identify phenomena that might be working early in the process, and we again arbitrarily cut it off at 24 hours, and then look at phenomena that might be at play much later, 24 to 30 days.

And we cut the exercise off at 30 days, although many of these phenomena, again, would continue to transpire as long as the mission time would need to occur.

Now, the PIRT approach was very standard. We had brainstorming issues. We brainstormed within all of these four time periods, and then we had the experts individually rank issues with respect to importance, and we just used a three level classification scheme, high, medium and low, and then also knowledge also three level, known, partially known and unknown.

The way we did the PIRT, while we had them do their initial PIRT individually, we did come back after we accumulated all of the results and had a feedback session because as you might imagine, some issues some people ranked high, some people ranked low, and we tried to understand the reasons for the disparity in the results.

Was it just difference in technical opinion or in an understanding of what the issue was? So we also had some feedback. We had several conference calls where we addressed issues and tried to reconcile areas where we had differences of opinion.

I'm not going to go over all of the PIRT results because, again, we're still preparing that, and you'll be seeing something on that within the next few months, I would expect. But I do want to touch on some of the issues that were raised not only by the PIRT, but then also within the NUREG 1861.

The issues can be grouped a number of ways. I've chosen seven categories. Again, there's nothing unique about these, but a lot of the issues fall within one of these seven categories.

Underlying containment pool chemistry. Again, by "underlying," I mean the containment pool chemistry that's formed as a result of the reactor break. So not so much chemicals that get added in after the break, but the initial chemistry that's formed upon the break.

Radiological considerations; physical, chemical, biological debris source terms; core solid species precipitation; agglomeration and settling. And, again, I wanted to emphasize with the agglomeration and settling that the emphasis here is on chemical effects and how they may affect agglomeration and settling.

Organics and coatings, and then downstream performance of pumps, heat exchanger reactor core.

So with --

MR. BANERJEE: Would you include the temperature gradient effects that they refer to?

MR. TREGONING: Yes. In fact, you've caught my next slide already.

So what I've done here, all I've done for your consideration, I picked ten items, ten issues. Ten is a good number, and these were issues that were important. They were raised either individually or as a part of the PIRT process.

But I also wanted to span all of the different categories that we talked about. So the one that you've mentioned, Dr. Banerjee, is this ECCS thermal cycle effects under solid species precipitation.

So what I'm going to do now, I'm just going to talk about these ten very briefly to describe and define what the issue is. Okay? So that's what I'm going to do on the next two slides.

So the first phenomena, containment debris mixture effects. The idea here is that different debris characteristics, and that could be the mass, the mixture, the constituents of the debris as well as the compositions of debris.

MR. WALLIS: Several reviewers talked about scrubbing of CO_2 out of the containment atmosphere. It doesn't appear here, but it's not a kind of containment contributor to the sump.

MR. TREGONING: Well, that was an interesting one because that was one that early on in the review process got a lot of attention, and there were some calculations that were done on that. And later on when we had the PIRT, it actually came out being of relatively low importance.

MR. WALLIS: So it was less than --

MR. TREGONING: Yes. so initially it was highlighted as being a potential concern, but that was one that, again, some of the individual peer reviewers actually followed up and addressed that concern to help inform their PIRT evaluation.

MR. BANERJEE: And the aging of the concrete and structures, that was also minor effect, yeah.

MR. TREGONING: That's a more important effect, and the notion there was that would introduce carbonates into the containment pool environment. I think some calculations were done though, and at the risk of speaking out of turn, there's other contributions of carbonates that may actually overwhelm those contributions. So that was some of the consideration that went into this.

And as Dr. Shack mentioned, it's a dirty environment. So there are cations, anions floating around the containment pool.

Again, I'm not trying to be exclusive here. There are other things that are still important. I've just picked ten somewhat randomly, and like I mentioned earlier, I wanted to pick ten to sort of fill --

MR. BANERJEE: These are the ten highest ranked?

MR. TREGONING: Not necessarily. They were ten highly ranked. Like I said, I wanted to give coverage in all of these areas. Okay? So these aren't necessarily the top ten that we need to work down, but these are ten that were ranked highly that are somewhat representative, and they were issues that were raised by a number of the peer reviewers, so not just one peer reviewer.

So briefly, let me define these. Again, I define the containment debris mixture effects; pH variability, and this was with respect to the initial variability within the reactor coolant system as well as the evolution in pH that evolves in the post-LOCA process.

We've seen in many cases the effect that pH can have dramatically on chemical environment and precipitation that occurs.

Radiolysis effects, specifically the effect of core radiation fields on the formations of radicals, primarily hydrogen peroxides and the notion that that can effect the readout potential, which can then fundamentally affect the types of chemical products and precipitants that could form.

Another issue was radiolytic conversion of nitrogen. This is certainly not a new issue, but it's one that within this context there was concern that the nitric acid that was formed during this may actually alter the containment pool pH.

MR. POWERS: When they thought about that, did they give consideration to the radiolytic attack along your cable insulation?

MR. TREGONING: They did, although that was the one -- that was an aspect that was specifically considered in ICET because we added -- at least I added hydrochloric acid to simulate the breakdown of cabling insulation within ICET.

I think those are amounts -- Bill might correct me -- but I think it was around 100 ppm or so, and I think there was some thinking that the nitric acid effect may actually be a bigger effect

You don't think so?

MR. POWERS: Small effect, typically.

MR. TREGONING: Okay.

MR. POWERS: Well, it depends on what your dose rate is and your containment.

MR. TREGONING: Right.

MR. POWERS: But my recollection is that if you use two mega rads per hour for your equipment qualification for an ECCS in a PWR, that's my recollection, and that's a healthy enough dose rate. Of course, it depends on how much cable you have in the containment.

Some of these containments have enough cable.

MR. TREGONING: Right. Okay. Well, thank you. That's good information to have.

The other area was crud release, and I think that's important to define what we mean by crud, and these are essentially the iron and nickel corrosion oxides from RCS piping that are released during the hydrolic thermal transient due to the LOCA.

And the idea that the crud release itself could create a radiolytic environment on the sump screen debris beds that could affect subsequent reactions. So you'd have some percentage of that which would settle out, but you could have some crud that makes its way to the screen and actually affect the reactions that go on right at the sump screen.

Some other issues that I've chosen to highlight is the silica concentration and the idea that we at least need to consider the presence of silica both in the RCS and the water storage systems. The idea that it can combine with certain cations to form species with retrograde solubility, of course, that's particularly of concern because you want to make sure that you don't have plating on the reactor fuel or other hot surfaces.

And that also of course silica also provides another source for precipitation as well.

Thermal cycle effects, which Dr. Banerjee referred to. The idea that there's at least two thermal gradients throughout each cycle that a volume of water goes through during ECCS recirculation. There's cooling that occurs when it goes across the heat exchanger, and then there's subsequent heat-up when it gets near to the fuel cladding surface.

And there was concern about precipitation under both of those types of environments, where the high temperature would cause species with retrograde solubility to precipitate out while the heat exchanger would cause normal precipitates due to solubility considerations.

And also co-precipitation would affect what would go on there as well.

Quiescent settling of precipitates. This was the idea that the nominal low flow rates within the containment pool may allow many chemical species to settle out or may allow them to grow, to become larger particles, more stable particles because they don't have the hydrodynamic forces that would tend to keep them small.

Coating decomposition and leaching, again, they were two different effects. One was classical leaching from sump coatings, and ones that were raised were lead based paints, which I think are in some of the older containments, phenolics and PVC, and then also hydrothermal hydrolysis that would essentially depolymerize some polymeric materials, and you could actually get gels forming from that depolymerization process.

MR. POWERS: If you look at the work that's gone on in Canada, they would insist loudly that what you leach from the paint is the folic, and that the ketone that comes out of there gets converted radiolytically into an organic acid.

MR. TREGONING: Yes, I'm aware of some of that work, and that's something that we'll certainly be looking at moving forward.

MR. POWERS: I don't know whether it's true or not, but they will insist it very loudly.

MR. TREGONING: Yes.

MR. POWERS: And God help you if you're talking to them and don't bring it up.

MR. ABDEL-KHALIK: Some plants are talking about changing their normal operating water chemistry to operate in a high pH regime to reduce AOA likelihood of axial offset. How much would an increase in the normal operation pH affect the post-LOCA pH in the sump?

MR. TREGONING: Well, right now initially there'd be an effect in terms of the initial conditions at the break, but because of the amount of buffering that's used overall, my expectation would be it would be a second order effect at least with respect to longer term pH in the sump pool.

MR. BANERJEE: I suppose one way to deal with this, which I'm sure industry is looking at is to either change the buffers or maybe remove some of them, in which case, I guess, that would have more of an effect, right?

MR. TREGONING: Yes. If there was no buffer, then, yes, you're driven by the chemistry of the RCS plus the injection system at that point.

MR. MAYNARD: Probably more so by your refueling water storage tank volume, and that's going to be a larger volume, and it's going to influence your pH more than the RCS pH itself.

MR. BANERJEE: Right.

MR. CORRADINI: So maybe you said it at the beginning and I missed it. These are just examples of phenomena to consider. These are not the high importance phenomena nor the unknown phenomena.

MR. TREGONING: No.

MR. CORRADINI: These are just example.

MR. TREGONING: They're examples, but --

MR. BANERJEE: All of them are unknown.

MR. TREGONING: -- they're examples that in the PIRT process were identified as being of high importance to consider.

MR. CORRADINI: But not necessarily unknown in terms of a knowledge base to evaluate their effect.

MR. TREGONING: Right. What I haven't done is, again, there were separate rankings for knowledge state, and there's two types of knowledge state. There's knowledge state with respect to the basic physics, and then there's knowledge state with what actually exists within a given, let's say, a single plant environment.

So there's two types of knowledge that you really have to look at when you're evaluating these things, but, no, what I haven't done in this is indicate ones that we thought we had particularly I'll say a low level of knowledge state on.

MR. POWERS: Well, when we looked at the TMI sump, we saw a lot of copper. Obviously we were corroding out copper wires and things like that. Did the experts comment on copper coming into the sump?

MR. TREGONING: You know, we talked about copper, and because of TMI, of course, copper was something that was considered in the ICET test. We never saw much copper though actually within that ICET test.

So when we went through the PIRT we identified all of the different metallic components that could cause corrosion, that could corrode and then, you know, lead to ionic species contribution to the sump pool environment. And copper was considered, but again, I think based on ICET and other considerations it hasn't been a driving consideration at this point.

MR. POWERS: Well, I know that certainly on the TMI sump we definitely had lots of copper in there.

MR. TREGONING: Right.

MR. POWERS: And I know it definitely has a huge effect on aqueous radiochemistry. Now, whether it affects any of this stuff or not, I have --

MR. TREGONING: Well, I have to be care -- learned a lot of lessons from TMI, but it was certainly not prototypical in terms of how post-LOCA cooling would be expected in an ECCS.

MR. CORRADINI: Why is that? Because it was a small break and you'd only get these sorts of deleterious effects when you have a large break and a lot of break-up of the insulation?

I assumed just the opposite, that TMI might be very representative.

MR. TREGONING: Well, they pooled cooling water from the Susquehanna River. So that was one thing that was certainly not prototypical, and the other thing that you have to remember, and I think others may correct me, others more knowledgeable, but by the time they actually had got in to evaluate what was in the sump, some time had passed.

MR. POWERS: We were doing it within days of the accident. I was getting samples within nine hours.

MR. TREGONING: So you were even seeing high copper then.

MR. POWERS: Oh, yeah, very early.

MR. TREGONING: Within days.

MR. POWERS: Very early in the accident.

MR. TREGONING: What do you attribute the high copper to?

MR. POWERS: It's just cables are being -- electrical cables are being collated.

MR. TREGONING: Okay. Because the interesting thing, again, when we ran the ICET test, we didn't see large amounts of copper, by and large.

MR. POWERS: Yeah. Well, see, you weren't running a radiolytic solution over copper wires there and having it drip down into the containment sump.

MR. TREGONING: Okay. You know, that's something we probably at least need to follow up on.

MR. POWERS: Well, I don't know that. And, in fact, they bring up lead based paint and lead is interesting because it will form a hydroxide that's kind of amorphous and ugly and things like that. I just wondered if they had commented on the copper. I don't know that it's a major contributor.

By far and away the biggest contributor was aluminum oxide. I mean there was sludge everywhere, in the sump very critically.

MR. TREGONING: In the samples.

MR. POWERS: Yeah. You had a gradation, and it was mud at the bottom of the sump.

MR. CORRADINI: So if I might just go back, you kind of said something that kind of triggered my interest.

So you said TMI wasn't representative. I mean, has the staff thought about what makes it atypical versus typical in these various areas of concern in terms of timing and chemicals present and various particulate?

Because it would just seem to me given the fact that we've been lectured that large breaks are a low probability event and small breaks are a probable event and all of this, it seems to me TMI might be a very representative sampling of how I might go into a large recirculation phase for a very long time.

Granted, they may have handled it differently than the typical bad accident, but it would seem to me -- so am I missing something in that?

MR. TREGONING: I think Tom Hafera from NRR is going to address that question.

MR. HAFERA: Tom Hafera from the plant staff.

Recognize, okay, many plants on small break LOCA don't even go into sump recirculation mode. They cool down, depressurize, and go right into shutdown cooling mode.

Small break LOCAs don't generate a lot of debris. They don't transport a lot of debris. They don't create a lot of mixture of debris. Really TMI was a very unique event. You know, TMI, they pumped river water, and I thought that was pretty much well documented, that the majority of the source of some of their chemical concerns were from when they pumped the

Susquehanna River into the containment.

MR. CORRADINI: Okay.

MR. HAFERA: I don't know. Maybe we can produce an updated document or a document to tell us that, but the staff, we're certainly considering all of these things, and we evaluate LOCAs in many ways, not just small breaks, but large breaks, and we're typically finding that the small breaks are not as limiting. Let's just say it that way.

MR. CORRADINI: Thank you.

MR. TREGONING: And there have been other experiences where we've have plants go into recirculation mode that we've been able to learn lessons that we thought were probably more realistic.

Well, again, Tom should have stayed up there, but you know, Barsaback (phonetic) is -- just looking for operating experience questions, especially with BWRs.

MR. BANERJEE: Sump clogging.

MR. HAFERA: Well, clearly, Rob mentioned, yes, BWRs. We have seen that there is actual operating experience in the boiling water reactors based on their containment designs, the fact that they have a suppression pool or a tourist that's maintained in a turbulent, how flow rates are much higher and suppression pools and turbulence are much higher.

The post LOCA flows are actually directed there versus the pressurized water reactors, this large building containment that's open, typically large areas of very low flow velocity where debris can be settled out.

And plus, the other one is that they're designed typically to blow the debris to the upper levels of containment. So to then get the debris from the upper levels down, all of these issues, you know, get factored in, now, recognizing that the strainer is nothing more than a subcomponent of the RHR system and it supports operability of the RHR system to meet 5046 criteria.

MR. TREGONING: To get back to your original copper question, Dr. Powers, we did discuss it. I can go back and pull some of that information up. I'm not at liberty unfortunately right now. So I can do that if you're interested.

MR. POWERS: It's not worth pursuing very far.

MR. WALLIS: I'm worried if you're going to meet your deadline of time here.

MR. TREGONING: It depends on the amount of questions. I've only got --

MR. WALLIS: Three, thirty, is it?

MR. TREGONING: Yeah, I think so. I think so.

The other thing we got from the peer reviewers, we got issues, but they also gave us recommendations on how to proceed with testing and analyzing some of these issues, and I wanted to at least -- these are mainly contained not within the PIRT process, but these were mainly documented in the NUREG itself. So I wanted to make sure that I summarized these.

A number of them indicated that small scale testing can be used to effectively evaluate the effects of key variables, especially looking at quantifying variables affecting solubility, addressing temperature cycling effects, and also evaluating specific combinations of materials not in the ICET test.

There was a lot of --

MR. BANERJEE: As hydrogen peroxide, I take it.

MR. TREGONING: Yes, potentially. And by materials I'm thinking other insulation materials or other materials that you would find in containment as well because there's a whole suite of materials out there that the ICET by its nature was not able to simulate.

There was a lot of discussion about the analytical modeling work that we had done. I think the general consensus is the work that we had done, didn't fully exploit the existing capabilities of available codes. Again, we had done thermodynamic equilibrium calculations, and many of the reviewers thought that we really needed to either explicitly or implicitly consider the effects of kinetics, and then also potentially that we could use these codes to incorporate and address some of the radiological considerations.

However, I have to mention this last bullet since this has been a point of discussion several times both within the NRC and then also at ACRS meetings. A number of the reviewers recognize directly in their reports that modeling the chemistry at the sump screen from first principles is highly challenging because of the fact that it's expected to be non-equilibrium and the numbers of different types of reactions that are expected to go on over the mission time, 30 days.

So a number of the reviewers thought that trying to develop a code at this point was probably well beyond the existing capabilities of any of these commercial codes and would certainly be a state of the art exercise.

So I think a number of the reviewers really recognized the challenge of that.

MR. WALLIS: The debris on the bed itself is a very good reactor. I mean, they're flowing fluid through it all the time and bringing it into contact with --

MR. TREGONING: Yeah.

MR. WALLIS: And that was in there.

MR. TREGONING: And that's exactly the point.

MR. WALLIS: Bed reactor.

MR. TREGONING: Yeah, and then if you've got --

MR. WALLIS: And the sump within the bed. You've got this very good atmosphere for chemical reactions.

MR. TREGONING: Right. So how are we moving forward with the issues that we got from the peer review? This slide I'm going to talk about a general path forward, and then I'm going to give some examples of dispositioning the items that I raised earlier. These are just examples of disposition.

This isn't any -- and it's based on my proposal. So it's not an official disposition at this point certainly.

The issues that have been raised, certainly we'll be communicating this information to both the vendor teams and the licensees that are evaluating chemical effects, and we want to do that in a way to facilitate resolution of the generic letter responses.

As I mentioned earlier, currently working on documenting the PIRT process and summarizing the important issues identified in the PIRT.

Now, this initial document will not deal with disposition, but it will simply document the PIRT process and then the results from the process.

And then individually we'll we looking --

MR. BANERJEE: This was sort of finished at least with the peer reviewers about a year ago, right?

MR. TREGONING: No, not quite a year. We finished the PIRT about last July of so.

MR. BANERJEE: Okay, and so why is it sort of taking so long? Is it because not much effort is going into this right now?

MR. TREGONING: Documenting a PIRT process can be fairly lengthy because, again, the process itself, as well as summarizing the issues, you've got to draw on a lot of sources. So we've had to enlist the peer reviewers at various points in time to help fill out the document. So it's just taking the some to put the document together.

However, you know, the initial push was to get the documents out there, including the NUREG with their peer review comments so that they would be available publicly, and we always expected that the PIRT process would lag slightly behind that process.

MR. WALLIS: Finished in July if it's not documented, and they're still working on it.

MR. TREGONING: They finished the assessments in July.

MR. POWERS: If you're ever been through these things, there's lots of meetings and agonizing over filling out of charts and things like that, but then somebody has to go through all of that junk and try to make sense out of it.

MR. CORRADINI: And write it up.

MR. POWERS: And write it up, then send it back to the experts and see if their write-up agrees and where it doesn't, fix that. And of course, one guys says it's blue and the other guy says there's no change and it's green, and so there's quite an iteration. I mean it essentially doubles the --

MR. WALLIS: So they're still working on it then. There is --

MR. BANERJEE: Is that iteration going on or is it a dead duck right now?

MR. TREGONING: There's been some of that iteration. The document itself though is still in preparation at this point. But there has been iteration certainly as Dr. Powers indicated to make sure things are being captured appropriately.

MR. MAYNARD: A lot of times during the writing and the summary you almost go through another review process. I mean it's open to the question.

MR. BANERJEE: Right. If that's going on, it's fine, but I'm trying to get the real understanding of whether this is a very active area or one where sort of interest has waned or let's say activity has waned and sort of this decline right now.

MR. SHAW: No. In fact, interest has never been higher certainly.

MR. BANERJEE: Interest is high. Activity?

MR. TREGONING: Yeah, activity is. Interest and activity are quite often correlated.

MR. BANERJEE: They are in this case?

(Laughter.)

MR. BANERJEE: Are they actually in this case?

MR. TREGONING: Yes, they are correlated, as one might expect.

MR. WALLIS: What's the zero per month if it's active?

MR. TREGONING: I'm sorry?

MR. BANERJEE: So how many people are working on this right now? Let's ask it straight.

MR. TREGONING: How many staff or how many peer reviewers? I mean --

MR. BANERJEE: Staff, peer reviewers, whatever.

MR. TREGONING: You know, I think there's probably at least three staff that are involved in the PIRT in one form or another..

MR. BANERJEE: What fraction of -- I mean, I'm just trying to understand what fraction of time is involved in one form or another.

MR. TREGONING: What are you really trying to find out.

MR. BANERJEE: I'm really trying to find out whether, as I said, is this an active area or has it been basically dropped or partially dropped.

MR. TREGONING: One thing I will say is that you've seen all of the activities that we've had in the GSI area. We've been incredibly active as a group in terms of publishing and disseminating information and then working with NRR on evaluating the industry's path forward and making sure that they're informed and making sure that our evaluations are informed.

So it's a continual process, and with any process we juggle all of our priorities and commitments appropriately. So, yes, it's active, but also I would say in the same token that, yes, we're doing multiple things at the same time.

MR. POWERS: Just a brief idea, Rob. How many people do you think were attending the session for the American Nuclear Society meeting in Albuquerque for this?

I mean, we filled the room.

MR. TREGONING: Yeah. No, it was a good turnout.

MR. POWERS: The biggest room we had for concessions and we filled it.

MR. WALLIS: But this wasn't a discussion of research results, was it?

MR. TREGONING: Yes.

MR. WALLIS: It was?

MR. TREGONING: Yeah.

MR. POWERS: Mike Scott gave an outstanding introduction and Rob held forth for two hours, I guess.

MR. TREGONING: Well too long.

MR. WALLIS: No, he's very good at that. We know.

(Laughter.)

MR. WALLIS: Two minutes.

MR. TREGONING: I'm not quite sure if that's a compliment or not.

MR. POWERS: It wasn't.

MR. TREGONING: I don't think it is.

(Laughter.)

MR. TREGONING: I'll take it as one, but I know you didn't intend it as one.

Okay, and I'm almost done here. So we'll be dispositioning individual items and when we do the dispositioning, we'll be looking at where the industry is moving forward as mitigation. We'll be considering in more detail specific plant conditions, and as necessary, we'll be doing literature review scoping calculations, and then identifying anything that needs either targeted follow-on industry sponsored or NRC sponsored research.

I really think that issues are going to fall within three categories, and if I look at my ten here, I think many of the issues, and I think we're seeing that already, are already being explicitly considered in the resolution. And of the ten I've listed, at least five of them, again, are currently part of the resolution plan.

The challenge that we've got there is to make sure that with respect to the chemical effects, that we're either conservatively or realistically evaluating those effects. So that's still a challenge that we've had certainly.

Several of the issues that they raised do actually promote favorable chemical effects, and of the ten that I listed, there's one that clearly falls within that arena, and that's quiescent settling of precipitates, and again, I think with those issues that there will be opportunities that will be available to utilize those attributes in the resolution of the generic letter.

MR. POWERS: Nobody specifically said the words Oswald Ripening?

MR. TREGONING: Oh, yes. We had a lot of

discussion of Oswald Ripening in the peer review.

And then there will be a host of other issues that will require some pencil sharpening and some additional consideration, and of the ten I think there's four of those that probably will very easily fall within that mix.

And this one I just wanted to -- again, we got some very good testing and analysis recommendations, and I want to give the notion here that we are utilizing these recommendations and not just us, but there was questions earlier about how is the industry utilizing these information, and not only is industry explicitly using some of the information that's coming out of the research, but the strategies as well.

So the small scale single effect type testing, I think you've seen some of that in some of the surrogate testing work that ANL did, presented a little bit here today. Industry has used that approach in developing chemical source terms, and again, it could be an important techniques for considering plant specific issues.

There's no plans to develop a comprehensive chemical effect head loss code, again, following up from the previous slide. However, we certainly do believe that codes are valuable for addressing specific chemical effects phenomena, things like solubility, radiological considerations, and then predictions of precipitated species.

So there is certainly codes will play a role here, and we expect that codes will see use to evaluate some of these issues as we continue to move forward.

So the conclusions. The peer review attempted to comprehensively consider chemical effects, and again, when I talk about the peer review here, I'm talking about both the NUREG and the PIRT. They identified several chemical issues for consideration. The next step that we'll be working to is disposition specific issues. We're going to disposition these issues the same way we've been dispositioning all the issues that get raised with respect to the generic letter. So there will be nothing unique or unusual about the disposition process.

And I mentioned earlier that as we go through issue resolution, we'll make sure that we need to consider the industry mitigation strategies, specific plant conditions, and using scoping analyses as appropriate to identify any remaining issues that may need some more in depth study.

And, again, there's a recognition that the peer reviewers provided some valuable recommendations for addressing any issues that do remain.

MR. WALLIS: When you disposition these issues, are you going to go back to some of the peer reviewers and say this is how we dispositioned your issue? Do you agree with what we did? Are you going to do anything like that?

MR. TREGONING: I don't want to commit. I think we certainly may.

MR. WALLIS: It might be worth considering for a few things.

MR. TREGONING: Sure. Depending on the complexity of the issue, I think bouncing off the peer reviewers saying, "Hey, this is what we did. Do you think that this is an appropriate strategy?" I think that would be particularly appropriate.

And I just want it noted for the record that we started ten minutes late.

MR. WALLIS: I was going to say you did a very good job here.

MR. TREGONING: And that we finished almost more than five minutes on time or before our time.

MR. POWERS: Recognize, of course, that the committee holds you to blame for any of the deficiencies of start time or finish time.

MR. TREGONING: Can I have a motion to take the ten minutes extra and apply it to a subsequent presentation?

MR. POWERS: No.

MR. WALLIS: So now it is time to ask the committee if you want to ask Rob anything else, make any other observations.

MR. POWERS: I wanted to understand just a little more on the concern over crud. The amount of mass from crud is not very high. The only concern I could think of is the dose that you're getting from it, but the dose is already high.

MR. TREGONING: A couple of things with respect to the crud. The mass isn't high. I mean, we've heard things around 100 ppm, but there are several things that potentially are added. You're adding the radiological consideration to the loop. You're also creating additional co-precipitation sites.

MR. WALLIS: You're adding iron that you didn't have before.

MR. TREGONING: Well, you're adding iron

and nickel certainly.

MR. POWERS: You're tearing up the ying-yang here with the iron everyone.

MR. WALLIS: This is iron in --

MR. TREGONING: We didn't get as much iron as you would think in the ICET testing.

MR. POWERS: You will have iron everywhere.

CHAIRMAN SHACK: I mean, iron in a pH 9 environment, you know, that's pretty benign on iron.

MR. POWERS: Yeah, but there's iron everywhere.

MR. WALLIS: What form does it have?

MR. POWERS: Ferric oxide and ferric oxy and hydroxide.

MR. ABDEL-KHALIK: Ferrite, nickel ferrite.

MR. POWERS: Almost none.

MR. TREGONING: But the other thing with the crud is having that iron in there, depending on the redox and the amount of oxidation potential of the environment will determine the types of species that you might get that could form, you know, as --

MR. POWERS: Or catalytically to compose all of your hydrogen peroxide for you.

MR. TREGONING: Well, yes, and another consideration, again, even though the dose is much lower than in the core, but that if you got it trapped, if you had crud that actually made it through and trapped on the sump screen --

MR. POWERS: You've got gap release in this sump. That's a pretty fair dose right there. I mean what you get from the crud is largely manganese and Cobalt 60. And that kind of pales in comparison to the cesium.

MR. TREGONING: Well, I think we may be enlisting you to disposition certain of these issues as well. So --

MR. WALLIS: Okay. Are we through? We are through.

MR. BANERJEE: One thing which is still open is when are you coming? Mike had said that you are coming back in May or June. Is that still a date?

PARTICIPANT: Tentative date is May 16th.

MR. BANERJEE: I just wanted to verify.

MR. SCOTT: We plan to come back in the middle of May, yes.

MR. BANERJEE: Middle of May?

MR. SCOTT: Yes.

MR. BANERJEE: All right. Thanks.

MR. WALLIS: Which is quite soon.

MR. BANERJEE: So you'll have some idea of what industry is doing and things like that?

MR. SCOTT: The research guys can confirm this. I believe that we're going to, as one of the items we're going to talk about in May, we'll give you a progress report on this, right?

MR. TREGONING: Yes, we will have a progress report on this certainly, but I think his question was more --

MR. WALLIS: Well, will May be the time when we'll be ready to advise the Commission about how you are doing about actually resolving the issue? Will that be the time or will we have to wait a little longer?

MR. TREGONING: I'm sorry, Graham. What was your question?

MR. WALLIS: Well, the Commission, I think, would like opinion from us about how well you are doing in resolving this GSI. They've asked us to keep track of things and help them from time to time.

Will maybe the time when you sort of said, "This is where we are and we're on track and everything is going well," and so on and so on and so on, we can write the Commission that that's the case, or should we wait a little longer until we've got some more evidence?

MR. SCOTT: Let me tell you I've been kind of devoting a little thought as to what we would come talk to you about. For example, there are two key topical reports out there, one being the downstream effects ex vessel and the other being the chemical effects WCAP. Those documents, the RAIs have already gone out on, and we expect to have gotten responses to those by May. So we plan to come in and have both the staff and hopefully the owner's group give you an update on where we stand with review of those documents.

We will, as I mentioned earlier this afternoon, we will only just have -- well, actually by the time we're talking to you in May, we will not yet have received the in vessel topical report. So the jury will still be out on that issue.

The chemical effects testing that I know we're all interested in will be in progress then in some cases. We hope to bring you an update on some hopefully results on what's going on with chemical effects. Whether --

MR. BANERJEE: This is industry testing, right?

MR. SCOTT: Yes, that's correct. Whether that would then put you in a position to give us another report card on how we're doing, it might still be a bit premature, but that's the sort of subject I thought you might find of interest to hear from us on in May, and if you all have any different subject areas you'd like to hear about, maybe we should talk about them.

MR. WALLIS: That's fine. I think what you're going to tell us about is fine. It's just that if you could bring it up to the point where we could reach some conclusion, that would perhaps be good.

MR. SCOTT: Sure. I understand. I don't think that in May we're going to be at a real high confidence level yet that we know whether the chemical effects are all going to be resolved by 12/31/07 or not. I don't think we're going to have enough information at that time. We'll tell you what we know certainly, but we may not be far enough along in May to be able to give a complete picture of that.

MR. WALLIS: Okay. Thank you.

I'm ready to hand it back to the chair. Is that okay with everybody?

In that case I will do so. Thank you very much, everyone who presented.

MR. BANERJEE: So we will take a break now until five of four.

(Whereupon, the foregoing matter went off the record at 3;39 p.m. and went back on the record at 3:56 p.m.)

CHAIRMAN SHACK: Our next topic is the technology-neutral framework and related matters. I'll ask Dr. Kress if he will lead us through this.

MR. KRESS: Okay. Yesterday we had a future plant design subcommittee to review this issue. Practically everybody here was there. So I guess this part of the meeting is just for you, Sanjoy. You're the only one that wasn't there yesterday.

MR. BANERJEE: I was trying to teach without success.

MR. KRESS: Oh, okay. But anyway --

MR. POWERS: So was Mary.

MS. DROUIN: I thought we had a successful meeting yesterday.

MR. KRESS: I thought it was a very good meeting, and it supposed to help us maybe respond to an SRM. We were tasked by the Commission to make a recommendation on the relative merits of going ahead and continuing and finishing this approach versus the development of a framework specific for a given design.

I don't know if I captured the exact words, but it's something like that. So we were tasked with that, and perhaps this meeting will help us respond.

Plus I consider this as a fine opportunity for the committee to provide feedback to the staff on the framework, how we think they're doing and if we have any areas where we think this framework needs to be improved or refined. This is the good chance to let them know because they intend to publish the framework, which by the way the framework is the NUREG. Those two are identical. So they would like to publish it soon. So it's a chance to give any feedback we may have on that, in addition to developing a response to the SRM.

I think if I read the subcommittee right, and I think I do, there was some indication that framework work on it may be stopped, and I think we would prefer that there at least be continued work on it in some way. Maybe it's cleaning it up a little and then doing an application, specific application to benchmark it.

But anyway, having said that, I'll turn it over to Mary and let her lead us through this. I don't know if Farouk wants to make these comments.

MR. MONNINGER: Good afternoon, Mr. Chairman, fellow ACRS members. May name is John Monninger. I'm from the NRC's Office of Nuclear Regulatory Research. I'm the Deputy Director for Probabilistic Risk and Applications.

I want to thank you very much for taking the time and allow us to have the opportunity to present the framework to you. We've been working, you know, very closely with the ACRS, with the other offices within the NRC, NRR, and the new NRO in this. In addition to that, with stakeholders out there.

You know, this has been a very important project for us for the past three years, and essentially what it was meant to do was to pool together, you know, the various policy and technical issues that have been identified throughout the years, through such policy documents as the NRC's safety goal policy, the advanced reactor, the severe accident policy statement, and to pool these together for guidance for, you know, future reactors, for regulating future reactors.

You know, in development of this project we had multiple meetings, multiple stakeholder workshops to solicit input and guidance from the industry out there.

One of the things I think is important with where we are in this project is to be cognizant of the fact that, you know, we have been working on it for several years, and we've made some significant accomplishments in it. And approximately, you know, a year or so ago they passed the Energy Policy Act, and you know, there's a notion that, you know, it's a changing environment out there, and what we would like to do is recognize the future efforts that are coming down the road, in particular, you know, the development of the licensing under the licensing strategy for the next generation of nuclear power plants.

And the question is, you know, how could we use what we've done in the past and potentially feed into those projects.

So with that in mind, you know, I'll turn it over to Mary Drouin. She's been the lead project manager on this project sine its inception.

MR. POWERS: John, before Mary starts, let me ask you a question more pertinent to what our job is than yours. Is it not true that consistency is an attribute of good regulation and that without a framework it would be difficult to have a consistent regulatory structure?

MR. MONNINGER: Consistency, predictability, I mean, is paramount. I mean to not only the agency's success, but you know, any potential future.

MR. POWERS: So, I mean, it seems to me that this is an absolutely essential activity for the staff to undertake in order to carry out the Commission's mission in a consistent and predictable fashion.

MR. MONNINGER: Yes.

MS. DROUIN: Thank you, John.

My name is Mary Drouin with the Office of Research. We're here today to try and provide with you what our status and plans are with regard to this thing that we've come to call the technology neutral framework, where we are with it and where we go.

I want to very quickly go through the history, and when I say quickly, because I'm not going to take you through the myriad of SECY papers and SRMs. There's been a lot of communication and reports that have been developed during this program. Tell you where we are now and as you're aware we did issue -- there was an ANPR that was issued very directly related to the framework. Give you some of the feedback of the stakeholder comments, and then where we plan to go.

The program, you know, did get initiated back in January of 2003. When you go and look at the RES advanced reactor research plan, that's where it was first recognized, the need for the framework.

And it got to some of the things that you just brought up Dana, you know, the need for consistency, stability, and predictability. It was recognized right away that, of course, you can license these new advanced reactors under the current Part 50. We've never said you couldn't, but if you are looking for a more efficient way to do it and trying to be consistent and maintain, you know, the agency's goal of being predictable and stable was to have this framework because you had the Part 50. That is very LWR focused.

You do have unique characteristics and the issues associated with the advanced non-LWRs that aren't addressed by the current Part 50. So do you deal with these in a consistent manner or do you deal with them each time a new license comes in?

But probably to me the more bigger thing is, you know, the PRA. Do we now move forward in using Dr. Wallis's, your words yesterday of a new era?

Do we now make that step to the new era of bringing risk and bringing a probabilistic approach to how we license these plants?

And that grew out of the various policy statements that we had sent to the Commission back in 2003 asking should we be using a probabilistic approach. That was one of those seven policy issues and the Commission came back and said to proceed forward.

And that has probably been the single most challenging thing because there are so many nuances and technical challenges associated with that. When do you want to start using that PRA in terms of your licensing basis and not going, you know, risk based?

So the program was initiated to develop, you know, and those were the words used back then, risk informed, you know, performance based structure that could support the various different reactor technologies.

We have completed the work on the framework. That doesn't mean that in terms of implementation and understanding how it's applied, but in terms of the framework itself, you know, we do plan to publish it this summer, and we're looking for a June target frame.

Also we talked about this in quite some detail yesterday. You know, in the past we've used the word risk informed, but in terms of this framework we've changed the terminology to be risk derived because, again, we're not starting with a set of regulations that are already out there and coming in and revising them using risk.

We're trying to start in developing regulations from a blank sheet of paper where risk and your PRA results and insights are integrated from the bottom up.

And as John indicated in developing the framework, we tried to bring into play all the expectations from the various policy statements from the Commission, the severe accident, the advanced reactor, the PRA, and the safety goals more explicitly.

So getting to where are we right now. The Commission came back in several SRMs. In fact, it wasn't a single SRM. So if we didn't get the message the first time, they reminded us on two other occasions for the staff to issue an advanced notice for proposed rulemaking, and in the SRM they asked the staff to provide its recommendation on whether and if so, how to proceed with rulemaking.

Also in the SRM they didn't just ask us to come up with the ANPR, but in the ANPR itself and I've used the words directly from the SRM, is that we should seek stakeholder input in areas such as whether the effort is premature, whether the NRC should focus on developing technology specific frameworks for non-LWRs, and then what priorities should be given for the various non-LWR technologies.

And they also indicated that we should facilitate stakeholder input, hold public meetings and start that very quickly after the ANPR was issued.

The ANPR was issued in May. When we issued the ANPR -- and if you haven't read the ANPR, it was quite detailed -- I believe we had something like 70 questions in the ANPR dealing with precisely the things that the Commission asked us to, but then it got into a lot of detail, trying to get into some of the technical aspects of the framework.

But in looking at, you know, answering the Commission question of whether the effort is premature, should it focus on developing technology specific, what priorities, we did have very specific questions in the APR. For example, we had should the regulations be technology neutral, technology specific. If technology specific, which technology?

You know, is it premature?

But here was just a few examples of the questions that we did have in the ANPR seeking stakeholder input so that we could come back and be responsive to the Commission when we go back to them.

Also, in the ANPR, the ANPR noted that the framework, because as I said we had a lot of questions specifically on the details in the framework, and that the framework would be on the Web site. It was on the Web site at the same time we published the ANPR.

The ANPR also said that we would update the framework because at the time that the ANPR was out, we were still working on some things, trying to wrap up some final stuff. So we did alert the public that in July we would have the final version of the framework, which is the version that you all have, that you all have been looking at.

We held a public meeting in July. Then we held a two-day workshop in September. We received -- I didn't bring it with me today, but comments from the organization you see in there from Areva. Some of the organizations as you see, like ASME, NEI, ANS, sent in two sets of comments. They sent in some early comments like the September time frame, and then they sent in a lot more detailed comments in December because you have to recognize the ANPR was issued in May. It was opened until December the 29th.

The challenge has been that the bulk of the comments came in in December. We actually still did receive some in January, and when you have 70 questions there and they wrote detailed responses to all of these 70 questions, it has been a real challenge, and we're still ciphering through these comments trying to get a sense of them.

But if I go back to what the Commission asked us to respond to in terms of should it be technology specific, is it premature, we have gotten through those and gotten a sense of what the stakeholder comments are, and so that's what we've tried to summarize, you know, in the next couple of slides.

MR. KRESS: You need to add EPRI to that list.

MS. DROUIN: EPRI did not submit a formal comment.

MR. KRESS: They were part of the --

MS. DROUIN: No, they did not.

MR. KRESS: Okay.

MS. DROUIN: They may have issued something on their own.

MR. KRESS: Yeah, we've seen something that we thought --

MS. DROUIN: But they did not submit something under the ANPR.

MR. KRESS: Okay. I wondered about that.

MR. APOSTOLAKIS: But in that report they comment on the framework, but you don't have to respond to those, right?

MS. DROUIN: That's correct.

MR. APOSTOLAKIS: The question of whether it's premature, it seems to me, was not well posed. What does it mean it's premature? I think the impression I got from the Commission as far as at least some of them is that if we were to pursue this, we would not be doing something else, and in that sense, you know, the question is whether we should be spending money on this versus building up stuff to do license renewals or whatever.

MS. DROUIN: Right.

MR. APOSTOLAKIS: So premature, it seems to me, is a question that is not -- is it directly from the SRM?

MS. DROUIN: If you got back, I didn't write the whole question. I was trying to just give you a sense here that we did pursue this in trying to get input from the stakeholders.

There is more to the question than just that. The question had context around it.

MR. APOSTOLAKIS: Did the Commission use the word "premature"?

MS. DROUIN: Oh, in theirs back here.

MR. APOSTOLAKIS: The SRM?

MS. DROUIN: The SRM, yes. Those were their exact words, whether this effort is premature.

MR. APOSTOLAKIS: Okay.

MS. DROUIN: I didn't try and paraphrase. But when we asked the question, you know, we had more to the question. I'm rambling here.

This was the exact wording.

MR. APOSTOLAKIS: I understanding.

MS. DROUIN: But there were more questions associated with that to try and explain, you know --

MR. APOSTOLAKIS: What they mean.

MS. DROUIN: -- what they mean so that we don't just get a yes or a no.

MR. APOSTOLAKIS: Because in an absolute sense, the people are designing other factors. They're coming up with all sorts of designs, and of course, what you say here, if it becomes a rule, would have an impact. So it can't be premature from that point of view.

But anyway, we'll see what some of the wise members of the public said.

MS. DROUIN: Okay. And the problem is, you know, we've had to kind of synthetize these, that you know, they're answers when exactly, you know, mapped. So we tried to stand back and see, well, what were they saying.

So I've tried to give you some exact quotes here, and here are you some examples. You know, you should move forward with developing a risk informed. Supports the NRC efforts. Supports a regulatory framework. We had one comment that says you depart too much, but I wanted to give you the whole -- the whole quote is about two paragraphs, but I wanted to pick out the real sense of it, and their issue was they felt that we had totally departed in addressing common cause failure.

And I'll be real honest. I'm not sure the way they got that impression because --

MR. APOSTOLAKIS: Who made this comment?

MS. DROUIN: This comment was made by -- he made it twice, and when I say he made it twice, he sent it in under his own name, and then he sent it in as ANS member so that he could get it in. I'm trying to remember his name.

Eileen, do you remember the gentleman's name?

MR. APOSTOLAKIS: It was an individual then.

MS. DROUIN: Well, he sent it in under the ANS logo as the ANS. I think he was chair of a working group or something.

MR. APOSTOLAKIS: But did the ANS form a committee or a group that debated these comments?

MS. DROUIN: I have no idea how it came about, but I can tell you that when you look at their comments, it is word for word exactly the same when he sent it in under his own personal name.

MR. APOSTOLAKIS: And by the law you have to respond to this?

MS. DROUIN: I'm going to let Eileen explain better what we have to do.

MR. APOSTOLAKIS: What's the answer?

MS. DROUIN: I'm going to let her so that you get the right answer.

MS. McKENNA: This is Eileen McKenna, NRR staff on rulemaking.

For an ANPR, the obligation of how we respond to the comments is a little different. We're really responding to the Commission at this point. They asked us for the range of views. We don't have the same obligation as we do in a rulemaking to give a point by point response. So we're going to be looking at the comments more collectively in giving our feedback to the Commission of what -- because they asked us what were the stakeholder comments and making sure we covered the range of views, but we don't have to do a point by point: Commenter A said this and here's our response. Commenter B said this and here's our response.

MS. DROUIN: But you will evaluate the comments presumably before you send them up.

MS. McKENNA: Well, certainly, yes, I agree. We do evaluate them and I think as Mary indicated, too, some of the comments were more technical with respect to the framework, and we evaluate those in a different context than those that were specific to the advanced notice of should we be doing rulemaking and if so, what kind of rulemaking. Is it neutral, specific and on what time frame?

And those are the comments that we owe back to the Commission with respect to the ANPR.

MS. DROUIN: Right, and we talked about this a little bit yesterday because, you know, what

Irene said is exactly right. You know, in terms of what we're going to give back to the Commission is related back to their request here on this viewgraph.

So there were questions that were in the ANPR that addressed that precisely. But we also had -- I think that summed up to like eight questions out of the entire 70 questions. So we had like 60 questions that dealt more with technical stuff in the framework, and those are, you know a lot more challenging to go through and understand.

Now, it is not our intent, as I said yesterday, to go through and respond to those one by one, but what we're trying to do is get the sense of, you know, what were their issues or problems with the various technical aspects of the framework and we are going to put an appendix to the framework that at a very high level is going to say, okay, in terms of like we've got a bunch of observations. It doesn't require any change to the framework.

Comments, we're going to summarize at a high level the comments that deal more with implementation, but we're not making any changes to the framework based on those. That will depend on what happens in the future in terms of how the framework may or may not be implemented.

Questions that we just disagree with and we may have a short summary of why we disagree and I think that's about it. I can't remember. There's five categories, but we're going to summarize that at a high level in an appendix, but we're not going through a one-by-one point of the comments.

I just had to do that on another program, and it's a very laborious thing to do.

Okay. Let's go back two.

So on the three things that the Commission asked us to look at, those were generally -- you know, I could have given you more, but they were all of the nature, you know, move forward or support, and the one negative that we got was this.

We got those exact words twice.

MR. BONACA: With no further explanation.

MS. DROUIN: I'm sorry?

MR. BONACA: With no further explanation than that. I mean, so I don't understand it. I mean, why is this being raised? Do you understand what the comment is about?

MS. DROUIN: Wait. I'm pressing the wrong button.

That's why I tried to add more, because when I read the whole comment and trying to understand why they were saying it departs too far from using the deterministic approach.

What I finally understood is that they had a feeling. They don't explain it, but they had the feeling that we're not addressing common cause failures. That was the sense I got.

MR. APOSTOLAKIS: Well, he probably means also that we have a long experience with deterministic defense in depth type methods, and why are you changing? That really is his objection.

MR. BONACA: But it's so specific about common cause failure.

MR. APOSTOLAKIS: Well, that comes later, after three dots and three dots.

MS. DROUIN: Right, but that was really the essence when you read the comment.

Okay. Whether we should be technology neutral, technology specific, there was no consensus here, and --

MR. WALLIS: Is there some kind of a percentage though? I mean, did 90 percent say one and ten --

MS. DROUIN: No, no.

MR. WALLIS: -- percent say the other?

MS. DROUIN: No, and that's why I wanted

back on the previous one. They were all supportive, and you had this one negative that he did it twice.

MR. WALLIS: So on this one --

MS. DROUIN: On this one it was truly no consensus.

MR. WALLIS: It was 33 percent for each?

MS. DROUIN: The best I would say would be yes.

MR. APOSTOLAKIS: But I really have a problem with that, and I hope when you write to the Commission, you consider this. This is not an issue to be decided on a democratic vote.

MR. KRESS: No, that's right.

MR. APOSTOLAKIS: It is not. There has to be some logic behind the argument and so on, like the issue of consistency that Dana raised and so on. To say that some people said this, some people said that, I mean, it's a true statement, but I don't know that that's what you should be written to the Commission because I don't know how much time these people spent thinking about it. I don't know what kind of information they had, you know, how many people really understand the regulatory structure and what it's trying to do and the benefits of risk informing the regulations.

I mean, you know, somebody might have sat down and said, "I'll show you. You know, you are risk informing, taking away the margins." It doesn't make sense to me to report percentages here.

MR. MONNINGER: Well, I think behind all of the questions, the questions that were asked were not just yes and noes. It was, you know, should it be this and why, so we would always ask for them to provide the basis. So this is just a high level summary, but I assume, I would hope that they provided the basis behind it, too, and we would have to --

MR. APOSTOLAKIS: If someone gave you reasons that you find legitimate, then I think you should report them, but if they just wrote down, you know, you should --

MR. WALLIS: If Mary has a rationale and if they don't shoot it down, why should she listen to them? If she has a really good rationale for doing something --

MR. APOSTOLAKIS: No, but in this case, you guys are supposed to be neutral, right? And report to the Commission what these people said. You're not supposed to take your --

MR. MAYNARD: I'm not sure I fully understand their task, but I think it's interesting to know what the views are, but I think what's important for this particular question is what does the regulatory believe is the most appropriate way to move forward.

I think it's more important what rationale that the staff has and what do they believe is the best way to move forward for regulating licensing a new technology. It's nice to get the views from the others, but this is one of the things the regulators --

MR. APOSTOLAKIS: The Commission knows what the staff thinks. This is a specific question to the staff to find out what other people think. So the way it will be presented to the Commission, what other people thin, I think is very important, and the worst thing you can do is to go with percentages.

MR. WALLIS: That's before they saw your design. This is just preliminary reaction to the idea really.

MS. DROUIN: Well, I don't know that this is preliminary because there has been a lot of interaction on this program with the public.

MR. WALLIS: Do you think they really look at the details?

MS. DROUIN: I don't think that sometimes that people use the words "consistently" in terms of what they mean, and people may use the word "regulation," and I've noticed that particularly with the public, they'll use that very loosely, nd they may use regulatory guide when they're saying regulation and vice versa.

People have not been clean in their uses of the words. And I think that has caused part of the problem.

MR. WALLIS: Well, when you're trying to do something visionary, you're really stuck by using this kind of method, and I'm thinking of the development of computers when they were first developed. All of the experts said there will be no market for computers.

That's absolutely wrong, but some visionary came along and designed these things and they worked and they're everywhere now. So you've got to be the visionary here.

MR. KRESS: Besides, you've put a lot of energy and thought in this, and that's worth a lot more than somebody who sat down maybe at one time --

MR. APOSTOLAKIS: Also, I mean, this is clearly a case of expert opinion elicitation. If the expert who submits the opinion is, say, a responsive organization, like NEI, which tries to build some sort of consensus among its members, they at least have a debate with each other. Then I would pay more attention.

Areva, it seems to me, is a respectable organization. So I'd like to know what they say. If they say premature, forget it, I'd like to know that.

MS. DROUIN: Well, I'll tell you what Areva said.

MR. APOSTOLAKIS: Okay.

MS. DROUIN: Areva was -- they're one of the ones that was the first one.

MR. APOSTOLAKIS: They what?

MS. DROUIN: They were one of the ones that were in the first bullet.

MR. APOSTOLAKIS: Right.

MR. WALLIS: They set technology to regulations, and they were truly meaning the word "regulation."

MR. APOSTOLAKIS: Because they took the time to understand what it means.

MS. DROUIN: And that the implementing guidance should be technology specific.

MR. APOSTOLAKIS: Right. That's very good information.

MS. DROUIN: That was where Areva was.

MR. APOSTOLAKIS: You see it depends very much on who says what, but to have one random individual sit down in front of his or her machine and start typing, you know, that doesn't make sense to me. You might as well as them what the frequency of a large LOCA is.

(Laughter.)

MR. BANERJEE: Might have a more realistic idea.

MR. ABDEL-KHALIK: Have the people who advocated the second position provided any rationale for such a position?

MS. DROUIN: They all provided rationale. The question is could you understand their rationale, and that's what we're struggling -- that's what personally I'm struggling with because sometimes I don't understand the rationale.

I don't know if I agree or disagree with them. I'm just trying to understand what they're trying to communicate to me.

MR. BANERJEE: Can you ask them for clarification?

MR. WALLIS: Well, the last one is kind of stupid because you have to have some regulation for future reactors. So what are you going to do? Just say it's too premature to decide. You --

MR. APOSTOLAKIS: That was my problem, too. What's premature? It doesn't mean --

MS. DROUIN: Well, you had about three or four saying it was too premature.

MR. APOSTOLAKIS: Out of how many, by the way? How many?

MS. DROUIN: NEI indicated it was too premature and then you had other saying, who when they submitted their comments, their comments were a one-pager, and they said we support NEI's position.

MR. APOSTOLAKIS: No, but in that case I'm sure those guys because it's NEI, they knew that if resources went to this, they wouldn't go somewhere else, and they know what's coming according to rumor at the end of this year.

So for them the word "premature" didn't really mean much. They knew that the agency has limited resources.

MR. BONACA: But what confuses me is that since everybody knows that any new plant will have to have a full PRA to support the design of it, what's premature about some guidance on how to use it?

I mean even if this stands alone as a

document --

MR. CORRADINI: But can't we just interpret this just in a straightforward manner, which is some indicated too premature to decide and, therefore, the default is deterministic with the PRA being some sort of information on --

MS. DROUIN: No, no, no. That's not what this is. This is too premature to decide whether it should be technology neutral or technology specific.

MR. CORRADINI: Oh.

MS. DROUIN: That's what these responses are to.

MR. WALLIS: Oh, so it's one or the other.

MR. KRESS: The trouble I have with that is generally things that are specific are derived from the general, and the technology neutral thing is the general, and the specific is derived directly from that. I don't understand the verses myself.

MS. McKENNA: Well, I think somewhat it's a balancing question in terms of whether you write the regulation at the very pure, neutral level and then have everything else in guidance where it's less binding, you know, or are we able to do that at a regulation level versus putting going a little further down and being more specific to, say, a gas cooled technology in the regulations.

You may still need implementing guidance to talk about one kind of gas cooled reactor versus another, but I think that's why there's some of this people aren't sure, you know. How can we really write it at the neutral in a complete and understandable way, putting a little more of the specifics in.

MS. DROUIN: I think across all of these questions, I think it goes back to if you look at many things that we're doing, for example, on Part 50 and risk conforming it and what we should be doing next. You hear quite often, well, let's wait and see. They want to wait and see how is that implemented, how is it going to work out. So I think you're seeing a lot of the same, similar hesitation here. They don't know really what this means yet.

MR. CORRADINI: What the implications are.

MS. DROUIN: Right. So I'm hesitant to come in, commit myself to a very specific, you know, whether it should be technology neutral or whether, you know, we should be a separate regulation or the other.MR. KRESS: I think without an actual rule here; is that what you're thinking?

MS. DROUIN: That's why, you know, yesterday in part of the presentation we tried to give you some examples that if you turn the crank here and you created, you know, these regulations, to give you a feel here's what we're talking about, and so I think people have not seen that. So, you know, we're all scared of the unknown. You know, I'm not really sure what this is you're going to give me. So, you know, I like the devil I have, you know, than a new devil.

MR. WALLIS: But the devil you have doesn't apply to new reactors, especially if you don't look at water reactors.

MS. DROUIN: But I know I can still use that devil. I know that I can license a plant under current Part 50. It can be done.

MR. POWERS: We've done it twice.

MS. DROUIN: We've done it.

MR. KRESS: Yeah, it can be done.

MR. CORRADINI: More than twice.

MR. POWERS: Actually more than twice, but for the specific regulations that we have, twice.

MR. CORRADINI: Twice.

MS. DROUIN: You know, the problem is that this is a Catch-22 because, you know, going down you're talking about resources.

MR. CORRADINI: So let me just ask one other question. Instead of just looking at the written comments, in these workshops that you had, what was the feedback you got verbally from the same sort of responsible organizations. Similar comments?

MS. DROUIN: Yes. We didn't see --

MR. CORRADINI: Similar discussions?

MS. DROUIN: Nothing surprised us.

MR. CORRADINI: Okay, fine.

MS. DROUIN: Nothing surprised us.

MR. CORRADINI: right.

MS. DROUIN: Well, I shouldn't say that. That one negative about, you know, that we're not dealing with common cause failures.

MR. CORRADINI: The reason I'm asking it relative to the workshop, because then you can have some give-and-take and explore and understand what their thinking was.

MS. DROUIN: Yes.

MR. CORRADINI: That's what I'm asking. Okay.

MR. BANERJEE: So was there a sense originally that the current regulations would lead to designs that are too conservative for new reactors? Why was there a reason for initiating this ? What was the reason?

MS. DROUIN: That we initiated this whole program?

MR. BANERJEE: Yeah.

MS. DROUIN: Let's go back to --

MR. BANERJEE: Well, leaving aside the -- I mean, I'm trying to understand why the Commissioners may have asked for this unless there was a thought that there was something wrong with the current regulations.

MR. ELTAWILA: Professor Banerjee, this is Farouk Eltawila from Research.

The Commission did not direct the staff to develop the technology near term framework. It was the staff initiative to start this activity, and we started this activity and took on in the past three years and we engaged the stakeholder. So that's all the staff initiative.

The only thing that the Commission directed us is to proceed with the advanced notice for rulemaking, and that's because the effort was taking too long and we needed to make a decision whether we are going to proceed this way or we're going to change the course.

MR. WALLIS: So why did the staff initiate it? Somebody initiated this thinking it was a good idea.

MR. ELTAWILA: Staff initiated this work because we were faced a few years ago with the potential for non-light water reactor application that was going to proceed on a very accelerated schedule, the Exelon application, and so on.

So we started this activity to try to get some experience about how to come up with the set of regulation that can be used for this non-light water reactor.

And as Mary indicated, we were proceeding. We are going to do either using Part 50 or if we have this information available at that time we could have used it.

MR. BANERJEE: But if you apply Part 50 in the regulations as they stand, does that lead to a very conservative design or is it -- I'm trying to understand.

MR. ELTAWILA: No, you can still if you have a peer -- you don't have to be a conservative designer. You can be a best estimate and you can be risk informed, you know. We have all of the technology that we can apply for existing regulation.

For example, the Exelon or PBMR right now have proposed a risk based approach to identifying the design basis requirement for the plant, and we can look at an approach like that and from that define what belonged to the design basis and what belonged to beyond design basis. You don't have to be conservative. You have to apply if you have best estimate methodology and you PRA, you can come with a realistic requirement.

MR. BANERJEE: Within the current regulations.

MR. APOSTOLAKIS: But, Sanjoy, one of the criticisms that a lot of people have raised over the years is regulatory instability, inconsistencies, and all sorts of things.

When in doubt, blame he NRC.

(Laughter>0

MR. APOSTOLAKIS: So here is the stuff coming back saying, you know, not in response to that in particular, but saying, "Look. We have this new generation of designs that may come. How can we have a self-consistent framework? And also it's a matter of resources. I mean, if you develop a set of regulations for the PBMR and something else for their gas cooled fast reactor or something else and something else, then they don't come in. What do you do?

They are under pressure from the Senate to be ready.

MR. BANERJEE: But the question I am asking: do you need to develop a new set of design specific regulations or are the current regulations sufficient and interpretation of these is what's needed.

MS. DROUIN: Well, I think you missed -- Farouk hit on a very key thing, and if you go back, you know when this was started, the thinking about this in 2002 and there were several things that happened at that time. We had the sense from industry that they were going to be not just one but a lot of applications coming in for these advanced non-light water reactors, not just one, and that it was going to happen on a fairly short time frame.

At the same time that was giving us that indication, NEI came in with IO-202 also supporting that, and so when you look at that, you know, like we said, you can't do it under Part 50, but if you have multiple applications coming in, you're doing it on a case-by-case basis, and you quickly will go into an unstable, inconsistent because you're having to revisit each time the application comes in. Each one is open to litigation on an individual basis.

So it was trying to get to those key things of predictability, instability, and when you're having to revisit for each application each time and each time you're open to litigation, then you haven't achieved that.

Now, would you want to go down that path if it was just one application coming in? But at the time the sense was that it was going to be numerous.

MR. KRESS: And, Sanjoy, be realistic. To license one of these things under the current Part 50, you have to make substantial revisions. You have to have a whole new set of design basis accidents and ways to evaluate them and figures of merit, and you have to go though and figure out which don't apply and get the exemptions from them. It's a major revision to those. It's not just a simple --

CHAIRMAN SHACK: But, I mean, it's an ad hoc thing. I mean you make these --

MS. DROUIN: That's the point.

CHAIRMAN SHACK: They make them over again. There's always the completeness issue. I mean, these regulations were really developed with a light water reactor in mind and, you know, maybe it's complete; maybe it isn't, but I think there's a substantial reason to --

MR. BANERJEE: I think you've answered my question.

MR. ELTAWILA: I think the current regulation is developed for light water reactor, but Mary always reminds that most of regulation is technology neutral unless you got to Part 50 and 5046 and become technology specific. So if you used the exemption process I really don't think we're going -- I'm not advocating that we're not going to be far off. It has been done in the past, and you can achieve the consistency that you want, and you can achieve a realistic assessment, you know.

So I don't think it is as bleak as that we are trying to portray it here.

CHAIRMAN SHACK: Well, especially under Part 52 where you are going to produce a PRA.

MR. ELTAWILA: A PRA, that's correct, yeah.

MS. DROUIN: That's right, and as I said yesterday, the real challenge and I thought I reiterated today was not the technology neutral aspect. The real challenge in all of this was making it -- and I'm going back to the new word we've coined -- risk derived. You know, that to me is the real decision on the table. Are we trying to go, you know, take the NRC regulatory structure to that next step?

And if the answer is no, now a lot of people will probably shoot me here, but if the answer is no, then there is no point in proceeding with this framework because the heart and soul of the framework is creating this new risk derived thing, using Graham's words of, yes, they're going into the new era.

We're not prepared to go to that.

MR. WALLIS: Let me ask you something else, too. I think you ought to have another motive, which is not only to be able to handle to this new area, but be able to handle it more effectively, efficiently, and maybe have simpler regulations because these regulations have been stacked on top of each other over the years.

And if you took a new look at it, you might decide you don't have to have DBAs and you don't have to have this and that. You can do it in a better way.

MS. DROUIN: I don't disagree, but if that's what you wanted, if that was the goal, then I would never develop this framework this way.

MR. WALLIS: No, you wouldn't. You'd do a better one.

(Laughter.)

MS. DROUIN: Of course, it would always be better, but the approach would have been quite different if that's what I was trying to achieve.

MR. WALLIS: But you've carried along a lot of the baggage of the old regulations.

MR. ELTAWILA: But the bottom line, if you want to hear what is the staff recommendation, is that what's important as Eileen indicated, we are going to be informed with the information, the public comments, and we are going to make our recommendation to the Commission based on the staff assessment, ACRS views, and that, you know, the public comment.

The bottom line, and I think if you read through all these comments, and Mary, correct me -- read them more than me -- is that the bottom line, it's much sure to go and for a technology neutral framework, spend some time trying to get some experience behind applying that methodology for non-light water reactor and then at that time decide whether you want to go to rulemaking or not. That's the bottom line. So it's not, again, set completely or --

MS. DROUIN: That's correct. That's correct.

MR. APOSTOLAKIS: Graham, they are only publishing a NUREG. In the meeting we had yesterday and today, they raised some of the issues that depart from the current way of doing business. By the time the rulemaking process begins, that may be all these ideas will be folded into it.

So I see this as a good first step that says here is a way of developing a technology neutral framework. Then all sorts of ideas will come up and say, you know, you're really following this whole thinking of such-and-such. So maybe we should consider.

So ultimately there will be a sound approach in my view. This is not the end. By far it's not the end. So we are in the process, but at least we have something now that is specific and we can comment on it.

MR. WALLIS: I think you have to have a sales pitch, too. You have to have a sales pitch which says there's a new set of framework. We'll do this, this, and this, which are very big advantages over the present system. You have to have some measure of advantage and success and some motivation for adopting it which can sell it to the Commission and the industry and the public. And I haven't really seen that. It's all a kind of vague promise that somehow this is going to be good.

Not that I don't think it is good. I just think you haven't got that document, that sales pitch.

MR. BANERJEE: Until a concrete case comes up that will be very difficult.

MR. APOSTOLAKIS: But the problem, Sanjoy, is that when the concrete case comes up, the applicants will not even want to hear about this.

MR. WALLIS: That's right. They just want to know do we win or not.

MR. APOSTOLAKIS: I don't want to suffer through this. Let's go with Part 50, and here is a list of 3,000 exemptions that we would like to see.

MR. ELTAWILA: But that's not what we are doing. But that's not what we are doing. For example, under PPMR, they are developing a technology specific risk informed type of regulatory framework that we can license the plant on, and we're working on that one.

Also under our cooperation with Department of Energy on the NGNP as John indicated, we are going to be developing an option for the Commission that part of that option will be a risk informed framework for licensing an NGNP.

The same thing will happen with the GNEP global nuclear energy partnership. There will be efforts underway again to be risk informed. So all of these things, and once we --

MR. BANERJEE: What parts of GNAP are you including?

MR. ELTAWILA: This is the debate that's going on, and I don't want to get into the details of that because that's is NMSS' responsibility, but GNEP is because of the debate right now whether we focus on the advanced burner reactor or you focus on the whole process itself, from the recycling to the burner, to the processing and so on, the chemical separation.

MR. CORRADINI: So can I repeat what you said to us, Farouk, a bit differently? And that is that you are planning to test portions of the framework relative to the PBMR as the white paper thing, and you're thinking of testing portions of the framework relative to the NGNP and beyond, depending on what things start coming up that you have to or that the staff has to consider.

MR. ELTAWILA: To insure, I think that is right, but to insure also to address Dr. Power's question, to insure that they are consistent, we did not leave any holes.

So the framework will inform our decision or our review process of this proposed approach.

MR. BANERJEE: The framework will encompass separation plants as well as reactors?

MR. ELTAWILA: Again, you're talking about GNEP.

MR. BANERJEE: yes.

MR. ELTAWILA: We're really at the very, very initial stage right now of discussing. There will be a commission paper going very soon to provide different option for the Commission.

MR. CORRADINI: It's not even clear that there will be a GNEP.

MR. ELTAWILA: Yeah, so it's very early. But the point here is that we have at least two applications right now that we can test this approach, the NGNP and PPMR.

MR. MAYNARD: Well, I think what has been done is good, and I think this is a necessary process. I also believe that some of the comments made by the members yesterday -- and we'll probably talk about it again -- would be some good enhancements to the process.

I'm a little uncomfortable with just saying this is enough for now or we're just going to put this as a guide because if we don't start on rulemaking some time soon, if anybody does come up with an application, then we are really pretty much going to be tied to the existing regulations using this process for exemptions because you're not going to put a new rule in that's going to cover certification within the time frame that a new proposal is going to come in to be reviewed.

So we've either got to start on something fairly soon or we've got to say that this process is just going to be used for exemptions to the existing process.

MR. BONACA: One point I would like to make. Why would you believe that somebody would come in and say just license under Part 50? I mean, they're all coming in with PRA. They're all using PRA to do reasonably one way something similar to what we've done under this program, I mean, and they are going to identify sequences based on PRA. That's what they're doing.

And so, you know --

MR. CORRADINI: Well, I guess -- can I just try an example at you? Let's just take the NGNP. So DOE is the applicant then. So in comes DOE, right? I think they're the applicant. They might be.

No? Then who is the applicant for --

MR. ELTAWILA: We don't know yet.

MR. CORRADINI: Okay. So somebody is the applicant, yet to be determined, potentially between Areva, Westinghouse, and I can't remember the other grouping, GA, and they'll come in and they'll say, "Okay. If it's going to be under Part 50, we're going to run the PRA, but we're going to take what we know to be the case at Fort St. Vrain. Here are the set of DBAs that were at Fort St. Vrain. It's an indirect cycle. So there's no steam potentially put ingress into the core, but there may be other water ingress accidents.

We're going to come up with a set of potential accident scenarios, and we're going to do the PRA, and we'll show you all of the bad stuff that we don't want to consider and don't have a containment or so low that they're over here, right?

Then the staff is still going to have to go through the same sort of analysis with that PRA and that set of accidents and argue through this and decide potentially using this framework, what they calculate to be these things, and if all of these things over here on the right-hand side start drifting to the left and they have to be considered as part of the DBA.

So that's when you said test. I felt good because if they're truly going to test it with this, at least they're moving down a path. I guess that was my interpretation of what.

MR. WALLIS: How about this division of new reactors or whatever it is called? They're going to do something, aren't they, all of those people? They need tools in order to do something. Do they need this tool?

MR. ELTAWILA: The Office of New Reactor?

MR. WALLIS: New Reactor.

MR. ELTAWILA: These all are live water reactors, Graham. The office are all for live water reactors, and the --

MR. WALLIS: The regulations?

MR. ELTAWILA: I'm sorry?

MR. WALLIS: They're just going to use existing regulations?

MR. ELTAWILA: Existing Part 52 that's applied to them. Yeah, that's correct.

MR. APOSTOLAKIS: But wait a minute now. I mean, they must use existing regulations. It's not their choice. They must, and PRA and existing regulations play a supporting role.

MR. WALLIS: Well, are they crying? They're not crying for this thing then.

MR. APOSTOLAKIS: I don't know what they want.

MS. DROUIN: This program was never meant to support the current light water reactors, even the advanced light --

MR. WALLIS: Will support something more in the future?

MS. DROUIN: But I don't know of -- yes.

MR. MAYNARD: I suspect this started primarily because of PMBR, and with the emphasis that a few years ago it was getting and the sales pitch that there's going to be a bunch of these coming --

MS. DROUIN: That's exactly right.

MR. MAYNARD: -- it's a new technology, and how are we going to license it?

That has kind of fallen off, but this question still comes in, is if there's a new technology that comes forward, how would the NRC proceed with licensing and certifying that new design?

What would be the staff's recommendation right now if one came in? Is it to be licensed under the existing regulations?

MR. APOSTOLAKIS: Sure, yes.

MS. DROUIN: Absolutely.

MS. McKENNA: I think part of it that was mentioned earlier is the time frame. If somebody tomorrow dropped an application on our desk, we would be using the Part 50 requirements and do the best we can.

If somebody tells us in five years I'm going to send you a gas cooled application that looks something like this, then the agency would have to decide am I going to spend the effort now to try to come up with some new requirements so that when I get that application I'll be able to handle it in a more straightforward manner or am I going to say, well, no, I'll just sit back and wait till the application comes and I'll do my best with Part 50.

It somewhat goes to the question of, well, if there's one of these that's coming in, is it worth writing a whole new set of requirements for this one design versus we're going to get six different kinds of gas cooled reactors, and maybe we want to spend some effort to figure out, at least migrate ourselves a little bit away from light water to some other form.

And this is why it's a real challenge for us, because of the timing. Yes, we know it takes a finite -- you know, we talked yesterday of how many years it would take to get from A to B, and you kind of like do you spend your resources now on the presumption that somebody might come or do you wait a little longer and see who comes and then spend them and then are you in time?

And those are the challenges we've been wrestling with for the last year.

MS. DROUIN: And that's, you know, what we said, that back in 2002 it looked like it was going to be multiple. It didn't look like it was just one. It looked like it was multiple.

MR. APOSTOLAKIS: But, Mary, isn't the only place where you really depart from existing regulation the choice of the LBEs? You really do something new there. Everywhere else you're using difference in depth. You're using the protective strategies. We're doing a lot of that stuff, most of it.

MS. DROUIN: Well, I think the protective strategies is a departure, not a huge departure, but I do think it's a departure, but the big departure is the risk part, and that's what I've said all along.

MR. APOSTOLAKIS: But I mean the choice of the licensing basis events is really something new.

MS. DROUIN: Right. That's the risk part, yes.

MR. APOSTOLAKIS: Because, you know, everything else you can go to the existing regulations. In fact, even in your FC curve, you go through pains to show that you chose this because it's in the EPA or the --

MS. DROUIN: But the point is you're choose, you know, those events. We are not predescribing those DBAs.

MR. APOSTOLAKIS: No.

MS. DROUIN: We're using the PRA to help decide what those are.

MR. APOSTOLAKIS: And that's what I'm saying.

MS. DROUIN: That's a fundamental departure.

MS. DROUIN: It's a fundamental departure. Everything else exists already.

MR. WALLIS: The measure of success is still vague because you don't have that cumulative probability curve.

MR. APOSTOLAKIS: No, but that's a detail.

MR. ABDEL-KHALIK: If no one comes up with a non-LWR design in the next 50 years, would proceeding with development of a new regulatory framework based on this framework be a worthwhile thing to do for LWRs?

MR. CORRADINI: If there were nothing but those.

MR. ABDEL-KHALIK: Correct. If we were to take these ideas and proceed to develop a Part 53, knowing that nothing will come up before the Commission other than LWRs. There might be evolutionaries, slight variation.

MR. CORRADINI: Well, which LWRs?

MR. ABDEL-KHALIK: Would that be a worthwhile exercise?

MS. DROUIN: I would say no.

MR. CORRADINI: I had a feeling that was going to be --

MS. DROUIN: And the reason that I would say no is that I think that you don't have to go and create a new Part 53 to take advantage of a lot of the concepts in the framework for current LWRs. I think you can use those concepts with a lot of the current Part 50 there by going in and changing a lot of the regulatory guidance, not the rules in and of themselves. I don't think you need to go create this whole new regulatory structure.

And so to me when I talk about a Part 53, that's what we were talking about, a whole new body. I don't think you need to do that. I do think you can take advantage and fix some things in the current Part 50, not fix, but revise to take advantage of stuff that's in the framework, but I would not personally say go create this whole new Part 53.

MR. BANERJEE: This would be an alternative methodology?

MS. DROUIN: That's my personal opinion. I want to really make sure that that's personal.

MR. BANERJEE: But would this be an alternative methodology?

MR. CORRADINI: Or an alternative opinion from the staff?

MS. McKENNA: One of the reasons we call it Part 53 was to separate, say we were to leave existing Part 50 alone and remake a new part.

MS. DROUIN: That's right.

MS. McKENNA: So it could be there as an alternative as opposed to saying we're going to replace Part 50 with some new set of requirements which then causes a problem because we have plants that are already licensed as one set of requirements and we want them to remain.MR. ABDEL-KHALIK: I mean, the question is whether this new Part 53 would be so clearly defined and so well streamlined that anybody coming up for licensing would opt to follow that route other than, you know, following this hodge-podge process that evolved over the past 50 years.

MR. WALLIS: May starts off with this great objective, and then she puts in all the stuff which looks like what we do today. That doesn't mean to say that the amount of work is going to decrease or anything.

So what's the advantage?

MS. DROUIN: Well, I don't agree that we've totally taken everything we do today. I don't agree with that statement.

MR. WALLIS: You've taken an awful lot of stuff just like what we do today.

MR. CORRADINI: In fact, you could just, I mean, take Graham's point and Said's point and push it harder and push it harder and say remember that when I asked you yesterday after where did you test this, and you said, "Oh, we test it with the current LWR."

Okay. It seems to me that if I did that, then I tested with an ALWR, and I provided that you found some things that make it better or different, and you would change what you would consider.

You could push the point even harder and say, "Well, now I have a known quantity. I have a known technology" -- at least he thinks it's known enough -- "that I can do the analysis of the SC curve and actually get some efficiencies on how you do the whole licensing," which is what I think Said's point was.

And now you're actually dealing with an animal that you know versus the animal you don't know, which of all things worries me most about the neutral framework relative to these new plants where I'm not sure about the numbers.

MS. DROUIN: Right, and as I said, when we did test it against a known LWR we did find some things. You know, that plant against which we tested would have been licensed a little bit differently, and in my opinion now you have to understand that the plants are safe. Under this new process if it had been licensed, we'd be safer? I think so. To me the answer would be yes. If we had imposed a few more things on them, that would have made them safer.

Now, they would have been able to relax some things that I don't think would have degraded the safety. It was getting rid of things that didn't need to be done, and it would have imposed things that would have made it safer.

MR. APOSTOLAKIS: If it is that we only get LWR, this frame work would revise or replace in some meaningful way the existing 5046?

I mean, we're trying to risk inform it as a rule.

MS. DROUIN: Yes, it would.

MR. APOSTOLAKIS: It would.

MS. DROUIN: Yes, it would.

MR. APOSTOLAKIS: It would.

MS. DROUIN: Yes.

MR. APOSTOLAKIS: And it would in a manner that would be consistent with the result of the regulations.

MS. DROUIN: But do you need to create this whole new Part 53 to do that?

MR. APOSTOLAKIS: Well, I don't know because now we are focusing -- I mean every time we look there is a whole list of other regulations that are affected by changing this, and we have to make sure that there is consistency and so on. This one presumably would guarantee that consistency.

So there are benefit so this.

MS. DROUIN: I don't disagree there's benefits. I'm just coming from a gut feel for what would be the resources to go and create -- you know, let's just say we're never going to deal with anything but LWRs.

MR. CORRADINI: But you don't have a night job, do you? Sorry.

(Laughter.)

MR. CORRADINI: Sorry. That was uncalled for. I apologize.

MS. DROUIN: But John.

MR. WALLIS: Well, I would like to see a comparison between what we do today and what you are having. Your design and your design, the new design saves half of the work for the utility, saves 50 percent or 90 percent of the work for the government, you know, gives better measures of things, focused more on things that really matter. It increases public safety, it does all of these things. It has certain ways in which it's better than what we do today.

That would really he,p me a lot. What's the payoff for adopting it?

MR. ABDEL-KHALIK: Regardless of the --

MR. WALLIS: Regardless of the technology.

MR. BANERJEE: Reduces the number of ACRS meetings.

MR. WALLIS: Reduces there, increases our pay because we're more efficient in things like that. You have to do that.

MS. DROUIN: Well, I think we have done that. You know, we may not have expressed it or talked about it in detail to the ACRS, but you know, we've gone through that.

MR. WALLIS: Well, it seems to have the same number of DBAs and the same amount of work, and it has all the same requirements as far as I can make out. Defense in depth looks much the same as it did before. So what's different?

MS. DROUIN: Oh, I don't think defense in depth looks at all because right now you don't know what defense in depth is. There's no definition of defense in depth.

MR. ABDEL-KHALIK: There you have it. This framework has clarified something that --

MR. APOSTOLAKIS: One, one, seven, four hasn't --

MS. DROUIN: You've got to be careful. We have said that, you know, we have defense in depth, but we can't come in and precisely say what it is. What we say in 1.174, that if you do these things you're going to grade defense in depth, whatever that is, but you can't go and precisely say that these are the things that are what defense in depth is.

MR. APOSTOLAKIS: In the discussion there are six bullets.

MS. DROUIN: I know, the six principles.

MR. KRESS: I think Mary is right.

MS. DROUIN: And if you go back to one of the things that --

MR. APOSTOLAKIS: I think there are too many hypotheticals right now. So why don't we go on?

MS. DROUIN: Well, I'm there.

(Laughter.)

MS. DROUIN: Sorry.

MR. APOSTOLAKIS: The thing that worries me though is how you're going to present to the commission what you learned from this exercise with the stakeholders. That would be very crucial. You know, the words you're using and so on because --

MR. MONNINGER: We have a May paper due to the Commission on this and we have another, at least one more meeting with the ACRS to present that paper. So at this stage, you know, we store digesting, evaluating, strategizing on our plan four, but we do owe that paper to the Commission, and we are scheduled to brief ACRS on that paper.

MR. APOSTOLAKIS: So you will brief us at the May meeting?

MR. MONNINGER: Yes.

MS. DROUIN: Right. That's if you look at the last slide, but we do plan -- Eileen plans to come back, and I get to sit over there.

MR. APOSTOLAKIS: So at the end of May that it is due?

MS. DROUIN: Yes.

MR. APOSTOLAKIS: So if we make any comments then, they are not really going to be --

MR. WALLIS: So you're going to publish this thing and recommend that no more work be done and the rulemaking not be pursued. So you're essentially saying stop work.

MR. ELTAWILA: The rulemaking is deferred until we learn something from the application of the approach to non-light water reactor. It's not not pursued; deferred. Because I think the question the Commission asked us, should we go for rulemaking at this time, and we were recommending to defer any rulemaking on the technology neutral framework.

MR. APOSTOLAKIS: Is there any way we can see what you plan to send to the Commission at a subcommittee meeting before the May 4 committee meeting so you will have a chance to respond to any possible comments?

MS. McKENNA: Well, and I think we are trying to give you a little preview of where we think we're headed now in terms of this is the kind of recommendation that we're moving to in terms of deferring the rulemaking. So the paper will be speaking to, okay, we had the ANPR. We got the comments, there will be some summary or analysis of the comments. Then there would be and this is the staff recommendation and why we're making this recommendation, that we will learn things from the pebble bed and see how the NPNG goes and that we don't see the need to launch into rulemaking right now, that we're kind of reserving that recommendation until we have a little more information.

And so that's the kind of paper that we would expect.

MR. WALLIS: Well, if you write down these two green things, my indication is to say, "Well, I don't need to worry about this. I mean, here's a NUREG and it's out there and nothing is going to happen. So why should I do anything?"

MR. APOSTOLAKIS: Why don't you actually say or recommend to try this framework on the white papers of the PBMR that you have? That would keep the effort going, giving you valuable experience.

The statement, all activities to be terminated, is terrible.

MR. ELTAWILA: I think the word "terminated" is definitely a strong word. I think Mary in her verbal discussion said the technology neutral framework completed and cannot be advanced any further than that. What we are right now, we are in the application or exercising of the approach, of the framework. So we don't have any additional technology neutral framework, development work to be done.

MR. WALLIS: Well, it may surprise you. I sometimes work with industry on new products, you know, and when we develop some new thing, we do a lot of research and we look at all of the engineering. You have to make a decision. Are you going to go from that stage to develop an actual thing you put in your factory and make things?

And when you have a statement like this, it indicates to me you're killing a project. Is that really what you want to do?

MS. DROUIN: Go ahead, John.

MR. MONNINGER: I mean, the notion was, you know, the notion is to take what we have learned with this and to see how with some of the more concrete specific designs out there how can we advance these concepts.

The notion was the staff has worked on this; we have worked on this for several years, and it's still very conceptual. So that was our belief, not knowing exactly what the Commission wanted, but our belief that the Commission wanted to advance some of the conceptual concepts, move it into potential rulemaking, and really flush this thing out.

And our hope is to really flush this thing out, you work through some pilot designs, applications, et cetera, as opposed to continuing to work in the conceptual framework. I mean, we've been working the conceptual piece for three, four years, and now it's time, you know.

MR. KRESS: But that was for activities related to the framework.

MR. WALLIS: The conceptual frame doesn't get you a design. You have to then look at the advantages and disadvantages of how you implement it, and that's the next step, and you're just saying stop that.

MS. DROUIN: Right, and remember that yesterday I tried to explain that the word "framework" here means NUREG 1860. That's all it means.

MR. APOSTOLAKIS: I would eliminate that and say the next step is to look at the PBMR white papers and experience with NG --

MR. WALLIS: Right, and see if it works, see how it works.

MR. APOSTOLAKIS: Yeah. I mean right now the best opportunity you have to exercise this is these whit papers, right?

MS. DROUIN: Yes.

MR. APOSTOLAKIS: Because you have nothing on the NGNP. So put that the first sub-bullet and then say that further experience will be gained with NGNP and GNEP.

MS. DROUIN: And it's my understanding that that will be in the paper.

MR. APOSTOLAKIS: But the first sub-bullet --

MS. DROUIN: Exactly how it will be I'm not real sure.

MR. APOSTOLAKIS: The first sub-bullet really should not be there.

MR. WALLIS: You put the bullet there hoping we'd disagree with it, didn't you?

(Laughter.)

MR. KRESS: I think it's a face saving clause.

MR. APOSTOLAKIS: What is face saving?

MR. KRESS: That terminology. I'm not going to say any more than that.

MS. DROUIN: But, you know, we've tried to clarify what we mean by that, you know. The NUREG 1860, you know, we're publishing it, you know, and a we, you know, try this out with these white papers and everything, you know, we may come back at some time and say, you know, does it make sense maybe to update it.

But right now, you know, we don't see that because it is a conceptual document. The details of it would not show up in the framework. That would show up in a different document. So it's not that you aren't going to try and apply or understand further the details of how they would work, but I don't think that the details of it -- in my mind they would not show up in this document. It wouldn't be the right place for it.

MR. ABDEL-KHALIK: But wouldn't it be a better statement to replace that first statement by saying that the concepts outlined in the framework will be test piloted against the white paper application for the PPMR --

MS. DROUIN: We agree we could have --

MR. ABDEL-KHALIK: -- as your first statement? And that means that --

MS. DROUIN: We could have written the statement better.

MR. ELTAWILA: I think we could have. Yeah, Mary is right.

MS. DROUIN: We could have written it better.

MR. APOSTOLAKIS: Good.

MR. BONACA: Now, framework is a structure. So is this a structuralist approach or --

(Laughter.)

MR. CORRADINI: Is that an insider joke?

MR. POWERS: A structuralist report. We'll lose our status if it's not structuralist.

MS. DROUIN: And that puts the fear of God in me, Dana. I can't lose my status with you.

MR. KRESS: I think this is a good spot to turn it back to you.

CHAIRMAN SHACK: Has everybody made their comments?

MR. KRESS: I think we're happy. We made a lot yesterday.

CHAIRMAN SHACK: Yes.

MR. KRESS: And I think staff knows how we feel about it all, and so the meeting is turned back to you, Mr. Chairman.

CHAIRMAN SHACK: Well, thank you, Mary, for another excellent presentation and for putting up with us again for two days in a row.

And we'll go off the record now. That will be the last thing we need to do.

(Whereupon, at 5:08 p.m., the meeting in the above-entitled matter was concluded.)