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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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480TH MEETING

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

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FRIDAY

MARCH 2, 20001

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ROCKVILLE, MARYLAND

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

COMMITTEE MEMBERS:

GEORGE APOSTOLAKIS	Chairman
MARIO V. BONACA	Vice Chairman
THOMAS S. KRESS	Member
GRAHAM LEITCH	Member
DANA A. POWERS	Member
ROBERT J. SEALE	Member
WILLIAM J. SHACK	Member

COMMITTEE MEMBERS: (cont.)

JOHN D. SIEBER	Member
ROBERT E. UHRIG	Member
GRAHAM B. WALLIS	Member
F. PETER FORD	Invited Guest

ALSO PRESENT:

KAREN COTTON
GENE CARPENTER
STEVE DOCTOR
BILL BATEMAN
DEBBIE JENSEN
BILLY CROWLEY
LARRY MATTHEWS
VAUGHN WAGONER

I N D E X

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

(10:01 a.m.)

CHAIRMAN APOSTOLAKIS: The next item is a briefing event at V.C. Summer Nuclear Station. Dr. Shack is the lead member on this.

MEMBER SHACK: I'm sure of the members are aware that they found a crack in the weld material of the reactor coolant hot leg piping system at V.C. Summer.

The crack occurred in alloy 182 weld metal, which is a high nickel weld metal that they typically use essentially as kind of a buttering when you're joining a Ferritic component, in this case a pressure vessel nozzle, to the stainless steel piping and essentially it minimizes the mismatch in thermal expansion and reduces thermal stresses.

We know in the past that PWR primary coolant piping systems have been very reliable and we've found very little evidence of cracking in those systems. They've been approved for leak-before-break, largely because of that reliable experience, and so there's some interest here in the general nature of whether this experience can be generalized to other systems. And, again we wanted to understand just how well, for example, inspections can be done in other plants.

Joining us on the phone today, in addition to the staff at the front of the table is a contractor, Dr. Steve Doctor from Pacific Northwest Laboratory, who's an ultrasonic UT for Dr. Wallis, expert on crack detection. And I guess Gene, you're going to start off, Gene Carpenter.

MR. CARPENTER: Karen Cotton will be discussing this.

MEMBER SHACK: Okay. Ms. Cotton then, you can start the discussion.

MS. CARPENTER: Okay. First, I'd like to say good morning. I'm Karen Cotton and I'm a mechanical engineer and the project manager for V.C. Summer. Gene Carpenter, from the division of engineering will talk about the technical review and future activities regarding the Summer crack.

Larry Matthews of Southern Nuclear, he'll talk about the MRP. I would like to acknowledge Billy Crowley sitting here, he's the team leader for the special inspection team and, as you heard before, we have Steve Doctor on the phone listening in.

I'm going to discuss the history of the event and I'll discuss it in three parts. I'll talk to you about the actual event, I will talk to you about what the licensee did in response to the event and I'll also talk about NRC's actions. Then I'll give a brief synopsis of what was the function of the special inspection team.

During refueling outage 12, during a routine walk through, boron deposits were discovered near the "A" hot leg reactor nozzle. The licensee, what they did was they continued with their routine outage activities but they began to investigate where the boron was coming from. They did a PT inspection and they discovered a four-inch crack. In the four-inch crack, they soon found that this was only a surface indication.

They continued and they did UT and they did eddy current testing and they found a two-and-a-half inch crack, and this exited through a weep hole.

Summer designated a team of industry experts to look at the situation, and the industry experts they looked at the repair and they looked at evaluation of the repair. Their focus was to come up with a root cause analysis and to come up with a repair method.

MEMBER WALLIS: It surprises me that the first thing that was mentioned was boron deposits. I would think there would be all sorts of other indications of leaks before that.

MS. COTTON: What happened was --

MEMBER WALLIS: A new activity or just loss of fluid.

MS. COTTON: There were no other indications of leaking. This leak was very small and it wasn't detected through our normal leak detection.

MEMBER WALLIS: Doesn't it take a lot of water to make much boron deposit?

MR. CARPENTER: That is correct, sir. This is Gene Carpenter. Typically, you have very small amounts of boron in the reactor system fluid, and obviously there was literally hundreds of pounds of water that had to escape before this was detected.

However, as Karen said, it was a very tight crack and the leak rate was much below 0.1 GPO, so they never did trigger the tech spec required 1.0 in any unidentified leakage.

MEMBER SHACK: What was the unidentified leakage sort of in the period leading up to the incident?

MS. COTTON: It was like 0.6.

MEMBER SHACK: Three-tenths.

MR. CARPENTER: Yes, 0.3 GPO was about the average over the operating cycle.

MS. COTTON: The team's primary goal was to ensure that the plant would safely start up. They looked at all the welds, they looked at the code requirements, they had to address all the failure scenarios, even the worst possible case. And they looked at all the indications and made sure that all these indications in the other welds were evaluated.

The licensee also developed a communications plan and this plan ensured good communications, thorough communications with NRC, with the other members of the nuclear industry, and also with the community surrounding the plant.

They also took a further step and they committed to enhance their leak detection procedures. They decided that they would examine the B and C welds during refueling outage 13, and they also committed to examining all the welds during refueling outage 14.

MEMBER SHACK: When had this weld been last inspected, or had it even been inspected?

MR. CARPENTER: Yes, it had been last inspected in 1993 during their ten year ISI.

MS. COTTON: The licensee's activity included we chartered a special inspection team, we chartered and formed a communications plan. As part of the communications plan we did a communications team, which met on a weekly basis, bi-weekly, we met twice a week on a weekly basis to handle all issues dealing with the Summer crack.

We developed a web site that was specific to just this Summer event. We issued three information notices, the last one was February 28, was issued February 28. We received a WCAP from Westinghouse regarding the integrity of the B and C welds. We did a safety evaluation regarding this and we completed and issued the safety evaluation on the 20th of February.

We also had five public meetings, the last public meeting was February 15 and that was a public exit meeting. We chose to have a public exit because all the meetings were public and we got very good comments from the public regarding our openness and our willingness to involve them in this event.

The licensee's root cause analysis was primary water stress corrosion, and this basically was due to the susceptible material of alloy 182, coupled with the repeated welds, or the repeated rewelding and rework done during construction of the weld.

MEMBER WALLIS: How was the grinding related to residual stresses? Was it that the grinding was too gross and rough, or was it something to do with heat generation, or what was the coupling between grinding and residual stresses?

MR. CARPENTER: When the weld was originally installed they had multiple weld repairs. It took, I believe, something like 40 days to do the complete weld repair of the Alpha hot leg nozzle weld. In that time they basically took out the entire weld and rewelded it in at least once.

MEMBER WALLIS: So grinding wasn't necessarily a cause of stress at all?

MR. CARPENTER: Well, they did do a lot of grinding out of welds, of flaws, and then rewelding.

MEMBER WALLIS: But the grinding itself didn't cause the stresses?

MR. CARPENTER: It added to it, sir.

MEMBER WALLIS: It did?

MS. COTTON: Steve, do you want to talk about the V-shaped? I have a slide I could put up for you? Steve? Do you want to talk about the V welds? I have a slide I could put up for you as for our discussion about the root cause analysis?

DR. DOCTOR: I think the key point is the fact that when they put in this bridge path, what this forced them to do was basically form a double V type of weld. And the work that EPRI had funded had shown that the stresses on the inside were much higher with that type of a weld design as compared a single V type of weld design.

And so the fact that you've got a grinding was due to remove the old material, but they used this bridge path and it forced the design into this double V type of design.

(Slide change)

MS. COTTON: This basically sums up the history portion of what actually happened. Now we'll talk about the special inspection team.

As stated in the history, a special inspection team was chartered. The focus of the team was to ensure that the licensee's corrective actions were appropriate. They looked at and reviewed the root cause determinations, and they looked at all corrective actions activities.

The team's activities included, as I said before, corrective action review, review of the licensee's records, they observed the welding processes, NDE activities. They also did on site metallurgical analyses that reviewed this, of the spool piece at Westinghouse hot cell labs. So the team was pretty active and they were on site for several weeks during this whole incident.

The team's findings were that the root cause analysis was appropriate and acceptable and that there were no deviations from weld requirements. From code requirements.

MEMBER SHACK: Just on this inspection, doing the weld techniques, do you have to go through the piping to inspect the weld? Or is this something that is really done just through the weld metal?

DR. DOCTOR: This is Steve Doctor. When you perform the inspection according to the Section 11 requirement of ASME code, you're required to inspect the inner third of the weld plus some adjacent material on both the pipe side and the nozzle side. Generally, this is approximately this a half-inch.

So the inspection includes both base material, structural weld and buttering.

MEMBER SHACK: Steve, I guess I was interested in whether, for example, if you were in a plant that had centrifugally cast piping, in order to inspect this weld you would have to look through the cast piping.

DR. DOCTOR: That's correct. As a matter of fact, if you look at the cold legs those are a nozzle weld with buttering structural weld going to a cast elbow. And they perform those inspections in a similar vein. The fortunate thing is that these inspections are conducted from the inside, so the amount of cast materials, the very coarse grain cast materials that you have to penetrate, is relatively small.

If you perform the inspection from the outside surface you have extremely long paths through the coarse grain material, which would then make the inspection extremely difficult.

MEMBER SHACK: Okay. Thank you.

MS. COTTON: The purpose of my talk was just to provide a snapshot of the history of what happened with the event. The actual event history, the response of the licensee, NRC's actions, and to give you some detail of what happened with the special inspection team.

Both the special inspection team and the staff feel that this event is beyond Summer, and that there are further generic activities, we should look into this further. And this will be discussed by Gene Carpenter. Gene.

MR. CARPENTER: Thank you, Karen. First, I'm going to go over the technical review that the staff did of the B and C hot legs, and then I'll be discussing some of the generic activities that the staff is following.

The staff performed an independent evaluation of the licensee's assessment of the B and C nozzle legs. Now since they had physically removed the A hot leg nozzle weld and replaced it, there really wasn't a need to evaluate the cracks in that.

This was done by the licensees submittal, which was the WCAP-15615 Rev 1, which is a proprietary document and the non-proprietary version 16616 Rev 0 which is available on the web site for public inspection.

The WCAP provided the results of the Westinghouse UT and the eddy current examinations of the nozzle-to-pipe welds for loops A, B and C. In those loops, they found in five of the six nozzles, that there were crack indications -- or I should say eddy current indications. The C cold leg was the only one that did not have any indications found.

These indications were evaluated based on the destructive examination that was done on the A hot leg nozzle that was removed and was destructively examined at the Westinghouse hot cell facilities. And, based on those determinations, the licensee determined that Summer could be safely operated for approximately two further cycles before they needed to do any inspections or possible repairs to the existing indications in the B and C hot legs.

MEMBER SHACK: Is eddy current an accepted inspection technique for this kind of consideration?

MR. CARPENTER: No, it is not. They went beyond that. The UT could not find these eddy current indications, so basically we are going beyond the code on this.

MEMBER SHACK: Well, how are they estimating sizing then for these flaws?

MR. CARPENTER: The eddy current can determine the lengths. We're doing a 2:1 aspect ratio, so basically for a one-quarter inch long crack indication, we're assuming that a depth of one-eighth inch.

MEMBER POWERS: How did they possibly make a prediction that they can operate for so long of a period of time without fixing these things?

MR. CARPENTER: The determination was made on the basis of the susceptible material. It was made on the basis of the crack growth rate.

MEMBER POWERS: What is the crack growth rate in a nozzle in Summer?

MR. CARPENTER: The crack growth rate that was assumed.

MEMBER POWERS: I'm not interested in assumptions. I want to know how they knew what the correct growth rate was.

MR. CARPENTER: When they did the examination, the destructive examination of the A hot leg, they went in and basically -- if I could flip to that slide.

(Slide change)

MR. CARPENTER: This is a representation of the Alpha hot leg and this is the crack that grew through wall. The assumption -- basically Westinghouse went through and evaluated the crack, found that there were multiple initiation sites and they grew together. And from that they made a determination using a fairly extensive formula which, if you'll pardon me for just one second -- 1.4 x 10 the minus 11, K minus 9 to the 1.1 -

MEMBER POWERS: Show me the experimental data, applicable to Summer, that validates that formula.

MR. CARPENTER: I don't have that with me, sir.

MEMBER POWERS: I mean there can't possibly be any data that's directly applicable to this to validate that formula -- unless there have been a lot of cracks in Summer. I mean how do you justify an analysis like this that says oh, we can operate for two more cycles based on this magic formula, that is based on data for some other situation?

MR. CARPENTER: I will grant you that there is not a lot of data, and that was one of the problems that the staff had. And that is one of the reasons that we did not agree with a crack growth rate that would allow for two cycles before they did any further examination.

We looked at the crack growth rate in this extremely, and bear in mind that this crack growth rate is assumed, is bounding the limited amount of data that we do have. So what the staff did was we took what they licensee and Westinghouse provided to us.

MEMBER POWERS: Now, when you say you bounded the data you have, I mean how do you go about bounding this data? Presumably the crack can't go any faster than the speed of sound in the metal. I mean I -- accept that as a bound. What other bound can you possibly come up with?

MR. CARPENTER: When you take a look at all the data that is provided and look at the scatter growth, the licensee had a best fit to that data. The staff disagreed with that and we increased our bounding crack growth rate so that it incorporated all the data.

MEMBER POWERS: How do you know that's enough? If I took two more data points maybe they fell outside your bound.

MR. CARPENTER: We don't have two more data points, sir.

MEMBER POWERS: Yes, but if I had taken -- why do I know that bound?

MR. CARPENTER: I cannot sit here and guarantee that this is the absolute bounding crack growth rate. It is much faster than what we have assumed in the past. And it is the reason that we were only comfortable with wide - operation, approximately 18 months.

MEMBER POWERS: I'm trying to understand why you were comfortable with five minutes.

DR. FORD: Gene, can I try and help you?

MR. CARPENTER: Please.

DR. FORD: Is that formula that you just gave the Peter Scott formula?

MR. CARPENTER: Yes, sir.

DR. FORD: That's based on secondary side cracks in tubes, I think. Therefore, the argument I think that's being made here, Dana, is that that could be a worse case material environment situation. The follow up question to that, however, Gene, would be if you used presumed residual stress profile through that 182 crack, would you have predicted what happened on Leg A, using that formulation? I think that would answer your question, Dana, or go towards it.

MR. CARPENTER: Perhaps, yes.

MEMBER SHACK: Well probably not because the residual stresses that were used for the Summer analysis were the standard sort of piping stresses, or the standard circumferential weld residual stress distribution which probably would have arrested the crack.

MR. BATEMAN: This is Bill Bateman from NRR. We're into an area here when Gene does not have the technical expertise. We do have a technical expertise, however, the individual is not here today, the one who wrote the safety evaluation and was involved in asking all these questions.

We can follow up at a later time, if need be, to answer the questions when we have the appropriate technical expertise available.

VICE CHAIR BONACA: I just have a

clarification, and I apologize for it. Maybe I missed something during the presentation. I thought that there was a claim that the crack that we found in the A leg was due to the unique welding process used in the location.

MR. CARPENTER: That is the claim that the licensee made, yes sir.

VICE CHAIR BONACA: Okay. But now you're telling me that the inspection showed that the other nozzles also have cracks?

MR. CARPENTER: Five of the six.

VICE CHAIR BONACA: Okay. So these nozzles, were they subjected to the same welding processes as the --

MR. CARPENTER: No.

VICE CHAIR BONACA: No, they were not. Okay.

MEMBER SHACK: But they do apparently have smaller cracks. At least you can't see them in the UT.

MR. CARPENTER: Correct. Okay, going onward. As I was saying, the staff's review basically disagreed with the licensee's premise that they could operate for two cycles, and we said that they could operate for one cycle before they needed to inspect again.

Again, we decided to bound the crack growth rate that they had provided to us, and that's because there is a limited amount of crack growth data.

MEMBER WALLIS: Can you tell me how much does happen in this one cycle? How much crack growth do you anticipate in this one cycle's okay and two are not. How much crack growth is happening in the one cycle which makes it impossible to operate any longer?

MR. CARPENTER: Assuming that there is a crack indication that is one quarter inch in length, with an aspect ratio of 1:2, with this crack growth rate it will not grow three quarters of a way through wall in one cycle of operation.

MEMBER WALLIS: But how much will it grow? Halfway through the wall?

MR. CARPENTER: Roughly, sir.

MEMBER WALLIS: So it's growing a lot?

MR. CARPENTER: Yes, sir.

MEMBER WALLIS: So you'd better be careful about up the bounding so much.

MEMBER POWERS: If the plant has some misadventure and they shut down, something like that. Does it change the crack growth rate?

MR. CARPENTER: Define "misadventure," sir.

MEMBER POWERS: An unplanned shut down SCRAM. Something, anything. Does that change the crack growth?

MEMBER SHACK: It would take an enormous upset event, you know, to cause mechanical crack growth rate here so this is really a, you know, a sort of stress corrosion crack growth rate.

MR. CARPENTER: Albeit rather fast.

MEMBER SHACK: Yes. I mean the 182 crack growth rates are really as high as you find in any material that you know we know in stress corrosion cracking. And, as Peter mentioned, there's a fair amount of data on alloy 600 in the cold worked state, there's less data on the 182. When you combine the two data sets, you have a fair amount of data so that you have a reasonable confidence when you bound the whole combined set of data because 182 is something like cold worked alloy 600. You can argue that there's an analogy there and the existing data points to the 182 are basically bound by the data that you see for the cold worked alloy 600.

So if you combine the whole total data set there's relatively little for 182 in this PWR environment. I think you can have a reasonable amount of confidence that the crack growth rate the staff has used is bounding.

MEMBER POWERS: I guess I just don't know where you derive your confidence here. You've got a stress corrosion cracking phenomenon, it depends on how much stress you have. That must be unique to this situation.

MEMBER SHACK: Oh, the crack growth rate that you have is a function of the stress. That is you have a bounding curve that it depends on the stress intensity at that location. So that becomes a variable that you have to account for in a specific analysis for a specific circumstance.

MEMBER POWERS: It also depends on having an aggressive corrosion chemistry. That must surely be unique to this situation?

MEMBER SHACK: No. That's the one good thing about dealing with primary water stress corrosion cracking is that you probably do understand the chemistry environment, that is the environment that you've studied the crack growth in is a PWR primary water environment which is carefully controlled.

MEMBER POWERS: Would this alloy, this

particular weld material and all of its associated impurities have been exactly reproduced in this test stage?

MEMBER SHACK: Of course not.

MEMBER POWERS: Well, and then you've got to convince me that you've bounded it.

MEMBER SHACK: But that's why you have data on multiple heats of material and, again you know, when can I say I bounded the data. You know, as Gene said, I don't think you can say you have an absolute bound but what you have is an amount of data on a reasonable number of heats of material under chemistry conditions that are representative of what you have here. It doesn't exactly represent it but you think the population is quite representative and you have to make the judgment that when you bound that it's reasonably close to them.

MEMBER POWERS: No, I think all they've done is they've parted the data points and run a curve that goes over the top of it. And I don't think they've done any of this, okay, does the chemistry span the range of chemistries that I'm likely to encounter or not.

MEMBER SHACK: Well, the other good thing of course is that under ASME code conditions, the range of the material chemistries is not all that broad. It's a fairly tightly controlled situation, especially for stainless steels. Again, for ferritic steels, impurity levels are a good deal higher. Welds, one of the bad things about welds is the fact that impurity levels are higher but, again, without an extensive study I'm not sure that you could say you've bounded the range but you certainly have a reasonable population.

MEMBER WALLIS: When this crack gets bigger you said it could grow as much as halfway through, does its growth rate slow down or increase as it gets to such a big crack?

MR. CARPENTER: As the crack grows it will reduce, it expends the energy so it will tend to slow down a bit.

MEMBER WALLIS: It will slow down. And when will be the next inspection? And I guess you're giving them permission to run for another cycle?

MR. CARPENTER: For 18 months, yes sir.

MEMBER WALLIS: Eighteen months. So what's going to happen in-between in the 18 months? No inspection?

MR. CARPENTER: I should alter that just slightly. We said that they could operate for up to

18 months. They have told us that they're going to be operating for a short cycle so they will be shutting down before next summer to inspect.

MEMBER WALLIS: And no one will be looking for boron stalactites till next summer?

MR. CARPENTER: They will be looking for evidence of leakage. But it's very difficult to get into this area during operation.

MEMBER WALLIS: And you're satisfied that there's a good way of detecting these very small leaks? They weren't detected before.

MR. CARPENTER: That is correct. And that is one of the things that I will be talking about in a moment regarding leakage. Okay.

MEMBER SHACK: But, again, these cracks will still be relatively short in terms of structural integrity of the pipe. You know, they'll be a long way from any kind of large failure, the margin to a small leak is admittedly much, much smaller than it is to a large --

MEMBER WALLIS: Well it may be fine, it'll just be sort of embarrassing if you go in there next summer and find there's a huge boron stalactite somewhere.

MR. CARPENTER: But also bear in mind,

sir, that virtually all of these cracks were axial in nature. As Dr. Shack said, it takes a considerable amount before you have a concern beyond that.

Some of the ongoing activities that the staff is engaged in at this time is that we're reviewing similar cracking in foreign reactors. We haven't seen anything similar to what happened at Summer here in the U.S., but the root causes of both the Summer and the Ringhals cracking in Sweden is PWSCC. So we are talking with the Swedes about that. We're also investigating --

MEMBER WALLIS: When you talk about PWSCC, is it stress corrosion cracking?

MR. CARPENTER: Primary water stress corrosion cracking. And we're also investigating reports of other foreign cracking. We haven't yet been able to verify that there are others that are identical, or at least similar to what has happened here at Summer, but we are looking at that.

MEMBER POWERS: When you say identical, I get the sense that we don't have to be very identical to be about the same. At least as far as our data base. So I mean how do you -- I'm trying to understand the links and bounds of identicality in this sense.

MR. CARPENTER: Well, I'm not trying to say that it has to be one for one matching every point. We're looking at similar welds, we're looking at similar locations. Trying to find something that we can lump together.

Some of the other ongoing activities that the staff is engaged in at this time is, again, we're looking at the generic implications of the Summer cracking and the industry activities.

Mr. Matthews of the MRP will be discussing in a few minutes what the PWR owners groups materials for a liability program is presently engaged in and I will leave that to his capable hands.

We're also looking at the implications on the leak-before-break analyses that have been done for virtually all the PWRs at this time. We're also looking at ISI programs, both deterministic and risk-based, seeing if we need to make any alterations to those programs.

MEMBER SIEBER: Since you're discussing ISI, is there any movement to augment with another technique the UT examination?

MR. CARPENTER: Right now the UT examination is required by code, and if the code needs to be altered then --

MEMBER SIEBER: Somebody has to put in a code case?

MR. CARPENTER: Correct.

MEMBER SIEBER: On the other hand, you can do the UT exam and satisfy the requirements of the code, but you could require an additional augmented inspection using other techniques. Seems to me that when I look at the pictures, the weld prep for the examination wasn't very good and it seems also that probes have a pretty good footprint and maybe this is a very difficult weld to examine just because of geometry, notwithstanding the fact that you're shooting through a pretty thick cross section of material of varying grain structure and composition.

I take it that since these kinds of cracks are not reliably always found by UT, that nobody is making a move to do something better.

MR. CARPENTER: Well, I'm not saying that yet, sir, and you're leading me by about three slides. So I'll discuss that in just a moment if I could defer, okay.

MEMBER SIEBER: All right.

MR. CARPENTER: Again, as we were just mentioning, the ability of the code required NDE to detect and size small ID stress corrosion cracks, this is one of the things that we definitely need to get a handle on. And the appropriateness of the ASME code standards allowing flaws approximately 10 percent of wall thickness that, in the case of Summer, could grow with such an apparent high crack growth rate.

And Dr. Wallis mentioned a few moments ago about the effectiveness of the leak detection systems. These are all things that we are very much following and trying to get a handle on.

MEMBER WALLIS: Are you thinking of putting in some supplementary leak detection system in the places where you might detect something such as just by the well?

MR. CARPENTER: We have discussed that with the industry and I believe that -- will you be discussing that, Larry?

MR. MATTHEWS: We're going to be looking at it.

MR. CARPENTER: Yes. So this is part of what we're talking about.

MEMBER WALLIS: If you're going to look at it, are you going to have anything in place during the next cycle?

MR. CARPENTER: No, sir.

MEMBER WALLIS: You seem that you want to put something in there now.

MR. CARPENTER: The lead time for developing supplemental inspections or supplemental leakage evaluation --

MEMBER WALLIS: Well it seems to me there was, I'm trying to remember the pictures I saw, but the boron stalactites were pretty obvious, right. So even just a camera would see them, and that's not a remarkable piece of technology.

MEMBER SIEBER: Well, the boron that was visible was not directly at the crack in the pipe, it was underneath the boot and, you know, and that's where the air flow ventilation for that section of piping comes from. So it had to appear where the boot was not tight.

MR. CARPENTER: When you're talking about all this, you know, it came out through here so it is not readily accessible during power operations.

MEMBER SIEBER: And it might not come out there.

MR. CARPENTER: Correct.

MEMBER WALLIS: But it's too rough an environment for some sort of video surveillance?

MR. CARPENTER: I don't know the answer to that, sir.

MEMBER SIEBER: It could be done.

MR. CARPENTER: Some of the further activities that the staff is working on right now is that we're proposing confirmatory research into the primary water stress corrosion cracking issue, and that will include some of the NDE and the ISI issues that we've discussed so far.

MEMBER WALLIS: What are you trying to confirm?

MR. CARPENTER: Confirmatory research meaning is our capability of other inspection toolings to go in and find and size these indications. For instance --

MEMBER WALLIS: This is a kind of, I know it's a misnomer, but research is to figure out something new not confirm something.

MEMBER SIEBER: But they're not anticipating a problem. They have the problem.

MR. CARPENTER: Determination of a bounding crack growth rate and just how the residual stresses play into that. Development of susceptibility model, and because we know that the welds that were, for instance, the welds at Summer were field fabricated, you also have some that were shop fabricated at other PWRs. You have different materials being used at different PWRs. So the susceptibility model is going to have to take a look at multiple factors.

The assessment of possible repair and mitigation methods that the industry may come up with and overall following of industry activities.

MEMBER SIEBER: Now, in all Westinghouse plants with stainless steel piping do they use the 182 weld model?

MR. CARPENTER: No, and all of the Westinghouse plants from my understanding is that they have something like virtually every weld was slightly different. So it's going to add considerably to the complexity here of all this.

DR. FORD: Gene, could I make a comment? You mentioned at the beginning of this is the generic activities. When you're looking at the industry experience, are you confining yourself to pressurized water reactors? I'm thinking specifically of the vast amount of boiling water reactors which are into hydrogen water chemistry with a lot of 182 welds.

MR. CARPENTER: Yes. Yes, sir I have been. At this time we are looking specifically at Ps, we may expand into Bs. But this appears to be a PWSCC concern right at this moment. If we need to, we will expand the scope beyond that.

MEMBER SIEBER: I mean he is running at hot leg temperatures that are a good deal higher than your BWR.

DR. FORD: Yes I recognize that but we know what the activation enthalpies are for the cracking in these systems, so you can make some sort of comparison.

VICE CHAIR BONACA: I had a question regarding all previous inspections, including the year 2000. They found no indications. Now, what kind of inspections were they? They were not using eddy current, of course.

MR. CARPENTER: If you don't mind I'll defer to Steve Doctor on that one. Steve?

DR. DOCTOR: Yes, I couldn't hear the complete question. Would it be possible to have you repeat it, please?

VICE CHAIR BONACA: Yes. My question is all previous inspections of these nozzles showed no indications, including the 2000 inspection. And I was wondering what type of inspection that was, I mean what kind of technique do you use?

DR. DOCTOR: They basically employ the same techniques that they employed back in 1993. The biggest improvement on the ultrasonic side was that they employed an improved transducer sled that allowed each transducer to independently gimble to do a better job of tracking the surface and thereby providing better coupling.

This was a significant improvement. It didn't accommodate all the conditions that in fact are associated with the ID conditions of these particular wells. The size of the footprint of the transducer and the housing that the transducer goes in is quite large and, as a consequence, it has some difficulty accommodating the root, the counterboard, and there is a difference in the diameter between the nozzle and the pipe.

And, as a consequence, it did create some problems. I believe that obviously one of the things that industry is going to be looking at in the future on how to ensure a better ability to track the surface and thereby improve the quality of the UT inspections.

And for this particular inspection, the staff at Summers and Weston, you know, agreed to use the eddy current. An eddy current inspection is primarily a surface inspection type of technique. It has not generally been used for this kind of application.

However, it is very sensitive to any kind of surface breaking flaws and, as you saw from I think the result from the Alpha leg hot outlet nozzle dissimilar amount of weld, the eddy current was very effective at detecting a number of cracks that were verified through the destructive testing. And it should be noted that there are indications in four of the five other dissimilar amount of welds that we have found with the eddy current, they have similar characteristics to the cracks that were in the Alpha leg, but at this point there are still indications. They have not been, you know, verified by any other means.

There's a possibility that some of those in fact may not be cracked because some of the indications that were found in the Alpha hot leg were not verified through destructive testing. So there is some uncertainty there and in the analysis they've taken the approach to assume that, in fact, all of the indications are assumed to be cracks, although that's not proven at this point.

VICE CHAIR BONACA: So the previous inspection used the ultrasonic testing. And some forms of eddy current, if I understand it.

MR. CARPENTER: No.

VICE CHAIR BONACA: No. No eddy current. Okay so it was ultrasonic testing. And that is the standard testing that is being done by the industry, right?

MR. CARPENTER: Correct. Code required.

VICE CHAIR BONACA: Thank you.

MR. CARPENTER: Okay. That brings us to where the industry is right at this time. The PWRs have proposed an industry initiative to respond to the cracking issue that was found at Summer. And, as we have discussed with the ACRS before, the staff has an industry initiative process that we can utilize for this, in which case an issue occurs, the industry and the staff meets on this. The industry proposes to follow this as an industry initiative, and the staff either forgoes any generic communications or generic letter per se, to tell them what needs to be done in lieu of the industry coming in and actually telling us what they're going to do following this.

Now at this time we have met with the materials reliability program on this twice now. And they have proposed to respond to the issue and, again, Mr. Matthews will be discussing this in a couple of moments.

VICE CHAIR BONACA: I just want to get

back to it. It seems to me that there has to be some past experience of V&V on the ultrasonic testing that is adequate or is not adequate. We were left here with a statement that says that we have eddy current indications of cracks in the other nozzles which were not identified by UT. We're not sure yet that they're cracks, they may be something else. So we're trying to understand, in fact to validate these observations here.

And so my question, again, is do we have V&V of ultrasonic testing identifying these kind of cracks?

MR. CARPENTER: The Alpha hot leg had both eddy current testing done on it and ultrasonic examination. It was then cut out, the weld was cut out, and was destructively examined. As Steve Doctor mentioned before, some of the indications that were found by eddy current were not found in the destructive examination. Some of the indications that were found by destructive examination were not found by UT. So we're still struggling with that, sir.

VICE CHAIR BONACA: Okay.

MEMBER SHACK: Let me ask it in a different way. The inspectors that do the inspections, do they go through a performance demonstration on stress corrosion cracks?

MR. CARPENTER: The PDI program -- Performance Demonstration Initiative -- as I understand it, I'm not the expert on this. Steve, did you want to respond to this?

DR. DOCTOR: Yes. Right now this is a PWR issue and all the people that are really trained for stress corrosion cracking do inspections on BWRs. There is a requirement for a supplement independent -- regarding dissimilar amount of welds. That has not been implemented as of yet. It's in the process of being developed with regard to the PDI program and it's something like I think about 18 months off until that will be fully implemented, and then all inspectors will have to go through that.

And, of course, the timeliness of the V.C. Summer event is that now we've identified failure mechanism and so the type of flaws that have to be included in that demonstration are PWSCC.

MEMBER SHACK: Thank you.

MR. CARPENTER: Okay. Going back to where we are with the MRP. Again, the staff has met with the industry on this at least twice now. We've had multiple telephone calls with them following up, discussing the agenda items that have been in these public meetings. We will have another public meeting with the MRP in three weeks time to discuss the assessments that they are going to be providing to the staff. We have also gone down to one of the vendor sites, Framatone specifically, to take a look at the mock up that they have been making use of to look at the welds for four plants that we'll be inspecting this spring outage. And further technical and management meetings are planned to discuss what is going on.

And now we get to the slide that Dr. Sieber was leading me to.

(Slide change)

MR. CARPENTER: Some of the staff expectations of the generic activities. What we are hoping to come out of this with. The MRP assessment of the generic susceptibilities; they have promised this to us by the end of March and that is what we will be discussing in three weeks time.

The NDE methodologies and the toolings that the industry is going to be using to do their examinations. The staff has told the industry that they should be making use of the best practices and capabilities to address potential weaknesses that seem to have come out of this examinations at Summer.

If potential code cases are necessary to address some of the things that we have discussed already, the staff will be looking at those in an expedited manner.

We also need to get a better handle on the implications for the ISI programs and also for leak-before-break. And long term assessment of the alloy 82/182 applications, we're going to be discussing with the industry to take a look at that.

And we'll also be looking at the review of their repair and mitigation methods that they will be proposing to us.

And that concludes my discussion for this morning.

MEMBER WALLIS: I'm just wondering, the expectations, are results expected or activities?

MR. CARPENTER: We're hoping that there will be activities that will lead to results, yes.

MEMBER WALLIS: Well that's the thing, I see a lot of activity and I just wonder about the results.

MR. CARPENTER: We are at the very beginning of this, sir, and it's too early to --

MEMBER WALLIS: That's what concerns me a bit, yes. You may discuss with industry for a long time without achieving anything.

MR. CARPENTER: We have made our expectations very clear that this is something that needs to be expedited. It's not going to be a five or ten year practice before something occurs. That we need to have something sooner. And, again, under the industry initiative process, if the staff determines that the industry is not being as proactive as we would like, we always have the option of going out with generic communications of some sort.

MEMBER WALLIS: Well at least by next summer you'll have some data points?

MR. CARPENTER: We certainly hope so, sir.

MEMBER LEITCH: The licensee seems to make quite a bit out of the uniqueness of this weld in its original instruction. But I guess from hearing your presentation, it sounds as though you are not accepting that idea, that you feel there's something more generic going on here. Is that a correct assumption?

MR. CARPENTER: Well, initially, sir, we were in agreement that there were, as the licensee correctly points out, extensive repairs done on this, especially as opposed to the other five welds. That there were mitigations there that could have caused this one to be of concern but not the other five welds. And then there were indications found in four of the other five. And also there was indications found at Ringhals in Sweden, which is a similar plant.

MEMBER LEITCH: Indications but not cracks, right?

MR. CARPENTER: Not through wall cracks, no, sir.

MEMBER SHACK: No, but Ringhals is confirmed to be a crack.

MR. CARPENTER: But not through wall.

MEMBER: Yes, but it is a crack.

VICE CHAIR BONACA: Ringhals identified it through eddy current?

MR. CARPENTER: They did do eddy current examinations there also, yes. That leads us to be a little less accepting of the uniqueness suggestion.

MEMBER LEITCH: Yes, do we know if there's anything unique about which plant is at Ringhals weld?

MR. CARPENTER: Well, it's a double V weld. It's fairly similar to what we were discussing earlier. But, again, we really need to get a better handle on all this information.

MEMBER WALLIS: So the Ringhals crack is

still growing is it? Or has it been fixed?

MR. CARPENTER: Debbie, do you remember what they said?

MS. JENSEN: They did some repairs. Debbie Jensen from the Office of Research. They did some repairs to the Ringhals crack, but we're going to meet with them next month and have face to face conversations and exchange of technical information with the similarities and the differences between the two plants in this particular issue with the pipe crack.

MEMBER WALLIS: Well did some repairs, do you mean they cut out this area and rewelded it or something?

MS. JENSEN: From what I understand, yes, they did some grinding and they replaced with addition weld metal and they took out some samples to do some testing.

MEMBER LEITCH: I have a question about the enhanced leak detection procedures that were mentioned. Are we going to get some more about that later, or is now an appropriate time to ask that question? I'd like to know specifically how these leak detection procedures were enhanced.

MR. CARPENTER: Well, that's one of the

things that we have asked the industry to go and look into, to see what they can develop as far as enhanced leak detection capabilities. Right now we're not ready to discuss what could be used.

MEMBER LEITCH: Ms. Cotton in her presentation said that one of the licensing commitments was to enhance their leak detection procedures. Am I to understand that the plant will go back in service with -- that is that that enhancement is future, that the plant will go back in service with the same leak detection procedures?

MR. CROWLEY: What they plan to do is they plan to do noble gas sampling and analysis to provide additional verification of the RCS integrity. The other thing they plan to do is they're going to --

MEMBER LEITCH: You say they plan to do that, but will they be doing that when the plant gets back in service?

MR. CROWLEY: Yes. Yes, that'll be when the plant goes back in service. The other thing, the calculation of RCS water inventory balance, they plan to do that on a more frequent basis than they've done in the past to try to determine if they have additional leakage.

They're going to add a main control board enunciator to alarm at 0.75 GPM such that the operators will be alerted prior to reaching tech spec limit.

MEMBER LEITCH: 75 GPM?

MR. CROWLEY: .75 GPM. And then they're going to, of course this is not what the plants operating -- the inspection they do when they come down next time, they're going to have an enhanced boric acid inspection. They've had boric acid inspections every time a plant comes down, but they're also going to enhance that program also.

MEMBER WALLIS: What happens when you have this crack and there's a leak? Do you get a jet of suppurated steam coming out of it or what?

MEMBER SHACK: Sure.

MEMBER WALLIS: And this has properties like momentum?

MR. CARPENTER: Yes.

VICE CHAIR BONACA: It'll cut like a knife.

MEMBER POWERS: You can't get away from it can you.

MEMBER WALLIS: But it's invisible isn't it? It's invisible. It's a jet of some --

MR. CARPENTER: Yes.

MEMBER WALLIS: But it impacts on things and it carries boron with it. The boron is in the steam in some form, droplets or something?

MR. CARPENTER: Yes.

MEMBER POWERS: Vapor.

MEMBER SHACK: It's dissolved in it.

MEMBER WALLIS: Dissolved and then it comes out when it condenses on a cold surface somewhere.

MR. CROWLEY: Well the pipe is insulated, of course, so it has to -- whatever vapor that comes out has to get through the insulation.

MEMBER WALLIS: So what happens in the insulation? It deposits or is the insulation sort of blown off, does a hole get made in the insulation?

VICE CHAIR BONACA: Cut right through it.

MR. CROWLEY: Through the same, goes through the same.

MEMBER SIEBER: Well, most plants have mirror insulation and it travels all over the place.

MEMBER WALLIS: So this steam gets all lost in the insulation somewhere?

MR. CARPENTER: Yes.

MEMBER SIEBER: I was under the impression that most PWRs had some kind of noble gas detection as part of their containment radiation monitoring.

MEMBER WALLIS: Well let's go on. That insulation gets hot when you put steam through it and you get a hot patch on it when the steam comes in there, so if you had thermal couplers on the insulation they would get hotter if you had a steam leak. There seem to be so many things that could be done using pretty robust technology to detect some change that would be affected by a steam leak.

MR. CARPENTER: And these are things that we have asked the industry to go in and investigate and come back and talk to us about.

MEMBER WALLIS: But if you had to do it next week I would think that someone could actually come up with something. I just wonder why -- it seems to be a slow process, this asking and coming back with things. The agency doesn't seem able to respond quickly to the idea say let's put thermal couplers, or whatever it is, around something so we know what's going on.

It may take months to make a decision. By then the cycle's over anyway. Am I describing things right? It just takes forever to make -- not forever, but it takes so long to make decisions that it's unlikely that any detection system will be in place before the end of the cycle.

MR. CARPENTER: Well, there is detection systems in place at Summer. As to what needs to be done at other plants --

MEMBER WALLIS: Well what's the new -- there's a new detection system in Summer?

MR. CARPENTER: Yes --

MR. CROWLEY: Just the improvements that we --

MEMBER WALLIS: Just the ones that you mentioned. But they are still -- gross balances for the plant. They're not focused on the area of concern. There's nothing installed around the welds or anything like that.

MEMBER SHACK: Local leak detection is harder than you think because, as Jack mentioned, you know, water and steam have a way of moving around a lot.

MEMBER WALLIS: Well it's very true in your house, you get a leak in the bathroom and it appears in the living room.

VICE CHAIR BONACA: I just wanted to ask you a question about, this is not the first time that PWR nozzle cracks have been identified, right? It is not the first time.

MR. CARPENTER: I believe it is, sir.

MEMBER SHACK: Ringhals is the first,.

VICE CHAIR BONACA: Is it? I thought there have been some events.

MR. CARPENTER: But this is the first through wall crack.

VICE CHAIR BONACA: Oh through wall, yes I understand. But cracks which were not through wall, I thought there had been some instances.

MR. CARPENTER: Not that I'm aware of but I will get back to you on that.

VICE CHAIR BONACA: I guess I'm going after the issue of, you know, this seems to throw in full doubt the effectiveness of ultrasonic testing as an inspection means, and I thought that there had been some significant validations of the technique.

MR. CARPENTER: The ultrasonic examinations of dissimilar metal welds is a little bit more of a challenge, so that is something as Dr. Doctor mentioned a little bit ago, the PDI initiative is looking at that and they have approximately 18 months to come up with a solution to that.

MEMBER SHACK: I mean non-destructive examination, you know they're sort of trained to look for certain things and at this point PWSCC wasn't really considered to be a major problem for PWR.

VICE CHAIR BONACA: I understand. In 2000 they had no indications. Then eddy current comes and says there are indications. There are indications to the point where now we're putting restrictions on how long they can run. It begs the question of what do you do about all the other PWRs for which you have inspections using ultrasonic testing. And so that's why I'm asking those questions. I had more confidence in that testing than I'm getting out with now.

MR. CARPENTER: And these are questions that the staff are asking ourselves, yes.

If there are no further questions we'll turn this over to Mr. Matthews of MRP.

MR. MATTHEWS: My name is Larry Matthews, I work for Southern Nuclear Operating Company on the managing inspection and testing services group. I'm also chairman of the Alloy 600 issues task group of the materials reliability program, and I'm going to give you some information about where the industry is and where we're headed on this issue.

First off, a little brief history of how we got to where we are. You've heard about the crack and what's been done at the plant at V.C. Summer. The MRP Alloy 600 issues task group took the lead on this.

The event occurred in October of 2000, the initial root cause was available early December and the issues implementation group, or issues and integration group, we can't ever decide what IIG stands for but it's the parent of the ITG, recommended in mid-December that the MRP take on as activity the resolution of generic issues relative to the V.C. Summer event.

We received executive approval from some utility execs here in early January to begin activities. We developed an organization and we worked out a fairly detailed plan and budget but it's evolving as we go and as we learn more.

The issues task group met in January 19, after the V.C. Summer public meeting on the 18th, to address the key focus areas and we organized into three committees: an assessment committee, inspection committee and a repair and mitigation committee and I'll be going into what the activities of those committees are.

We met with the staff on January 25, at which point we outlined the approach that we were planning on taking with respect to this issue, and solicited feedback from the staff at that point in time as to whether they saw things additional we needed to be doing.

The feedback was basically they felt we were on the right path, saying the right kind of words. Of course, the proof is in the pudding -- can we deliver what we say.

On February 1, two of the committees had their initial meetings, inspection committee and assessment committees both met in Charlotte. They further refined their plans and schedules and budgets. On 2/16 there was an MRP/NRC executive management meeting. This is typically a meeting we've been having on an annual basis where MRP executives were meeting with the NRC management.

MEMBER WALLIS: Has anybody done any work yet?

MR. MATTHEWS: Yes.

MEMBER WALLIS: No, I mean you have all these meetings in the management and budgets, has anyone done any engineering yet?

MR. MATTHEWS: Yes, yes. I'm going to get to that.

This issue was one of the topics that was discussed at the meeting along with all the other MRP activities, and just this week we've scheduled another technical meeting with NRC staff and I'll go into what we're going to discuss in that meeting.

The industry plan includes a short term assessment in which we want to demonstrate that the continued operation of alloy 82/182 welds is acceptable. We're trying to get that to the staff by late March. The NSSS vendors are at work right now performing the analyses and working on this assessment.

We had a goal of getting interim inspection guidance.

MEMBER POWERS: You say here the continued operation with alloy 82/182 welds, that's just the weld not a flawed weld that you're dealing with?

MR. MATTHEWS: We want to -- well, what we're going to show is the margins that are available in there to cracking and even if it does crack, the margins that are available to a rupture of the pipe. We're going to try and prove here that it's not really a safety issue, it's a leak issue, it's an operational issue, we have to be very concerned about it, it's very expensive to have this kind of leak. But we want proof and show that it's not a safety issue.

MEMBER POWERS: What you want to show, I think, is that if you have a flaw in that weld, that it will not propagate rapidly to create a pipe rupture.

MR. MATTHEWS: Exactly. Analyses to that effect were certainly part of the report that Westinghouse put together for V.C. Summer. And we will build on those analyses for the whole industry.

MEMBER POWERS: But you're not going to have any more data than they did.

MR. MATTHEWS: No, not at this point in time. I mean there's no more data that we can get our hands on right now. We've got to go create some or find out what else is out there.

MEMBER POWERS: Well when you think about data on stress corrosion cracking, you think about things like residual stresses, you think about chemistry. Do we have now data that are taken in irradiated water of the type we have in --

MR. MATTHEWS: I don't think we have data in irradiated water, but we do have data that was taken with several heats of alloy 182 weld metal and there was created, samples cut from it, several samples were put into a PWR environment in an autoclave and tested to crack --

MEMBER POWERS: When you say environment you're speaking of the pressure temperature environment not the radiation environment?

MR. MATTHEWS: Not the radiation but these things are very, very low radiation where these welds are. These welds are not in the belt line region, they're above the core.

MEMBER POWERS: Well, I mean I just can't help but ask, you have a lot of radiolysis product, water radiolysis products in these and they tend to be fairly aggressive chemicals as far as oxidation and reduction reactions. Do they not affect the chemistry in these?

MR. MATTHEWS: I guess I don't know the answer to that but the tests that we've done are trying to stimulate the PWR primary water as best they can, given that we're not doing it with a reactor.

MEMBER POWERS: Well my question is is temperature adequate or do you have to simulate the ozonides and peroxides and things like that because of water radiolysis?

MR. MATTHEWS: I guess I don't know the answer to that. We do run these plants with a hydrogen over pressure and it tends to scavenge those things pretty quickly I would hope.

MEMBER WALLIS: Even short life -- and this is a hot leg, this stuff has been irradiated and everything else a very short time before it comes to this spot.

MR. MATTHEWS: Yes.

MEMBER WALLIS: So there could be some very transient type products which are in there.

MR. MATTHEWS: Yes, there could and I guess we haven't looked at that as an industry and perhaps we need to.

VICE CHAIR BONACA: I don't want to belabor it but it seems to me that the gentleman said they're trying to see if in fact this eddy current data is credible.

MR. MATTHEWS: The eddy current data? Yes.

VICE CHAIR BONACA: Now, assuming that you could prove that the eddy current indications were not correct, that would support your claim that this is a unique issue to do with that particular weld in that particular A leg, and all this would be gone. So why won't you focus immediately on the issue of the validity of eddy current as a means of inspecting these cracks?

MR. MATTHEWS: Well, we have some information, as I understand it, from the Ringhals test. They did UT and eddy current, and over there the eddy current was not the save all, in fact it missed flaws that the UT picked up.

VICE CHAIR BONACA: Okay. The combination of the two seems to be an effective means you mean?

MR. MATTHEWS: Perhaps. But the eddy current here was --

VICE CHAIR BONACA: So you can't discount the eddy current indication, that's what you're saying right now.

MR. MATTHEWS: Yes. It's not a proven technology for going in and detecting and sizing flaws.

MEMBER SIEBER: And it focuses more on surface indications.

MR. MATTHEWS: Yes, that's right. Another thing the plan included was to get out some interim inspection guidance for the near term outage plants, those plants that are coming down this spring. That was completed yesterday I believe. The letter was signed out to the industry.

The plan also includes a longer term assessment of all the alloy 82 and 182 welds in the plants, in the PWR primary systems. We'll be looking, reviewing and improving inspection technology where it's appropriate. And we'll also be reviewing repair and mitigation methods, if necessary, working to develop some improvements in those.

MEMBER WALLIS: Let me ask about UT. Isn't this a developing technology in the medical field that's highly developing, a lot more intelligence is used for it and they can see things they couldn't see before and it's improving very rapidly. Is this sort of a fossilized technology, or are improved UT methods coming out regularly?

MR. MATTHEWS: I think the industry is constantly looking to try and improve their technology for detecting --

MEMBER WALLIS: Is it happening?

MR. MATTHEWS: Yes, there's phased arrayed technologies that are coming out and have not been applied at this point to these welds, but that has been applied in the industry for turbine blade examination and things like that. There's new technology being looked at by the EPRI and NDE center right now for much smaller --

MEMBER WALLIS: Is it difficult to get approval for new technology because of the regulatory process?

MR. MATTHEWS: I think the code process would be the more difficult thing to get it through but, at the same time, if there's a better way to do things I can think we can push it through.

DR. FORD: Can I just come back to the very first bullet there, the short term assessment. What are the criteria for that? What are the criteria that your short term assessment is correct?

MR. MATTHEWS: I'm going to -- oh, I'm going to give a lot more detail of what we're going to do there.

DR. FORD: Okay. But there will be data? There will be stress corrosion data to back it up?

MR. MATTHEWS: There will be what data we have available will all be factored in to putting together the short term assessment.

DR. FORD: Okay.

MR. MATTHEWS: And while we've already started work on much of this, we expect there is an approval process for the -- the senior reps we anticipate them approving what we're laying out in our plan on March 9. But we've already started work with funds that were already available.

Basically, these are the three committees under my Alloy 600 ITG and we're part of the MRP and the MRP is looked to the NEI as the regulatory interface with the NRC. That's not to say we don't have technical discussions. We do. When there's technical issues to discuss with the staff, we'll discuss them directly.

MEMBER WALLIS: Excuse me. Who does the work? Do you contract with somebody?

MR. MATTHEWS: Most of the work would be contracted to vendors or consultants or done in house at EPRI. Most of the technical work, a lot of the guidance and overseeing of all that work is done by these committees. And these people are knowledgeable people in the industry in these areas too, on the committees.

These are just the chairmen of the three committees that we've set up. The chairman of the assessment committee is Vaughn Wagoner from CPNL. The chairman of the inspection committee is Tom Alley from Duke. And the chairman of the repair and mitigation committee is Gary Moffatt from the V.C. Summer plant.

One more detail about the committee activities. The first thing is to get this short term safety assessment done, the process that we've outlined involves identifying areas that are likely to be the most susceptible and that's primarily going to be based in this very short term on evaluating the size of the welds, the temperature and the weld materials. We felt that likely spots would be on the Westinghouse and combustion plants to hot leg pipe welds. At BNW is may indeed be the CRDM nozzle welds at the top of the head, but they also have some other pipe welds that they'll be looking at I believe.

Certainly not all the plants have the same welds. The difference between the vendor designs, the piping is completely different on the three plants, or plant designs, and even within the Westinghouse fleet, these welds have a wide variety of how they were constructed. Some shop welds, some field welds, some stainless steel, some inconel 182 butter with 82 weld material, so there's a wide variety of those and we have to go out and assess all of those.

One of the goals is to demonstrate that most of the cracks will be axial or in the case of the head penetrations they will be in the axial radio direction as was seen at the Oconee.

MEMBER WALLIS: Why will they be axial?

MR. MATTHEWS: It's primarily because of the stress field that the --

MEMBER WALLIS: The stress field stresses it more highly in that direction?

MR. MATTHEWS: Yes. Well the stress is in the circumferential making the crack --

MEMBER WALLIS: The flow direction has nothing to do with it?

MR. MATTHEWS: No.

MEMBER WALLIS: Well flows have effects around bends and things. Flows have some effects on these things don't they?

MR. MATTHEWS: A little bit of flow momentum I would imagine but I don't -- then that would be taken into account. That's going to be second order compared to the other stresses that are driving these things.

MEMBER LEITCH: Are you going to -- can you go back and identify welds where there was major repair activity at the time of original construction. Is that one of the things you're going to be looking at here? It seems to me if that was not the prime cause of this failure, certainly I think we would all agree that it accelerated the failure in this particular A hot leg. So can you go back and identify those welds?

MR. MATTHEWS: The amount of data that's available to each plant varies depending on, you know, some of these plants are 20, 30 years old and their construction records are sometimes hard to come by. But what's available is available and will be looked at by the individual utilities to see if there's anything.

MEMBER WALLIS: So chemistry comes into this propagation of the crack, chemistry is a factor.

MR. MATTHEWS: Water chemistry?

MEMBER WALLIS: Yes. And so there's a whole lot of flow mechanics and diffusion processes and things going on in these cracks. It's not just stresses, it's everything else, too. I just wonder how well that is understood. The biggest axial crack with the water whipping by with some sort of flow percolating around through the crack as well.

MR. MATTHEWS: These cracks are so very, very, very tight. The water in those cracks is probably --

MEMBER WALLIS: Well something has to go up there, there's going to be corrosion effects.

MR. MATTHEWS: Yes, but it's a very stagnant environment.

MEMBER WALLIS: So it's diffusion.

DR. FORD: If I -- maybe I could just help you out maybe. In boiling water reactors where you have an oxidizing environment, yes, the direction of flow could be important. But, in fact, the water does not enter into the crack very deeply and it becomes more an academic exercise.

MEMBER WALLIS: What's in the crack?

DR. FORD: Well all this water but you're talking about a replenishment of the water, and that does not occur to any great extent in these tight cracks.

The question of the PWRs, you're not going to get too much flow effect, rate effects in this reducing environment, if you do have a reducing environment, and Dana's observation is an interesting one as far as I'm concerned.

MEMBER SIEBER: Maybe I could ask another question. It seems to me that 82/182 I think and alloy 600 are all, as far as stress corrosion cracking, are all dependent on temperature. And the need is what, 608, 609 degrees Fahrenheit where higher temperatures than that to correct growth rate accelerates. It would seem to me, and I worked in a plant at one time, where because of the finding of some cracks, they reduced the temperature at the plant by about 10 degrees which virtually stopped the growth of the crack. Has anybody considered that as an alternative to all these other things?

MEMBER SHACK: People do it in steam generators. That's generally a pretty drastic step.

MEMBER SIEBER: Yes, well you lose some megawatts that way but a pipe break is a pretty drastic thing, too. And given the choice, I would rather lose a few megawatts.

MR. MATTHEWS: I don't think anybody's considered at this point trying to reduce their hot leg temperatures because of this. The drop may have to be significant to get it down below that need that you're talking about I would think.

MEMBER SIEBER: Well, it might have to be below 600. On the other hand, for a lot of plants that's seven or eight or 10 degrees.

MR. MATTHEWS: And for a lot of plants it's more than that.

MEMBER SIEBER: Well, and so I continue to question. You know, once you're above 610 as a hot leg temperature, that means the reactor vessel head is at the same temperature, well the inconel welds up there that are also subject to the same kind of cracking.

MEMBER SHACK: But you know he has a much different problem than the steam generator people. You know, they have typically much larger margins to failure. A short crack in a steam generator gets you a lot closer to failure than a short crack in a large diameter pipe. It certainly could be done but it certainly seems pretty far down on his list.

MR. MATTHEWS: And the temperature effects are certainly going to be taken into account in our assessment of susceptibility and crack growth. And temperature is one of the factors in the crack growth, too.

MEMBER POWERS: When you think about activation energies for processes like crack growth rates, you typically think about things with uncertainties in the activation industry on the order of five -- is that right?

MEMBER SHACK: Yes -- it is that much.

MEMBER POWERS: And so these temperatures that like factors two or three on the crack growth rate, so the difference is between the biggest between two cycles and one cycle is kind of the input -- the activation.

MEMBER SHACK: If all you were depending on was the activation energy. But it's certainly true that if you dropped the temperature 20C, you'd get a lot. But you may not want to.

MR. MATTHEWS: Somebody asked earlier if the crack growth curve that was used was essentially the Peters-Scott model. Well that model was I guess initially based on steam generators but it was modified for the Alloy 600 head penetrations and that crack growth model was used, the modified Peters-Scott model was used for the susceptibility modeling that we've done in the industry on the head penetrations Alloy 600.

When we tested, in the test data that we've seen on the Alloy 82/182 shows those crack growths were, depending on the orientation with the dendrites, five to ten times faster than the Alloy 600 crack growth rate.

And then the curve that the NRC used bounded all of that so it was even more than that, faster than the basic modified Peters-Scott model.

The short term assessment will demonstrate a large tolerance for axial flaws and the circumferential flaws. The stress analyses that we've done indicate a preference for the axial cracking because of the stresses in the welds and how they're lined up. The flaw, as you saw on the plot they put up, was limited to the axial length of the pipe weld, which is just a couple of inches long. Basically, that's based on the V.C. Summer experience, it stopped when it hit the ferritic steel, it stopped when it hit the stainless steel, and it was only the inconel weld metal that actually experienced cracking.

The flaw in the CRDM nozzle at Oconee 1

also stopped when it hit the Ferritic steel. It did propagate on into the Alloy 600 base metal of the penetration itself.

And also the load limit fracture mechanics analysis will show that there's a large margin to pipe rupture.

MEMBER WALLIS: These are intents or indications?

MR. MATTHEWS: We believe that this is what they're going to show.

MEMBER WALLIS: But is it what you want to show.

MR. MATTHEWS: No, we believe it will show it. I mean a lot of this analysis is done --

MEMBER WALLIS: So this is based on analysis having been done?

MR. MATTHEWS: The analysis -- a very similar type analysis has already been done for V.C. Summer and we're going to extend it to the rest of the situation.

Similarly, for the circumferential flaws, a large margin, but since they can go 360 they're not limited by their axial. We'll demonstrate in this case that leakage will be detected very easily from a partial flaw while there is still a large margin on the limit load.

MEMBER WALLIS: Are flaws necessarily axial or circumferential?

MR. MATTHEWS: Well I guess they could be diagonal, depending on what's driving in and what the stress --

MEMBER WALLIS: Do they tend to go in straight lines?

MR. MATTHEWS: Well, they're jagged straight lines most of the ones I saw. There was a circumferential flaw underneath at V.C. Summer that intersected the axial flaw but it was up underneath the ferritic part of the nozzle. And it grew for a small distance and even that tended to turn in the axial direction because of the stresses we believe.

DR. FORD: Sorry, did you say the crack went into the ferritic steel?

MR. MATTHEWS: No, underneath it. The ferritic steel is clad on the -- with inconel for part way and it grew to the ferritic and stopped.

And then finally the short term safety assessment will present arguments similar to V.C. Summer's presentation on the January 18 meeting about the pipe -- that are covered by defense and death. And piping failure has been analyzed in the SARs and there's systems in place to mitigate it. Also, visual inspections for boric acid have been an effective way of identifying leaks well before there's been any structural margins affected anywhere.

MEMBER WALLIS: What is it you see when you see boric acid?

MR. MATTHEWS: Pardon?

MEMBER WALLIS: What do you see when you see boric acid?

MR. MATTHEWS: Actually you see the powder.

MEMBER WALLIS: You see solid boric?

MR. MATTHEWS: Yes, solid boric. And finding those boron deposits on the walk downs has been an effective way, at least to date, of finding flaws before there's any structural damage, structural margin is significantly affected.

For the longer term, the assessment committee will complete our scope definition, identifying all the areas of concern. One of the things we want to do is evaluate the generic applicability of the hot leg cracking, one of the elements, so that we'll be looking at finite element analysis including operational and residual stresses.

We will assess the safety significance of the issue for all of the components, and then we will prioritize the locations based on safety significance into capabilities and the actual experiences in the field.

The assessment committee is also going to be charged with determining if any new inspection requirements are necessary and, if they are, such as ISI frequency, perhaps the ten year frequency we have on these may need to be modified. We'll be looking at that. And they'll assess the research needs. Where are the holes? They're defined where we need more information and then define research efforts to get that information.

One of the areas we'll be looking at certainly is crack growth data available worldwide. We have some data, we think there's other data available in the world and we'll be gathering that data and factoring all of that into our analyses.

VICE CHAIR BONACA: So when you're talking about determining inspection requirements, you're talking about refining the understanding of what inspection you need to do to detect?

MR. MATTHEWS: I guess the way the assessment committee would do it would say what do you need to find and how frequently do you need to look for it. And the inspection committee, which would be the next one, would be defining what we've got to do to find that kind of indication.

VICE CHAIR: Oh so you have -- okay. Yes.

MR. MATTHEWS: The next committee is the inspection committee. The first thing they wanted to do was get some guidance out for those plants with spring outages. I believe that letter was signed yesterday by Jack Bailey from TVA, the VP there who is the chairman of the MRP. The goal was to develop a consistent inspection approach. After looking at it, the committee and the people that EPRI NDE center both felt that for these nozzles the ID UT was still considered the best available technique. It's considered adequate certainly for the upcoming spring outages for a couple of reasons.

V.C. Summer's inconel weld was a field weld that was installed and had multiple repairs on it done in the field. The ID contour on that weld was not necessarily the best.

MEMBER WALLIS: Tell me more about UT. I'm sorry, is this a thing where some diagnostician looks at some picture? Or is it something where a computer analyzes a picture, or a computer analyzes certain facets of an image or what?

MR. MATTHEWS: At least for UT today, the way it's being done is it's a trained technician watches the instrument. These are automated instruments that are --

MEMBER WALLIS: So it's as prone to error as diagnostic X-rays in hospitals, where someone looks at a picture and tries to see a crack.

MR. MATTHEWS: Well it's not a picture though, it's a trace on an oscilloscope.

MEMBER WALLIS: Looks for some anomaly?

MR. MATTHEWS: It's looking for any kind of anomaly and the data that's taken on these is a digital form of data, with hot leg alphas anyway if they're done from ID, it's an automated exam where the data's gathered and stored and digitized and can be then reviewed.

MEMBER WALLIS: And can they zoom in or something? I mean if he thinks there's something there can he get a magnification of the signal and things like that?

MR. MATTHEWS: Well, you can go look at it closer but I mean all the data's there available for him to look in as much detail as is available.

MEMBER WALLIS: I'm just wondering if greater attention to detail in the inspection would buy you some better assessment.

MR. MATTHEWS: We think absolutely and that's one of the things that we're working, that's one of the recommendations that we're putting out is to enhance the awareness of those inspectors to the kinds of anomalies that led to missed indications at V.C. Summer.

MEMBER POWERS: And Indian Point and a few other places. I mean there's been pandemic missing of indications here.

VICE CHAIR BONACA: I mean I'm somewhat disturbed by the top bullet, the UT is still considered the best available technique.

MR. MATTHEWS: That's today.

VICE CHAIR BONACA: I understand but you know the whole experience we saw in the presentation says that eddy current was an important complementary technique to identify indications that are seen as significant enough to say you should go only one cycle.

Now if this is true, it has implications for the other plants too, and it's hard to take then at face value the statement that ID UT is still considered the best available technique. I may just have trouble in accepting both statements at the same meeting.

MEMBER POWERS: Separated in time they're okay.

(Laughter.)

MR. MATTHEWS: The inspection committee and the people that -- everybody there with the inspection had worked with the results from V.C. Summer. They were also aware of the indication, or the information out of Ringhals that those guys, the eddy current didn't even see some of those flaws that the UT did see.

VICE CHAIR BONACA: And that's why I used the word complementary. That together seem to really yield some information.

MR. MATTHEWS: The problem the industry has with UT at this point is it's never been used except at Ringhals and at V.C. Summer. We don't really know what's in the VNC loop, we haven't really got a clue in my mind what's there. There's indications there. They haven't been proven, we don't know what it is. And to jump in there with an unproven technique on a plant that's down for a regular ISI and say, okay, you find a scratch in there, now you're limited and you've got to come back and do the cold leg again next cycle.

We felt it was a little premature for the industry to jump to something like that.

VICE CHAIR BONACA: But for your plant, still you have restrictions based on ET.

MR. MATTHEWS: Well, it's not my plant, it's V.C. Summer. No, I'm from Southern Nuclear.

VICE CHAIR BONACA: Oh I thought -- I'm sorry, all right.

MR. MATTHEWS: The way the mergers are going I don't think it's my plant.

VICE CHAIR BONACA: I was referring to that, jut I confused the two, all right.

MR. MATTHEWS: Another thing that the inspection committee did do is there was a mock-up available that the EPRI NDE center had of this type of weld, with imbedded flaws. Now admitted they were fatigue flaws but it's the best we've got right now. Some of those flaws are very shallow and we recommended that the plants, and there's a very limited number of plants with iconel welds here on the hot leg that are going in for inspections this spring, I think there's actually only three plants with iconel.

And we recommended that those plants have their vendors perform a demonstration of their techniques on the EPRI mock-up, and all those vendors have done so and, as a result of doing those demonstrations, there have actually been some modifications to the procedures that were being used. New transducers and new scanning gains on the instruments to get a more sensitive examination.

Also, we said that we were going to enhance the awareness of inspectors and not just be willing to say, well, I got 90 percent coverage on that weld, that meets the code. If you get a lift off do what you can to remedy that situation. And be aware of what a lift off looks like on the data and see if there's not something you can do about it.

MEMBER WALLIS: How long does it take to do this inspection? Have you got something which is going around and traversing on some track?

MR. MATTHEWS: It's a robot arm typically that hangs off the vessel. It is done simultaneously with the belt line weld exams on the vessel by the ten year ISI. And it will go in and has a sled that will --

MEMBER WALLIS: Is this a day long operation type thing?

MR. MATTHEWS: I imagine it's at least that. I'm not sure how long it takes. Not per nozzle

I would imagine it wouldn't take all day.

MEMBER SIEBER: About 12 hours including moving into position.

MR. MATTHEWS: Per nozzle.

MEMBER WALLIS: Presumably the signal -- everything comes out as stored information so it's available at any time.

MR. MATTHEWS: For these particular nozzles and these particular welds it is. There's other inconel welds that are not done today with automated techniques where that's not true. But for these hot leg and the cold leg nozzles off the vessel, those are typically automated exams from the ID.

Back on the, well I guess I've mentioned the three plants that have inconel welds that are doing 10 year vessel ISIs we understand geometry is a very big issue here, the ID geometry in the contact of the sleds. Looking at it, those three plants, the inconel weld was a shop weld not a field weld and we firmly believe that the ID geometry for the inconel part of this weld will be in much better shape than the situation at Summer. I'm not sure we have ID contours but typically those shop welds are in much better shape when we ID than the field welds.

MEMBER SHACK: Can you try to finish up in five minutes?

MR. MATTHEWS: Oh, okay I'll hurry.

Other things that we're recommending is that we enhance the sensitivity of the boric acid walk down and enhance the awareness of the operations and chemistry people looking for small changes and unidentified leakage and possible, or notifying them where these 82/182 welds are.

Longer term actions of the inspection committee, they need to evaluate the need for alternative and new techniques and we'll be doing that. We'll be looking at the evolving capabilities of the vendors over the years and what new techniques, if applicable, could be applied.

We'll be looking internationally at what techniques are available. There may be something overseas that some of those vendors are using, and we realize we have to address in the little bit longer term the geometry concerns for the ID.

We'll evaluate the data we get out of the spring outages and feed that back in to the fall plants for further recommendations.

Also, we'll be defining what additional mock-ups are needed. We'll work with the vendors on delivery systems, such as the smaller transducer packages or better articulating tools, and coordinate the demonstration of capabilities with the PDI -- as they're developing their mock-ups for qualification of inspectors. That's a fall 2002 requirement that bimetallic or dissimilar metal welds be examined by qualified people.

And then through the NDE center we'll be providing training and expert help where it's needed.

And, finally, evaluate the impact on risk informed ISI.

But the industry experience is an integral part of that risk informed ISI process, so experience here will have to be factored in, and there's a required feedback loop in the risk informed ISI process that takes industry experience and phases it back in and into the program for those plants that have already implemented risk informed ISI. And they'll have to be assessing that impact on their programs.

Finally, the repair and mitigation committee's running a little bit behind the others. It's not quite as urgent for us to be addressing that. They'll be meeting in March and they will assess the need for improvements in the repair and mitigation processes. That will depend to some extent on what comes out of the assessment in the inspection committee.

What the repair group will be looking at will be prioritizing the locations based on repair mitigation inspection perspective which could be quite different than a safety perspective. They'll look at the likelihood and consequences of a failure or a leak, how difficult is it to implement a repair, trying to assess where we might need to work with vendors to come up with better ways to repair or mitigate the situation.

They're going to create a matrix by assessing the existing technology, look at what would be involved in the qualification and demonstration of a new technique, and where there's any kind of code or regulatory compliance or involvement, we'll be getting the NRC and the code people involved early in the development of those processes.

What is our schedule? We've scheduled a technical working meeting with the NRC on March 23. In that meeting we will be going over the detailed approach of the short term safety assessment and hopefully by that time we will have many if not all of the results available, possibly not in their final form. And we'll solicit their feedback on that short term safety assessment. The plan is to get that to them by the end of the month.

We're trying to arrange a visit to the NDE center by the staff. We'd be working with the staff and, as Gene said, the staff has already been down and audited the demonstration of the technology, or the inspection tools at FTI.

The short term assessment inspection to be completed in March. The inspection guidance, like I said, I believe that was issued yesterday. Longer term, the assessment inspection efforts for June time frame involve evaluation of the spring 2001 inspection results and assessment of all the 82/182 welds in the plant, in the primary system, not just the ones that we think might be the most likely.

And then even longer term there'll be continued assessment of all the Alloy 600 applications inspection and repair mitigation technology and whatever research efforts we and the staff have to come up with.

Finally, in conclusion, MRP has taken the lead for the industry in developing an industry plan here. We firmly believe this is not really a near term safety issue because of the margin available in these welds to failure of the piping. Visual inspections for boric acid have been effective and they are effective at finding leaks before there's any structural integrity threatened. Pipe welds are covered by defense and death approach has been inherent in the nuclear industry all along, and we're performing the short term assessment to demonstrate that we can continue to operate.

MEMBER WALLIS: I want to ask you about this effectiveness. Now at Summer, boric acid was used to find the leak, right.

MR. MATTHEWS: Yes.

MEMBER WALLIS: Suppose it had not been found for another period of time, how long can it go on before something worse happens?

MEMBER POWERS: One, two, or more cycles.

MR. MATTHEWS: The leak at V.C. Summer was through a very, very small pin hole where the crack had finally made it to the OD and it was a very, very small leak. It was 1.2 GPM. Before the crack gets anywhere near a crack size that could threaten a rupture of the pipe, you'll be leaking tens of gallons of water per minute and you'll easily pick that kind of thing up.

MEMBER WALLIS: Yes, but that's not really addressing the first question. I mean are you saying more visual inspections are effective, they're only going to be effective if they're caught on time, early enough. And if you inspect and you don't see boric acid and then you wait for so long, it must not grow in that period of time. How fast is it, I don't have a feel for how fast it would grow if you hadn't detected it.

MR. WAGONER: Cycles and cycles and cycles.

MEMBER WALLIS: Many cycles before there's a big leak?

MR. WAGONER: Yes, sir. I'm Vaughn Wagoner from Carolina Power and Light. And the point is that the, and I'm going to use some round numbers, but a half an inch a year, okay, three-quarters of an inch for an 18 month cycle. So you've got two or three inches of weld metal in axial direction and it's going to stop on both ends, theoretically you could run for ever. So you've got numbers of two, three inches that you'll be able probably to have a discernible leak and you've got even in the circumferential directions you've got tens of inches of flaw capability before you ever get there.

So you've got cycles and cycles and cycles of margin, even if you're in a circumferential direction, which is the only one we're really worried about it for a catastrophic failure. And those are round numbers, but I think it's the order of magnitude, I mean it's in the ballpark of what we're talking about.

MEMBER WALLIS: Is that something the -- agrees with.

MR. WICKMAN: Keith Wickman, NRR. Critical crack size both axially and circumferentially are very large. Okay. So on the face of it, yes.

VICE CHAIR BONACA: So really boric acid will be identifying those before leakage?

MR. MATTHEWS: No. The boric acid comes from the leak.

VICE CHAIR BONACA: No, I understand that, I'm saying that you would find it through an inspection, walking down, you see boric acid and that's on inspection before you find it through unidentified leakage. What you're telling me is that --

MR. MATTHEWS: That's a distinct possibility. That's exactly what happened at V.C. Summer.

VICE CHAIR BONACA: Because the growth is so slow.

MR. MATTHEWS: That's exactly what happened at V.C. Summer. And we do boric acid walk downs every outage and they're pretty thorough and we're enhancing the awareness of the people that are doing those boric acid walk downs to be sure you trace it back and don't assume it was a valve. Trace it back and make sure you know where it's coming from. That kind of thing. So if there is a leak and it's been going on for any -- or leaked out any significant amount of boric acid, we feel quite confident that we'll find those on the walk downs.

MEMBER SHACK: Coming back to Graham's question though a little bit, I mean circumferential cracks are a little more difficult to deal with because when you have stress corrosion cracking and you have residual stress pattern, you can at least in fusion systems where you get very large aspect ratio cracks, and he's certainly right that if you get a through wall crack of X inches it will take you a long time to grow that way.

If the crack is sort of growing at a very large aspect ratio when it comes through the wall, then things can get more exciting, which is why the NRC hasn't allowed leak-before-break in systems that have been susceptible to stress corrosion cracking.

MEMBER WALLIS: Aspect ratio I mean there's a long base to the crack, a little tip up here so --

MEMBER SHACK: Well, relatively shallow and a long length. The axial flaw are really much easier because they do, they butt up against the stainless steel on the one end and the ferritic vessel on the other, and they're sort of stuck there.

MEMBER WALLIS: Are they stopped forever there?

MEMBER SIEBER: Pretty much.

MEMBER SHACK: Forever as long as, you know, on the scale that we're interested in things, yes.

MR. MATTHEWS: And we'd certainly find those before they corroded away the nozzle from boric acid from the OD I think.

Interim inspection guides for near to term plants has been issued. We will revise that later as we get more information, as we have better handles on technology. The longer term assessment in the Alloy 600 and 182 and 82 welds in the PWR primary system and including inspection repair and mitigation, we'll be looking at all these things in a little longer term and we intend to keep the NRC staff fully informed of everything we do and as we're going along.

Basically, any more questions. Did I do it in five?

MEMBER SHACK: Close enough.

MR. MATTHEWS: Okay.

MR. BATEMAN: This is Bill Bateman from the staff. If you don't mind I'd like to make a couple of comments quickly because I know it's getting close to lunch time.

I'm the chief of the branch that had to make the decision as to what to do as the result of can Summer restart or not. And at least from a code perspective, the affected weld was totally replaced so we got out of the code realm when they cut the whole weld out and put in a whole new weld. So from that perspective Summer was in compliance with the code.

Regarding the other two indications on the cold leg, those welds, even assuming a 2:1 aspect ratio did not achieve 10 percent depth in the pipe, which would have required a flaw analysis by the code. So by code requirements there is no requirement to do a flaw analysis because the assumed depth of that eddy current indication was not at a 10 percent depth.

However, we took the bounding crack growth rate and applied it to the one-eighth inch assumed depth to that crack to assure that that crack would not exceed the 75 percent through wall. And the time we came up with was about one cycle.

So those are the conservatisms that the staff used in coming to the conclusion that it would be all right for Summer to restart. I want to try and firm that up. There seems to be some skepticism I think in terms of our rationale.

So, again, in terms of the code, there was never an issue with code. Everything was totally in compliance with the code, we went beyond the code and basically with the bounded crack growth rate analysis to make our determination.

And, again, with respect to the crack growth rate analysis, there's not a lot of data, but the data we did have we reviewed with our own expertise and we went to National Lab and got their advice in terms of whether or not this was a valid crack growth rate, and whether or not our assumptions were valid. And all the feedback we got led us to use the data that we did with confidence that we would not have a problem prior to an inspection after one cycle of operation.

MEMBER SHACK: Any additional comments? No. Mr. Chairman.

VICE CHAIR BONACA: With that I think we will take a break for lunch and we will come back at one o'clock.

(Whereupon, the above-entitled matter went off the record at 11:56 a.m.)

CERTIFICATE

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

Name of Proceeding: Advisory Committee on Reactor Safeguards

Docket Number: (not applicable)

Location: Rockville, Maryland

were held as herein appears, and that this is the original transcript thereof for the file of the United States Nuclear Regulatory Commission taken by me and, thereafter reduced to typewriting by me or under the direction of the court reporting company, and that the transcript is a true and accurate record of the foregoing proceedings.

John Mongoven

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

DISCUSSION OF V.C. SUMMER TECHNICAL REVIEW AND GENERIC ACTIVITIES

ACRS MEETING
MARCH 2, 2001

C. E. CARPENTER
NRR:DE:EMCB

STAFF'S REVIEW

- Staff Performed Independent Evaluation of Licensee's Assessment of "B" and "C" Nozzle Welds

  → "Integrity Evaluation for Future Operation: Virgil C. Summer Nuclear Plant Reactor Vessel Nozzle to Pipe Weld Regions," dated December 26, 2000 (WCAP-15615, Revision 1)

  → Provided Results of Westinghouse's UT & ET Examinations of Nozzle to Pipe Welds for Loops "A," "B," and "C"

  → Provided Flaw Evaluation Proposing That Summer Could Be Operated for Two Fuel Cycles Without Repair of Existing ET Indications on "B" & "C" Hot Leg Nozzle Welds

STAFF'S REVIEW (con't)

- Staff's Review Found Summer Could Be Operated with ET Indications in "B" and "C" Hot Leg Welds for 1 Cycle
  - → Used Bounding PWSCC Crack Growth Rate and Flow Stress for Weld Material, and Initial ET Indication Length & Inferred Depth
  - → Used Bounding CGR Due to Limited Crack Growth Rate Data for Alloy 82/182 Material
  - → Evaluation Issued February 20, 2001

ONGOING ACTIVITIES

- Staff Is Reviewing Similar Cracking in Foreign Reactors
  - → Root Cause of Summer and Ringhals Cracking is PWSCC
  - → Investigating Reports of Other Foreign Cracking

ONGOING ACTIVITIES (con't)

- Staff Assessing:
  - → Generic Implications and Industry Activities
  - → Implications on Leak-Before-Break (LBB) Analyses
  - → Implications on ISI (Deterministic and Risk-Based) Programs
  - → Ability of ASME Code-Required NDE to Detect and Size Small ID Stress Corrosion Cracks (Effect of Surface Condition)
  - → Appropriateness of ASME Code Standards Allowing Flaws up to 10% of Wall Thickness Without Evaluations Given Apparent High CGR
  - → Effectiveness of RCS Leak Detection Systems

GENERIC ACTIVITIES

- Staff Proposing Confirmatory Research into PWSCC Cracking Issue to Include:
  - → NDE / ISI Issues
  - → Determination of Bounding CGR and Residual Stresses
  - → Development of Susceptibility Model
  - → Assessment of Possible Repair / Mitigation Methods
  - → Following Industry Activities

GENERIC ACTIVITIES (con't)

- PWROGs Have Proposed Industry Initiative to Respond to PWSCC Cracking Issue
  - → PWR Materials Reliability Program (MRP) Alloy 600 Issue Task Group (ITG) Addressing Assessment, Inspections and Repair/Mitigation
  - → Met with Staff (January 25 & February 16) to Discuss Industry Plans to Respond to Cracking Issue
  - → Staff Observed Inspection Mock-up at MRP Vendor Site
  - → Future Technical & Management Meetings Planned

STAFF EXPECTATIONS

- Staff Expectations of Generic Activities
  - → MRP Assessment of Generic Susceptibilities
  - → NDE Methodologies / Tooling Should Make Use of Best Practices and Capabilities to Address Potential Weaknesses
  - → Potential Code Cases
  - → Implication for ISI & LBB
  - → Long Term Assessment of Alloy 82/182 Applications
  - → Review of Repair/Mitigation Methods

EPRI

Industry Response
Alloy 82/182 Weld Cracking

ACRS Briefing – March 2, 2001

Materials Reliability Program
Alloy 600 Issue Task Group (ITG)

Larry Mathews, SNC, Chairman
Al McIlree, EPRI Project Manager

EPRI

Industry Response to Generic Implications

- MRP A600 ITG has taken the lead in developing the industry plan
  - VC Summer event Oct, 2000
  - Root Cause information early Dec, 2000
  - IIG Recommended Industry Program mid Dec.
- Executive approval early Jan, 2001
  - Developed organization
  - Developed detailed plan and budget
- ITG organized 1/19/01 to address key focus areas
  - Assessment Committee
  - Inspection Committee
  - Repair/Mitigation Committee

EPRI

Industry Response to Generic Implications

- l/25/01 Meeting with NRC
  - Outline approach
  - Solicit feedback
- 2/1/01 Initial meetings of Inspection and Assessment Committees
  - develop plan, schedule, and budget
- 2/16/01 MRP/NRC Executive Management Meeting
- 3/23/01 Technical meeting with NRC staff - scheduled

3 MRP- A600 ITG

EPRI

MRP Status March 2, 2001

- The industry plan includes:
  - Short term assessment to demonstrate that continued operation with Alloy 82/182 welds is acceptable, by late March.
  - Interim inspection guidance for near term outage plants - Complete
  - Longer term assessment of all Alloy 82/182 applications in PWR primary systems
  - Review and improvement of inspection technology
  - Review of repair/mitigation methods and improvement if necessary
- Endorsement of plan by Senior Representatives is anticipated at their meeting on 03/09/01

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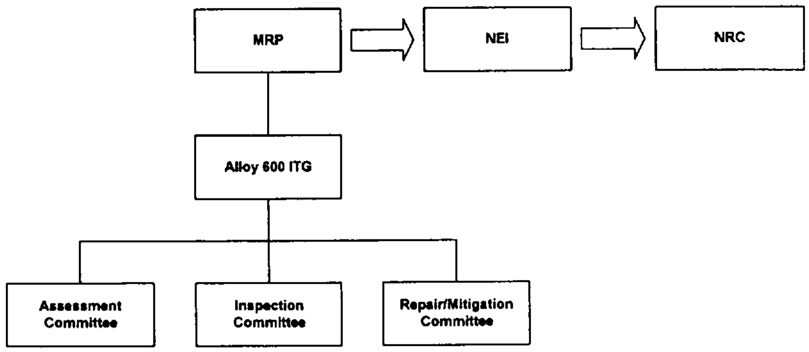
EPRI

Coordination of Overall Effort



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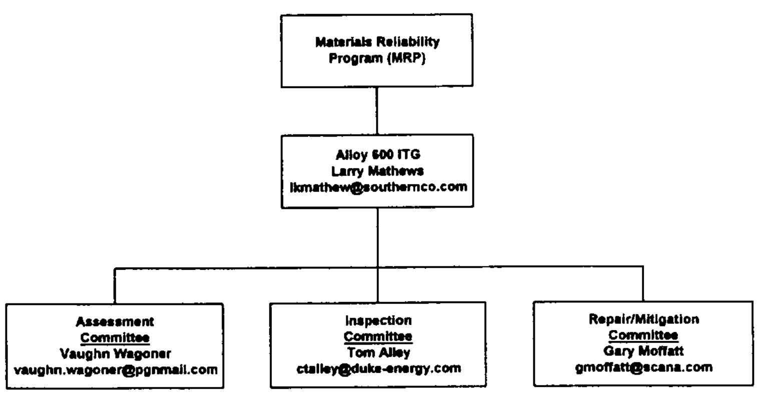
MRP- A600 ITG

EPRI

MRP/ITG Organization



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MRP- A600 ITG

EPRI

Assessment Committee Activities

- **Short Term Safety Assessment**
  - **Identify areas likely to be most susceptible**
    - » Evaluate size, temperature, and weld materials
    - » W and CE – likely to be hot leg pipe welds
    - » B&W – likely to be CRDM nozzle welds
  - **Demonstrate that most cracks will be axial, or axial-radial in case of CRDM nozzle welds**
    - » Domestic and international experience with similar welds
    - » Finite element stress analysis including welding residual and operating stresses

EPRI

Assessment Committee Activities (cont.)

- **Short term Safety Assessment (cont'd)**
  - **Demonstrate large tolerance for axial flaws**
    - » Stress analyses indicate preference for axial cracking
    - » Flaw limited to axial length of pipe weld
    - » Flaw limited to J-groove and nozzle thickness for CRDM welds
    - » Limit load and fracture mechanics analyses will show large margin
  - **Demonstrate large tolerance for circumferential flaws**
    - » Leakage will be detected from partial-arc flaws while there is still large margin on limit load

EPRI

Weld Assessment Technical Approach (cont.)

- Short term Safety Assessment (cont'd)
  - Pipe weld failures are covered by Defense-in-Depth (pipe failure has been analyzed in the SARs)
  - Visual inspections for boric acid have been effective in identifying leaks well before any structural margins are affected

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EPRI

Weld Assessment Technical Approach (cont.)

- Longer Term Action
  - Complete scope definition
  - Evaluate generic applicability
    - » Finite element analyses, including operating and residual stresses
  - Assess safety significance
  - Prioritize locations based on safety significance, NDE capabilities, and actual experiences
  - Determine inspection requirements
  - Develop consistent flaw evaluation guidelines
  - Assess research needs and oversee tasks
    - » Coordination with ongoing CGR work

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EPRI

Inspection Committee Activities

- **Short Term Inspection Guidance**
  - **Develop consistent inspection approach**
    - » ID UT still considered best available technique
    - » Considered adequate for upcoming spring outages
    - » Demonstrations on EPRI mockup
  - **Enhanced awareness of inspectors to signal anomalies**
  - **Review previous inspection data for geometry, signal quality, etc.**
  - **Enhanced sensitivity for boric acid walkdown**
    - » Visual inspections are effective
  - **Enhanced awareness of Operations/Chemistry personnel during operation**

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EPRI

Inspection Committee Activities (cont'd)

- **Longer Term Actions**
  - **Evaluate need for alternate/new techniques**
    - » Evolving Vendor capabilities
    - » International capabilities
    - » Geometry concerns
  - **Evaluate Spring Inspection results/feedback to Fall plants**
  - **Define additional mockup needs**
  - **Work with vendors on delivery systems**
  - **Coordination of demonstrations with current App. VIII actions**
  - **Provide training/expert help to utilities**
  - **Evaluate impact on Risk Informed ISI**

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EPRI

Repair/Mitigation Committee

- Need for repair/mitigation improvements depends on Assessment and Inspection Committee findings
- Prioritize from repair/mitigation/inspection perspective
  - Likelihood/consequence of failure
  - Implementation difficulty
  - Cost and dose
  - Material availability
- Create a repair/mitigation matrix
  - Assess existing technology
  - Qualification and demonstration
  - Code and regulatory compliance/involvement

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EPRI

Schedule

- Technical working meeting with NRC, March 23, 2001
  - Describe detailed approach
  - Discuss preliminary findings
  - Solicit feedback
- Arrange NRC visit to NDE Center
- Short term Assessment/Inspection effort completed in March
  - Safety Assessment of Alloy 82/182 welds
  - Inspection guidance for Spring 2001 outages
- Longer Term
  - Assessment/Inspection efforts for June
    - » Evaluation of Spring 2001 inspections
    - » Assessment of all Alloy 82/182 welds
  - Continued assessment of all Alloy 600 applications, inspection and repair/mitigation technology, research efforts

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EPRI

CONCLUSIONS

- MRP A600 ITG has taken the lead in developing the industry plan
- Not a near term safety issue
  - Visual inspections for boric acid are effective
  - Pipe weld failures are covered by Defense-in-Depth (pipe failure has been analyzed in the SARs)
  - Short term assessment to demonstrate that continued operation with Alloy 82/182 welds is acceptable, by late March
- Interim inspection guidance for near term outage plants - Complete
- Longer term assessment of all Alloy 600 and Alloy 82/182 applications in PWR primary systems, including inspection, repair, and mitigation
- Will continue to keep NRC informed

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V. C. Summer Reactor Coolant System "A" Hot Leg Crack

ACRS Meeting
March 2, 2001

V. C. Summer

ACRS Meeting
March 2, 2001

- V. C. Summer Background -- Karen Cotton
- Discussion of Technical Review and future activities -- Gene Carpenter
- Materials Reliability Program -- Larry Matthews
- Billy Crowley -- Special Inspection Team Leader
- Steve Doctor, Ph.D -- Special Inspection Team Member

History

- **October 7**: Discovery of boron deposits
- **October 13**: Liquid penetrant test revealed (PT) 4-inch indication on the "A" hot leg (later determined to be surface only)
- **November 6**: Ultrasonic testing (UT) and eddy current testing (ECT) revealed an axial crack approximately 2½" long with a "weep hole" exit point

V. C. Summer Activities

- Designated an evaluation and repair team
- Assembled a team of industry experts
  - Initiated Root Cause analysis
  - Researched Repair alternatives

V.C. Summer Activities Cont’d

- Established Completion Goals
  - Plant will be safe for start up:
    - Pipe and weld(s) meet code requirements
    - Repair will bound probable failure scenarios
    - Commonalities are addressed in the other welds
      - ECT indications found in 5 of 6 nozzle welds
- Developed a Communications Plan
- Licensee Commitments
  - To enhance their leak detection procedures
  - To inspect the ‘B’ and ‘C’ hot leg welds in Refueling Outage 13
  - To inspect all nozzle-to-pipe welds in Refueling Outage 14

NRC Activities

- Special Inspection Team (SIT) chartered
- Communication Plan developed
- Communication Team formed
- Summer Event Website developed
- Issued
  - Information Notice 2000-17 -- October 18, 2000
  - Supplement 1 -- November 16, 2000
  - Supplement 2 -- February 28, 20001
- Safety Evaluation of WCAP issued 02/20/01
  - Evaluation of the 'B' and 'C' hot leg welds

NRC Activities (Cont'd)

- Held five public meetings:
  - Atlanta - October 25, 2000
  - Washington - November 21, 2000
  - Atlanta - December 20, 2000
  - V. C. Summer Site - January 18, 2001
  - V. C. Summer Site - February 15, 2001 (public SIT Exit meeting)

Licensee's Root Cause Determination

- The construction weld process of grinding out the inside of the weld with a bridge pass in place created high welding residual stresses in the material (Alloy 182/82) susceptible to primary water stress corrosion cracking (PWSCC)

Special Inspection Team (SIT)

- **Inspection Objectives:**
  - To verify that the corrective actions activities were appropriate.

- **Inspection Scope:**
  - To review and/or observe licensee activities relative to root cause determination and corrective action.

SIT Cont'd

- **Inspection Activities**
  - Reviewed the licensee overall corrective actions
  - Reviewed original construction records, previous PSI and ISI records
  - Observed current welding and NDE activities
  - Two trips to Westinghouse to review metallurgical analysis of the spool piece removed from the 'A' hot leg weld

SIT Findings

- Root Cause analysis was found acceptable
- All welding and NDE activities met Code requirements