Official Transcript of Proceedings ACRS-T-3281

NUCLEAR REGULATORY COMMISSION

Title: Advisory Committee on Reactor Safeguards
512th Meeting

PROCESS USING ADAMS
TEMPLATE: ACRS/ACNW-005

Docket Number: (not applicable)

Location: Rockville, Maryland

Date: Friday, May 7, 2004

Work Order No.: NRC-1465 Pages 1-119

NEAL R. GROSS AND CO., INC.
Court Reporters and Transcribers
1323 Rhode Island Avenue, N.W.
Washington, D.C. 20005
(202) 234-4433

TR04

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

+ + + + +

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS (ACRS)

512th FULL COMMITTEE MEETING

+ + + + +

FRIDAY, MAY 7, 2004

+ + + + +

ROCKVILLE, MARYLAND

+ + + + +

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

COMMITTEE MEMBERS PRESENT:

MARIO V. BONACA, Chairman

STEPHEN L. ROSEN, Member-at-Large

GEORGE E. APOSTOLAKIS, Member

F. PETER FORD, Member

THOMAS S. KRESS, Member

GRAHAM M. LEITCH, Member

DANA A. POWERS, Member

VICTOR H. RANSOM, Member

WILLIAM J. SHACK, Member

JOHN D. SIEBER, Member

NRC STAFF PRESENT:

RAJ AULUDE

BARRY ELLIOT

PAUL GUNTER

DON HELTON

JORGE HERNANDEZ

ALLEN HISER

JIANG HONG

WILLIAM KROTIUK

SHAH MALIK

TONY McMURFRAY

LARRY ROSSBACH

THOMAS SCARBROUGH

DAVID TERAO

DOUG WEAVER

I-N-D-E-X

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

(8:28 a.m.)

CHAIRMAN BONACA: This meeting will now come to order.

This is the third day of the 512th meeting of the Advisory Committee on Reactor Safeguards. During today's meeting the committee will consider the following: potential adverse effects from core power uprates, subcommittee report on fire protection issues, future ACRS activities/report of the Planning and Procedures Subcommittee, reconciliation of ACRS comments and recommendations, topic schedule for discussion during the meeting with NRC Commissioners between 1:30 and 3:30 p.m. on Wednesday, June 2, 2004, and preparation of ACRS reports.

This meeting is being conducted in accordance with the provisions of the Federal Advisory Committee Act.

Mr. Sam Duraiswamy is the Designated Federal Official for the initial portion of the meeting.

We have received no written comments or requests for time to make oral statements from members of the public regarding today's session. A transcript of portions of the meeting is being kept, and it is

requested that the speakers use one of the microphones, identify themselves, and speak with sufficient clarity and volume so that they can be readily heard.

Are there any comments from members or questions? If none, we'll proceed with the first item on the agenda, which is potential adverse effects from power uprates, and with that I turn to John Sieber. He's --

MEMBER SIEBER: I'm the cognizant member.

CHAIRMAN BONACA: Right.

MEMBER SIEBER: Thank you, Mr. Chairman. I'm sure the members all recall the fact that about two years ago we wrote a letter to concur in the power uprate for Quad Cities and Dresden, and, in addition, the General Electric topical report on constant pressure power uprates.

And in our deliberations at the time, we were concerned about the increase in flow, but mostly in the context of flood-assisted corrosion as opposed to vibration and cracking. After Quad Cities began its upgrade, and shortly thereafter, they suffered a failure which was detected by an increase in moisture carryover to the main unit turbine and indicated that some part of the moisture separator inside the reactor

vessel had failed in one way or another.

You received all of the package late in April that has -- had 10 attachments to it. It came in the mail. He also -- it's also on your notebook CDs, and I got a third set as an attachment to an e-mail. But in any event, there is some important information in there that will give you some background.

For example, in 2002, the staff issued an information notice, which is 02-26, and then later on two supplements as information was gathered. Also in that package is a General Electric service information letter, dated August 2002, along with its supplement, and then most recently the correspondence between the NRR and the BWR Owner's Group, and presentation materials from a meeting that was held this past February.

So that sort of brings you up to date as to the issues involved in the potential damage caused by increased flow due to power uprates.

What I'd like to do now is turn to the staff. And David Terao and Tom Scarbrough are the cognizant NRR people that are responsible for this project, and we will also hear from Research later on during this period.

So why don't we just begin with --

CHAIRMAN BONACA: Yes. But I just need to say one thing. I would like to also bring up the issue that two or three years ago when we were reviewing the generic approach to power uprates, a number of members of the Committee raised concerns.

MEMBER SIEBER: Right.

CHAIRMAN BONACA: And that specifically was one of those -- regarding performance or components also during severe accident -- not severe accident, under accident conditions.

Since uprated powerplants will experience maybe higher blowdowns, or whatever, and forces solicitation of components, internals, etcetera, may be higher, we raised questions regarding margin. And we were provided the answer that there was no concern regarding this margin.

We also wrote a paper, I believe, myself and Dr. Wallis and Mr. -- and Dr. Cronenberg. And personally, the fact that we had these failures as a result of the power uprate in the steam dryers again brings up the question of, what about other components that are not going to be challenged during normal operation, but they're going to be challenged during accidents.

I think at some point we would like to raise this issue. I would like to hear something about it, if Research is doing something about it. And so I would like to, you know, bring this forth.

MEMBER FORD: And for the record, just before we start, could I just for the record state that I'm a General Electric retiree. I don't know if that constitutes a conflict of interest, but just for the record.

MEMBER SIEBER: I suspect that it does, but that's for the Chairman to decide.

MEMBER FORD: Okay.

MEMBER SIEBER: I would point out that, just to amplify a little bit what Dr. Bonaca said, with constant pressure power uprate, as far as blowdown loads, and so forth, are concerned, it is the same before and after the uprate, because the pressure is the same.

On the other hand, there are a lot of effects, as Dr. Bonaca stated, that are due to the increase in flow -- for example, strain on the main steam stop valves when they close. You know, the increase in flow is going to give you increases in force. So these are the kinds of things that we continue to be interested in.

So with all that, why don't I turn it over to the staff.

MR. LARKINS: Mario, let me just clarify. We looked at a conflict of -- Peter, you don't have a conflict on this particular review, because it's more generic than specific to a GE topical or some other thing.

MEMBER FORD: Okay. Good.

MEMBER SIEBER: Okay.

MR. TERAO: Good morning. I'm David Terao. I'm the Section Chief in the Mechanical and Civil Engineering Branch in NRR, and, first of all, I'd like to thank the ACRS for inviting the staff to present its views today on steam dryer cracking and other EPU-related issues involved with flow-induced vibration.

This is a high visibility issue that's getting a lot of attention lately. And although the staff may not have questions -- answers to all of your questions today, we are prepared to discuss and go into as much detail as you want on any particular issue.

What we want to cover today are basically some of the failures that we've seen of the steam dryer at certain plant -- certain BWR plants. We want

to discuss what corrective actions the -- what corrective action these plants have taken, what the possible causes are for these failures, as well as the industry and the staff's actions taken and/or planned to be taken to address these issues.

We also understand that the ACRS has invited General Electric and I believe the BWR Owner's Group to give a presentation sometime in the summer, perhaps getting into a little bit more technical detail on the loadings, the thermal hydraulics, and so we aren't prepared today to go into that level of detail.

With me today is Tom Scarbrough, also with the Mechanical and Civil Engineering Branch, and he will be giving the bulk of the presentation. In addition, we also have a couple staff from the Office of Nuclear Regulatory Research, who will be presenting some of their research activities related to steam dryers.

So with that, I will turn it over to Tom Scarbrough.

MR. SCARBROUGH: Good morning. What we'd like to do is just give a little bit of initial background of sort of where we are today. In the 1970s, licensees began implementing power uprates to

increase their electric power output. And there's various categories of power uprates.

You know, the lowest one is what we call the measurement uncertainty recapture, and that's involving improved feedwater measurement to reduce the uncertainty, and it's about one and a half percent. Then there's a stretch power uprate, which goes up to about six percent, and that involves instrument setpoint changes, and things of that nature, just minor adjustments to attain that type of uprate.

And then we go up to the higher levels, which seems to be where we're seeing, you know, most of the problems, called the extended power uprates, or EPUs, and they go up to about 20 percent. And those involve major modifications -- you know, turbine changeouts or generator changeouts, or pumps, things of that nature, but major -- major modifications.

In terms of reactor pressure vessel internals, we have had cracking issues with those components for a long time for BWR plants, and steam dryers were no exception. There have been cracking of steam dryers. Initially, as plants start up, a lot of times that was sort of below our radar screen, and the plants just corrected them and fixed those problems and moved on.

But recently, as we've gone to the power uprates, we've seen additional problems with both safety-related and non-safety-related equipment. And that's what's getting our attention now.

Specifically, with Quad Cities Units 1 and 2, they've had what we've termed catastrophic failures of steam dryers. So they've had significant loose parts generated to go through.

Now, the steam dryers, as you know, don't perform a safety-related function themselves in the removal of the steam. However, they need to maintain their structural integrity, so you don't have a problem with either it dropping down on top of the core itself or that you have numerous loose parts that might cause problems for components in the steam lines or get down into the reactor pressure vessel itself.

MEMBER SIEBER: I might point out that one of our concerns is if you generate loose parts, even though the dryers are not safety-related, they do pass -- the parts pass through safety-related equipment -- for example, the main steam stop valves, flow-measuring Venturis, which can be gouged and scored. They end up in the strainers of the throttle valves on the turbine, which is not safety-related, but nonetheless important.

The greatest concern is loose parts that you can't find. Are they in the bottom of the reactor vessel? Or in the case of the sampling nozzle, does it end up in the feed ring? Is it floating around where it can damage internal parts of the core? Did it go through the recirc pumps? And when you find all kinds of gouges in the recirc pumps, there's a clue there. And so I think every effort ought to be extended to recovering loose parts.

MR. SCARBROUGH: Yes, sir. We agree with that, and we've seen a lot of that in the examples we've had so far. And that's raising our concern as well.

MEMBER SIEBER: There are loose parts out there that people haven't found.

MR. SCARBROUGH: Yes, sir.

MEMBER SIEBER: Okay.

MR. SCARBROUGH: In terms of -- first of all, I talk a little bit about the scope and how the scope has expanded. First, you know, this seemed to be a steam dryer issue. But as we've had more events, the scope has expanded, and that's part of our growing concern in this area.

MEMBER SHACK: Tom, can you --

MR. SCARBROUGH: Sure.

MEMBER SHACK: -- tell me -- I mean, I see this as an engineering failure. You know, that flow-induced vibrations are not a phenomena that somebody didn't anticipate, you know.

MEMBER SIEBER: That's right.

MEMBER SHACK: They were presumably analyzed. We were told that they were analyzed, and they were okay. So there -- there was an engineering failure here. Did they -- are they getting the forcing functions wrong? Are they oversimplifying the stress analysis? Do we have assurance that when they bring in the new fix --

MEMBER SIEBER: That it won't fail.

MR. SCARBROUGH: And it's yes to sort of all those questions, because they -- they have done evaluations initially, and we'll get into a little bit of that as we get farther in. But that's where the -- finding out what exactly is the forcing function is part of the problem. I mean, we've had three failures at Quad Cities 2, one failure at Quad Cities 1. And each time we think we're getting closer to what the answer is, but we don't get there.

And so it -- yes, sir, it is an engineering problem. We don't really -- can't get our arms around what that forcing function is and what's

driving these failures -- these failures in these steam dryers so catastrophically. And that's what we're working -- that's what our -- our effort is right now is to work toward that. And we'll get more into that as we get --

MEMBER SIEBER: Well, one of the problems is when you come up with an engineered fix, and you put it in service and it fails, that means, you know, that you don't understand the problem.

MR. TERAO: Yes. If I may add, we're still -- we're still wrestling with whether or not and the extent to which this issue applies to Quad Cities, Dresden, and other BWR plants.

MEMBER SHACK: Yes. Every time you're analyzing flow-induced vibrations. I mean, if you don't understand the problem well enough to predict this, what gives you confidence that you're --

MR. TERAO: Right. And what we're going to show you is that the catastrophic failures of the steam dryers we've seen -- and it has only happened at Quad Cities, Units 1 and 2. It really hasn't even happened at Dresden or other BWRs.

So at this point, we aren't sure if this is a generic BWR problem, or something specifically related to Quad Cities. And so what we're trying to

understand is -- as you pointed out, is the specific forcing function, the low definition that is causing the failure at Quad Cities. And that's something that we're pursuing with Exelon at this time.

MEMBER SIEBER: Well, let me ask a clarifying question, then. Quad Cities has had failures where things have come apart. On the other hand, you found cracks that are precursors to failure at other plants. Is that not correct? But Dresden --

MR. TERAO: Yes. But I think what -- what you may see from the pictures that we're going to present is there is a big difference, at least in our mind, on a crack and a complete failure of the steam dryer, where you're generating loose parts, where the dryer looks like it has been -- it doesn't look like, it has been plastically deformed --

MEMBER SIEBER: Right.

MR. TERAO: -- and there's a big difference between just having a crack in the dryer where it's -- it's not likely to generate a loose part. That was the assumption that we had made when we first started approving the EPUs.

MEMBER SIEBER: When you get to that point in your presentation, I'd appreciate it if you would expand on that.

MR. TERAO: Okay. Thank you.

MEMBER SIEBER: Because that's an important point to me.

MEMBER APOSTOLAKIS: Why is it an issue of forcing function only? Couldn't you have deterioration of the material and --

MR. SCARBROUGH: Well, as an example, in the first Quad Cities Unit 2 failure, they had only gone up to EPU operation for 90 days. So they were only up three months.

MEMBER APOSTOLAKIS: Right.

MR. SCARBROUGH: And it catastrophically failed. So in terms of that short amount of time, we don't think it's a normal type of degradation issue. We do see stress corrosion cracking, and that's sort of normal. We see that in lots of steam dryers.

MEMBER APOSTOLAKIS: That assumes that the degradation would be the result of the extended uprate. Why couldn't you have some degradation before that was accelerated?

MR. SCARBROUGH: Well --

MEMBER APOSTOLAKIS: I mean, is that excluded or precluded?

MR. SCARBROUGH: That might have been the case. But now for Quad Cities 2, for example, they've

done quite a bit of inspection of the steam dryer after each failure to look for cracks and identify them.

MEMBER APOSTOLAKIS: Okay.

MR. SCARBROUGH: So, and then they have another failure, so in that short amount of time at EPU operation they have another failure. So it would have to be degradation, we feel, that occurred during that timeframe, and not something that was sort of preexisting.

MEMBER APOSTOLAKIS: Now, the forcing function is calculated using some GE guidance, is that --

MR. SCARBROUGH: Right. Well, part of the problem is in terms of how they dealt with it. There was a relatively simplized method for looking at the loads across the steam dryer, in terms of the static type of valuation. And we've been discussing the GE -- expanding that evaluation to make it more dynamic to deal with the dynamic aspects of the flow effects. And that's something that GE is working on.

And I think as they -- we'll give some examples of where they're sort of moving in this direction. I'm trying to gather more data to really nail down and look at that --

MEMBER APOSTOLAKIS: But all the BWRs are using the GE guidance.

MR. SCARBROUGH: Yes, sir.

MEMBER APOSTOLAKIS: Okay.

MR. SCARBROUGH: So in June of 2002, after this three months of EPU operation, about 17 percent power uprate, they had a failure of the -- the steam dryer coverplate, and pieces were found down on the steam separators and farther down in the steam line.

And if you can show the next slide, please.

MEMBER SIEBER: That's BWR 3, right? With the flat --

MR. SCARBROUGH: Right. Yes, this is a square hood design. These are the square hood -- that's -- this looks like a curved design, but it's a -- these are the square hoods. You can see the square hood design there, which causes much more -- let me see if this shows it better. You can see right now that this one -- the plate is there.

And so they repaired that, and we'll get into what the repair techniques were in some later slides. But just let's get -- let's go --

MEMBER SIEBER: How many BWR 3's are there? They're the most susceptible, right?

MR. SCARBROUGH: Right. And we have Vermont Yankee, we've got the Dresden units, Monticello, and Pilgrim. And we're going to talk a little bit about those later in the presentation.

MEMBER APOSTOLAKIS: Why are they the more susceptible, the most susceptible?

MEMBER SIEBER: Well, they're the flat --

MR. SCARBROUGH: Right. We do have a slide for that.

MEMBER SIEBER: The later models had sloping sides.

MEMBER APOSTOLAKIS: All right. We are preempting his slides.

MR. SCARBROUGH: Right.

MEMBER APOSTOLAKIS: I'm sorry.

MR. SCARBROUGH: That's okay. Well, no, that's a good question. That's exactly what we've been talking about.

MEMBER RANSOM: Is that steam outlet lined up with that plate?

MR. SCARBROUGH: Yes. It -- right, right through -- right up through here, right out through there.

MEMBER SIEBER: Right.

MR. SCARBROUGH: And so that's where they

thought a lot of the damage was, the higher flow effects right in that area as it went into that steam line.

Then, about 300 days later, in June, you know, a calendar year later, Quad Cities 2 had another failure of the hood, and now it's getting -- it's more extensive. And you can see this -- right through here there was a crack right here. Well, 90 inches of crack right through this area right in here.

And they ended up with internal braces failing. They had about three or four of those and some tie bars failing as well. So they -- they also had some additional cracking over on the other side, not as severe, but they had some cracking on the other side, too. So these two sides, as this -- as this flow came out and whipped over this corner here, this edge, and went out that steam line, that's where they have some severe vibration effects in the --

MEMBER ROSEN: You know, Tom, this drawing you have on the slide isn't very good, and it's not a real engineering drawing. It's almost like a cartoon. Is there something -- do you have a better drawing of that box and the hood and -- and so we can see the details, the thickness of the materials, the construction?

MR. SCARBROUGH: This is the one that they gave to us.

MEMBER ROSEN: That's as good as they've got?

MR. SCARBROUGH: Yes.

MEMBER SIEBER: They have better drawings.

MR. SCARBROUGH: Yes. Oh, they have better drawings. But in terms of what they give us, that's --

MEMBER SIEBER: Actually, that's in two pieces. You have to push that all together.

MR. SCARBROUGH: Right.

MEMBER SIEBER: And then, when you do that, you can't see the detail. But it is a --

MEMBER ROSEN: That's my first comment is we need to have a real drawing, real engineering drawings, of what these parts look like.

MEMBER ROSEN: Right.

MR. SCARBROUGH: That's not it.

MEMBER ROSEN: Well, that's what --

MEMBER APOSTOLAKIS: I mean, what happened between June 2002 and June 2003?

MR. SCARBROUGH: They just operated the EPUs.

MEMBER APOSTOLAKIS: Yes. But, I mean,

they had a failure.

MR. SCARBROUGH: Right.

MEMBER APOSTOLAKIS: Did they look into it, why, and so on? I mean, or was it --

MR. TERAO: Well, if I could answer that question, the first failure of the coverplate was -- was what we felt was an anomaly. We -- they thought it was a localized --

MEMBER APOSTOLAKIS: So it was considered to be aleatory.

MR. TERAO: They believed it was a localized effect -- a localized effect. They looked at other components with the same type of frequency as the coverplate and found there were no other components within that area of the steam dryer that had the same frequency.

The failure of the coverplate in 2002 was attributed to alignment of the vortex shedding frequency together with the acoustic load frequency, which matched the frequency of the coverplate itself. So that's why they believed this was a very localized effect, and we had no evidence to contradict it or to doubt that.

So that's why the second failure, when we had the second failure of the same unit on their steam

dryer, that -- became very serious about looking into the failures of these steam dryers, because we realized that something else was going on. And that's when we sent the special inspection team out to Quad Cities to review the details of their calculations and get a better understanding of the technical analysis that was performed on these steam dryers.

MEMBER APOSTOLAKIS: But this could have been done also in 2002, couldn't it?

MR. TERAO: Yes. But because they fixed it, they changed the -- they replaced the quarter-inch thick coverplate with a half-inch thick coverplate, they changed the frequency. At that point, we -- we believed that the issue was resolved.

CHAIRMAN BONACA: They did not notice anything during operation? Or simply the failure happened in June 2003, and then they shut down and went to see what happened?

MR. TERAO: Yes, yes. There were some indications that something was happening in the plant, including a change in the moisture carryover levels. That was probably the biggest indication.

CHAIRMAN BONACA: But they -- I mean, did they run for a period of time under these conditions? Changed condition? Or they simply, when they saw this

difference in moisture carryover, they shut down?

MR. TERAO: Well, when they first --

CHAIRMAN BONACA: I'm trying to understand for how long they ran in this condition.

MR. TERAO: When they first sensed the change in moisture carryover, I mean, a change in moisture carryover could be due to other reasons besides steam dryer failures. But they did monitor it, and as the moisture carryover increased, then they decided to shut down the plant and see what was causing --

CHAIRMAN BONACA: Okay.

MR. TERAO: -- causing it. But going back to Dr. Apostolakis' question on what happened before June of 2003, before the second Quad Cities 2 steam dryer failure, they did have a spurious actuation of their safety relief valve. Or they call it PORVs at Quad 2.

MEMBER SIEBER: These are the target rock valves?

MR. TERAO: It -- these were the target rock PORVs --

MEMBER SIEBER: Right.

MR. TERAO: -- I believe, yes.

MEMBER ROSEN: I think they're called

SRVs.

MR. TERAO: Well, no, these were called PORVs.

MEMBER SIEBER: No, they were --

MR. TERAO: They were very unique.

MEMBER SIEBER: They were pilot-operated.

MR. TERAO: Yes. And so these -- so the valve spuriously opened and did not close.

MEMBER SIEBER: Right.

MR. TERAO: So they're attributing that some of the loadings from this relief valve discharge contributed to the steam dryer failure a few months later, in addition to the flow-induced vibration from the EPU.

MEMBER SIEBER: Well, I have a question about that. When I read about that, I got the feeling that it was because of the higher flows condition and vibration in the line that may have contributed to the failure of the valve. Is that -- you know, it's a chicken-and-the-egg kind of a thing, and I couldn't figure out from what I read which came first.

MR. SCARBROUGH: Right. And they have found significant vibration effects, and we found that in the Unit 2 failures that occurred. And so it may have been that vibration causing that -- initiation of

that valve. So, yes, right.

MEMBER SIEBER: If my memory is any good, there was a broken drain line --

MR. SCARBROUGH: Right.

MEMBER SIEBER: -- involved with that, and some support damage, and --

MR. SCARBROUGH: We have some -- a slide on that, too.

MEMBER SIEBER: Okay.

MR. TERAO: Wait. Actually, we're getting two events mixed up. The broken drain line was at Quad Cities 1, which happened in November.

MR. SCARBROUGH: Right. And we're going to get to that.

MEMBER LEITCH: We had a subcommittee meeting at General Electric in San Jose in September of 2002. And so that was between the first and second failure, just a couple months after the first failure. And we asked General Electric about this issue, and at that time they told us they were going to model the steam dryer. And I was wondering: did you -- do you know if that was done?

In other words, were they in a position to predict or suspect that there may be a subsequent failure, which actually occurred in 2003? In other

words, before the 2003 failure, did they really seem to understand the problem and say, "Well, the next refueling outage you're going to have to go in there and do some additional work"? Was there some additional work planned, or do they think everything was fine, and it just failed again in 2003?

MR. TERAO: I think that would be better left to ask General Electric. I'm not sure what they knew at that time.

MEMBER LEITCH: Okay.

MEMBER SIEBER: Well, it seems to me that that's a very difficult geometry to model from the standpoint of vibration and force as --

MEMBER LEITCH: Yes. But they told us they were going to do it.

MEMBER SIEBER: Yes. But if they didn't get it quite right, I wouldn't be surprised. But if they didn't do it at all, or did a superficial job, then the --

MR. SCARBROUGH: And we've had four significant failures, so we don't think that we're quite there yet. I mean, we don't really think they nailed this thing down.

MEMBER SIEBER: Right. That would be a clue.

MR. SCARBROUGH: Yes. Yes.

Okay. Let me go on to Dresden, bring Dresden in here. Dresden, in October of 2003, they shut down for a refueling outage inspection after two years of running at about a 17 percent EPU, and they did find some cracks. And they were sort of in the -- that sort of gusset area on the diagonal -- diagonal brace/brackets area, so they were -- they found some cracks there.

They weren't as severe as what we've seen before, what had occurred at Quad Cities Unit 2, but they did see some issues. And at the same time, they found some holes in their feedwater sparger. And they discovered that there was a broken sample probe that was in there, and originally they thought they had problems with this before, and it was sort of a stress corrosion cracking issue.

But then they had done some upgrades, but then these seemed to break off as a result of the vibration effects. And so that started us down this path, and now we have this -- now we've moved from the steam lines into the feed lines, because they also have the increased flow. So now we're bringing in that other side of the plant, so our -- our scope is expanding here.

MEMBER ROSEN: Do you know for sure that the four-inch cracks that were found in Dresden 2 were not there prior to EPU operation?

MR. SCARBROUGH: No, that's part of the sort of the learning curve that we've been on here. A lot of these older inspections were not done very thoroughly, and then we moved up, and then there was a discussion of using the VT-3, sort of the visual inspection. Since it's not code, they were then doing a best effort. So, and then they found that even that wasn't looking -- finding some of these cracks.

And so we've had this learning curve as we've gone along. Probably the best we've done is most recently that Exelon has done at Quad Cities 2 in March where they did a VT-1 everywhere to see what's going on. But that has always been a point of discussion is some of these -- were some of these cracks there before and we just didn't see them? And we're learning more as we go along, so that's part of the -- the issue here is, where do these cracks start, and how long have they been there?

MEMBER SHACK: But the prior inspections were VT-3's?

MR. SCARBROUGH: If at all. I mean, they -- yes, they were -- and some of them were -- you

know, were less aggressive, especially they might do VT-1 on the welds themselves but VT-3 on the services. But as you saw, some of these go right into the base metal services themselves. They might not --

MEMBER ROSEN: This seems to pose the question as to whether the agency should require VT-1 prior to allowing extended power uprate operation.

MR. SCARBROUGH: The inspection is -- one of the areas we're looking at very closely is how -- how much detail they look at these steam dryers, in terms of identifying preexisting problems, so they know where they may have a problem in the future.

But yes, sir, that's something that we're going to be having to look at, especially since Vermont Yankee is in now --

MEMBER ROSEN: Sure.

MR. SCARBROUGH: -- to see what type of inspection they do.

MEMBER ROSEN: And others perhaps after that.

MR. SCARBROUGH: Right.

MEMBER FORD: When we visited GE in September 2002, they indicated some surprise at the issues that we are raising, because their view was that -- because the VIP designation that this was not

a safety-related component.

They also indicated that there had been many incidences of steam dryer cracking beyond just the stress corrosion cracking we know of the drain lines. Have you taken that into account -- these "many incidences" of steam dryer cracking? And were those locations of cracking in line with the locations that we're seeing now?

MR. TERAO: Yes. Well, first, we have to go back --

MEMBER FORD: And then this addresses the question that Mr. Rosen was asking, was this -- it was a precursor to these particular incidences, which are accelerated maybe by power uprate, but cracks were there beforehand.

MR. TERAO: Yes. We have to understand, first of all -- and keep in mind always that these are not ASME Code class components.

MEMBER FORD: Correct.

MR. TERAO: They were not constructed to ASME Code. They were constructed to standard industry practice.

MEMBER FORD: Yes.

MEMBER SIEBER: Well, they aren't pressure vessels either.

MR. TERAO: They're not pressure-retaining. So there's very little controls on these components. The inspections that we spoke about earlier that -- were just visual inspections. When they removed these dryers during normal refueling outages, they would look at them. But I would not characterize them as any type of formal visual inspections.

And what Tom was referring to were -- was the fact that some licensees may have done more detailed inspections than other licensees. But there were no -- there was no requirement to do any visual inspection.

MEMBER ROSEN: Well, I think that all that's true, and I think the presumption was that these things will retain their structural integrity, and there is no -- no issue. And, therefore, they can be treated that way. And if that were true, that would be just exactly the way it was.

But what we found through operation and experience is that they don't retain their structural integrity under some circumstances. So now we raise the question, which is the obvious one, is: where do the parts go? And if they go to places where they could affect safety-related functions, then we have a

business in asking: will these things retain their structural integrity? Are they -- have they retained their structural integrity?

We make a presumption when we agree to extended power operation -- uprate operation that those things have structural integrity. And maybe -- and that's what's being brought into question here.

MR. SCARBROUGH: Yes, sir, we agree with that. Let me go on to now Quad Cities Unit 1 in November. So they had been operating for about a year at EPU, about 17 percent, and they observed in late October or early November a sudden increase in the moisture carryover. And it kept increasing, and they shut down, and they found a -- if you want to flip to the next slide.

You can see the significant cracking in this vertical plate, and then there was a -- about a six by nine inch piece of metal that was missing, and they searched significantly for that piece of metal. I mean, they -- they had their little robotic camera go in many places looking for this.

Finally, they believe that it ended up in the bottom of their reactor vessel head, and that was circumstantial, because they saw some marks on the recirculation pump propeller that weren't there, from

their belief, during the replacement of that.

MEMBER SIEBER: So the pump ate the part.

MR. SCARBROUGH: Yes. You know, it pushed it --

MEMBER SIEBER: Like the dog ate my homework.

MR. SCARBROUGH: Yes, right. Exactly. And that's where they ended up with -- that was their best guess of where it was. And so it's there now.

MEMBER LEITCH: Where is the orientation of the steam line relative to that location?

MR. SCARBROUGH: It's right --

MEMBER SIEBER: Right there.

MEMBER LEITCH: There's four steam lines in this unit?

MR. SCARBROUGH: There's one over there. There's like one there --

MEMBER LEITCH: Not quite 90 degrees apart? I mean, they're --

MR. SCARBROUGH: Yes, sir, about -- yes. And so there's one about -- about right there, and that seems to be a real problem here where this flow whips out over there.

MEMBER LEITCH: And they inspected that steam line?

MR. SCARBROUGH: Yes. Yes. They went down that steam line, way down that steam line, looking for it.

MEMBER RANSOM: The flow comes out through slots in the top of this?

MR. SCARBROUGH: Yes, it comes out the --

MEMBER RANSOM: And then flows over that ledge?

MEMBER SIEBER: Over the wall.

MR. SCARBROUGH: And into the steam line, yes.

Now, they did a lost parts -- now we're into lost parts evaluation that the licensee did, and the staff did look at that and determine that there wasn't any immediate concern from that lost part. But there was a concern that -- that there might be some fuel fretting and things of that nature. And so there was concern that -- that that would be left there long term.

So the licensee is, by the time the next outage rolls around, determine if they're going to remove the core and get that part out of there. So that's still under discussion now.

MEMBER SIEBER: Well, this is a pretty big part. It's, what, six by nine or something?

MR. SCARBROUGH: It's six by nine and a half-inch thick. And the next slide --

MEMBER SIEBER: And so as far as fuel fretting is concerned, it's too big to get up into the fuel area.

MR. SCARBROUGH: Right. They're worried it might --

MEMBER SIEBER: But it could be rubbing down amongst control rod housings and --

MR. SCARBROUGH: Right. Yes, sir.

Now, if you wanted to put the next slide up, please.

MEMBER RANSOM: It might not be in one piece any more, right?

MR. SCARBROUGH: Yes. If it bends a little bit, it could push down through and get into the jet pumps and get down there.

MR. TERAO: That's right. In fact, the lost part analysis assumed that the large piece broke down into different and various sizes, I think as small as half an inch. So it looked at the implications of the lost part from half an inch all the way up to its full size.

MR. SCARBROUGH: Okay. Want to hit the next slide?

Now, you can see how this piece came out. You can -- you can see that it's -- the metal, it just ripped right out of there. I mean, this is rolled up, and so this is not the normal type of static, you know, load across that. Something severe is happening there.

MEMBER ROSEN: Did they look at the fracture surfaces?

MR. SCARBROUGH: Yes. And they determined it was fatigue of a type of failure. And I have a slide on that which talks about how they've migrated in terms of, you know, exactly the type of fatigue it was. You can see it's a catastrophic failure of this dryer.

Also, now we move beyond just a steam dryer, because as they did their walkdown they found -- in the main steam line they found electromagnetic relief valve -- a drain line was leaking from this particular valve, and they took the actuator cover off, and they said it sort of fell apart in their hands.

The plunger spring had been pushed right up through its holder, and a microswitch just was off -- was falling off. The ports on it were damaged, and it was inoperable. It was basically inoperable.

Now, they checked the other three ERVs, and they had some extent of damage, but they weren't this severe. So now we're into this severe vibrational effect into the main steam line.

They also had steam line supports that were damaged, and then, although we don't have a lot of detailed information about it, there was a HPSI MOV that had a limit switch problem in terms of the spring for the limit switch, the finger springs, were damaged by the vibration effects. And so this is --

MEMBER ROSEN: A HPSI MOV?

MR. SCARBROUGH: Yes. yes.

MEMBER ROSEN: This was located where?

MR. SCARBROUGH: It's into the HPSI steam line supply.

MEMBER ROSEN: Which is located where --

MR. SCARBROUGH: Right off the main steam lines.

MEMBER ROSEN: -- relative to the reactor vessel?

MR. SCARBROUGH: Right. Well, it's not near the vessel itself. It's into the -- it's into the steam line going off, and it taps off for -- the HPSI line taps off.

MEMBER ROSEN: I know it's in the HPSI

steam line. I'm just trying to figure out, was it close to the vessel or close to the HPSI turbine, the valve we're talking about here?

MR. SCARBROUGH: Oh, it's farther downstream. It's not --

MEMBER ROSEN: It's way downstream.

MR. SCARBROUGH: Yes. It's not near the vessel.

MEMBER ROSEN: So this effect is propagating way downstream.

MR. SCARBROUGH: Right. It's --

MEMBER LEITCH: Well, it's in containment, isn't it?

MR. SCARBROUGH: Yes. There would be one inside containment and one outside containment.

MEMBER LEITCH: Yes. So it's not all the way down at the HPSI. It's -- but it's not adjacent to the vessel.

MR. SCARBROUGH: Right. It's not the vessel itself that --

MEMBER ROSEN: That's what I'm trying to establish, what you just told me, Graham. It's 10 feet from the vessel or more?

MR. SCARBROUGH: Probably something like that, yes. It's -- well, it's a ways down. It's not

right next to it. It's not like right there, because it has to tap off the main steam line and then tap off there farther. So it's over its isolation valves for containment. So it would be next to the containment wall and --

MEMBER ROSEN: Yes. It would be helpful if you had a drawing that showed this.

MR. SCARBROUGH: Yes. I don't think -- I have a drawing, but I don't have one on a slide.

MEMBER ROSEN: I find that a lot of what you've got here is very simple. I mean, there's very little detail, and you need to provide more --

MEMBER SIEBER: Well, we'll get to that when we get to a subcommittee meeting.

MR. SCARBROUGH: Right. Well, we're still learning.

MEMBER ROSEN: Okay.

MR. SCARBROUGH: I mean, this is -- we're still in the learning phase.

MEMBER SIEBER: Well, let me ask you a question now. In this branch line, since this power uprate was essentially a constant pressure uprate, the flows in the line are the same as they were before the upgrade took place, because the pressure drop is the same.

So that tells me that the -- whatever vibration is coming is coming from the main steam line, mechanically coupled to this branch line, as opposed to something that's -- some phenomenon that's unique to the branch line. Is that the right kind of reasoning?

MR. SCARBROUGH: Well, part of it is that these have such smaller diameter steam lines. The steam flow --

MEMBER SIEBER: Yes, right.

MR. SCARBROUGH: -- is so great, much greater than the other plants, that it's causing this -- and they think it -- you know, some type of --

MEMBER SIEBER: Well, would it have failed whether the dryer was good or bad, or you didn't have a problem anyplace else?

MR. SCARBROUGH: Right. And that's an issue in terms of would -- would replacing the steam dryer fix this problem? It may be that the steam flows are so great, even if you replace the steam dryer you still might have problems --

MEMBER SIEBER: Well, that's --

MR. SCARBROUGH: -- these other components.

MEMBER SIEBER: Well, that's the other

issue. If you get a failure of one of these electromagnetic relief valves, the question is: did the failure -- did the damage mechanism occur before the dryer failed or after the dryer failed? You know? It could be the failure of the dryer that changed the operating condition in the line, or it could be you just have a lot of steam flow and you're wrecking supports and shaking -- shaking everything a lot.

MR. SCARBROUGH: Right, right.

MEMBER SIEBER: And so have you come to a conclusion whether there's a relationship between dryer failure and these other problems that you find, or are they independent?

MR. SCARBROUGH: Well, they do shut down. As the main -- the moisture carryover increases quickly, they shut down within a week or so. I mean, it's just a few days before they shut down.

MEMBER SIEBER: Yes, but it is days --

MR. SCARBROUGH: Yes.

MEMBER SIEBER: -- nonetheless.

MR. SCARBROUGH: Yes. So --

MEMBER SIEBER: And you can get a lot of cycles in a few days.

MR. SCARBROUGH: Right, yes. So I -- but that's something that some testing is going on, and

we'll talk to that later. Exelon has done quite a bit of vibration testing and evaluation to find out -- try to find out what's going on with this. And that's part of what they're supposed to present to us as the Owner's Group, is sort of taking responsibility for this and coordinating this.

MEMBER SIEBER: But they don't have a baseline, right?

MR. SCARBROUGH: Well, that's -- well, they are, in terms of they were gathering data --

MEMBER SIEBER: At the old full power?

MR. SCARBROUGH: No. They were -- they were doing some EPU -- going up to obtain vibration data at EPU as well.

MEMBER SIEBER: Okay.

MR. SCARBROUGH: So -- right. So they're working on it.

MEMBER SIEBER: All right.

MEMBER LEITCH: We had a problem starting up a BWR with -- where the turbine governor valves were fluctuating and causing pressure pulsations all the way back through the main steam lines. And basically, the fix was an electronic one. We had to retune the --

MEMBER SIEBER: Controls.

MEMBER LEITCH: -- the EHC control system with some additional capacitors and stuff to dampen out that vibration in the turbine governor valves. And this only occurred at high power. And I'm just wondering if -- if there's any possible connection here. In other words, these are now operating at higher power than they were before.

Might we have moved into a region of instability in the turbine governor system? And if those turbine governor valves are sitting there fluctuating, it could be reflecting fluctuations back to and up the main steam line.

MR. SCARBROUGH: Right. Right. Yes, and we have seen instances where the set points all need to be adjusted under these EPU conditions and places where they had not been adjusted. So this may be something that we can raise with the licensee to see if they have gone back and adjusted those governor valves and make sure they're working properly.

MEMBER LEITCH: Because they should be real stable. I mean, they can be made to be real stable. If they're tolerating some fluctuations in those valves, it can raise havoc, in fact, through the steam lines.

MR. SCARBROUGH: Thank you. We'll raise

that.

MEMBER APOSTOLAKIS: Well, I'm a little bit puzzled here. The issue -- I mean, the first failure was observed in June of 2002, and you will show in your next slide that cracks have been found as late as the spring of this year.

MR. SCARBROUGH: Yes.

MEMBER APOSTOLAKIS: What is the risk significance of this? Why do we keep seeing these things and the plants keep operating and we keep finding failures? Has somebody decided that the risk significance is very low?

CHAIRMAN BONACA: Yes. I had the same question exactly.

MEMBER APOSTOLAKIS: I don't understand why --

CHAIRMAN BONACA: Because if you go past the --

MEMBER APOSTOLAKIS: I mean, every other month you have a problem.

CHAIRMAN BONACA: So you just identify the problem, collect the broken pieces, fix it up, and start again, and then collect the next pieces. I mean, what's going on?

MEMBER APOSTOLAKIS: And then in another

plant you find similar problems. So can you tell me what the risk significance of this is? I mean, is it really low, so we don't care?

MR. SCARBROUGH: Well, part of it was the -- sort of how it progressed. You started off with June 2002, you had a failure. It was determined that that was a -- you know, a once sort of in a lifetime sort of situation, and they --

MEMBER APOSTOLAKIS: We can forgive the first instance.

MR. SCARBROUGH: Right. Okay. Then we had another failure.

MEMBER APOSTOLAKIS: Yes.

MR. SCARBROUGH: And then that -- that was caused by -- maybe it was aggravated by this PORV initiating. So they beefed it up some more, and I -- I have another slide which talks about how they beefed this piece of metal up more and more.

And then we get to -- you know, and now we're into late November, and we have these other failures. And then we start saying, "Okay. Let's get the Owner's Group involved and solve this problem." But it comes back to the steam dryer -- you know, it's non-safety-related, so there's this real --

MEMBER ROSEN: I wish you'd just stop

saying that.

MEMBER APOSTOLAKIS: That is, you know, the pre-PRA categorization. After that, we have now a tool that can give us some idea how important these things are.

CHAIRMAN BONACA: Right.

MEMBER APOSTOLAKIS: So how important are they?

CHAIRMAN BONACA: But, you see, even PRA by itself won't tell you the whole story, because, I mean, we don't -- we can't predict where these parts are going. They're going in different locations. Every time -- I mean, he'll show additional slides now that show that, you know, in following shut down for refueling, or whatever, identify additional failures, pieces located in different parts, etcetera, and --

MEMBER APOSTOLAKIS: But it's part of the development of scenarios.

CHAIRMAN BONACA: Yes, I understand that.

MEMBER APOSTOLAKIS: In one scenario, the part goes this way; in another, it goes that way. And you try to figure out, you know, what the risk is. Have you done any analysis?

MEMBER LEITCH: Pieces have been found on the turbine valves. So by definition, they have been

through the main steam isolation valves, which are safety-related. And these pieces could certainly impact the operation of the main steam line isolation valves.

MEMBER APOSTOLAKIS: So they can have an impact on the estimated core damage frequency.

MEMBER ROSEN: Well, you can have an impact on an enclosure -- the successful closure frequency of the MSIVs.

MEMBER APOSTOLAKIS: Okay.

MEMBER ROSEN: And figure that into the event sequences.

CHAIRMAN BONACA: But most of all, the point I was trying to --

MEMBER APOSTOLAKIS: How important is that?

CHAIRMAN BONACA: -- I was trying to make is that we don't know the initiators. I mean, every time it seems like we have a neutral price. Other pieces are missing that we didn't expect to see, and so you may have other -- you see what I'm trying to say is that, you know, it's not fully contained insofar as what is breaking off and what is going. I mean, we -- you know, so we can develop some scenarios, but --

MEMBER APOSTOLAKIS: Yes. But we can certainly say something about the consequences, yes, of these failures, at least the failures that have been observed. So have you done anything with this?

MR. SCARBROUGH: There is a research -- you know, some of the research activities are involved, and some of it is looking at what the consequences are of these failures. And, you know, the staff did look at -- the Systems Division did look at this issue, and they're the -- they have the PRA group. And they determined that there wasn't a severe immediate risk to letting them go back up, and that's -- you know, that's not a lot of --

MEMBER APOSTOLAKIS: Maybe there wasn't --

MEMBER LEITCH: That's another one of our other concerns here is with our other -- one of our other missions right at the moment is we're looking at license renewal for Dresden and Quad Cities, and we're somewhat surprised to -- to find that the dryers are not in the scope of the license renewal. And they're -- there are a number of -- I mean, the reason is that they're not -- they're not safety-related.

One of the other things is that -- one of the criteria for being in the scope is to be safety-related, but another criteria is to be non-safety-

related but to impact the operation of safety-related equipment.

MEMBER APOSTOLAKIS: Sure.

MEMBER LEITCH: And it seems to me by definition these could impact the operation of the MSIVs, which are safety-related. So, you know, it seems to me that these things ought to be in the scope of license renewal considerations.

MR. SCARBROUGH: Right. And there has been a lot of discussion about that, where they should -- I think right now what we're doing is we're trying to solve this as a current operational issue.

MEMBER LEITCH: Right.

MR. SCARBROUGH: Not even letting it get that far into, you know --

MEMBER LEITCH: Yes, sure. Right.

MR. SCARBROUGH: -- the license renewal space. It has to be solved now, and that's why we're dealing with it now. But you're right, there's been a lot of discussion whether it should be in scope or out of scope, but we're going to solve it now. I mean, you know, that's -- that's part of the issue now.

Like Quad Cities is not at EPU now. They're at - they're not allowed to go up to -- I

mean, that's -- we have more slides on that, is that -- is that part of this last failure in March, that was it. They cannot go up into EPU unless they get NRC approval to do that. They agreed that that would be a condition, and they're not up, so they're -- you know, after four times, they're staying at dual power level until they solve this problem.

MEMBER APOSTOLAKIS: Now, is there a document that documents this risk assessment -- I know this is not a significant risk issue -- that we can look at?

MR. SCARBROUGH: I can go back and ask if there was something that was prepared on that.

MEMBER APOSTOLAKIS: Because, you know, I find it a little bit -- that we are a bit inconsistent. I mean, in the reactor oversight process, the inspectors go around and they find some minor violations or -- not really violations and some minor problems. And then we have this elaborate SDP -- significant determination process -- to tell us what the color is. Okay?

And here we have real failures, and we don't do something like that. Or maybe you will do it, but we don't have access to it. But it would be, I mean, an interesting -- like I think this probably

is more serious than maybe finding that one siren is not operable, and, you know, going to the SDP.

And here we have failures that affect the primary loop, and I would expect to see, you know, some color or some -- something that says, you know, yes, this would affect the CDF and we are taking action because of that.

MR. TERAO: Actually, the ACRS will be hearing later this morning from the Office of Research on one of their activities involving the PRA or looking at the risk significance.

MEMBER APOSTOLAKIS: And they do this kind of thing? They do this --

MR. TERAO: Yes. Well, I don't know exactly what their -- I will let the Research staff address that issue.

MEMBER APOSTOLAKIS: I'm not even sure it's a research issue. I mean, you can actually see the impact title. Well, there's a PRA Branch in NRR, isn't there?

Any comments maybe? No? Okay.

MR. CARUSO: Well, George -- George, I just want to make a comment. I believe something like that was done as part of the BWR VIP program. There was -- this is Ralph Caruso. I'm from ACRS staff, but

I used to work on this.

And I believe there was a report that was done by a research contractor as part of the BWR VIP program to look at the consequence of vessel internal failures and the effect of pieces coming out of components in the upper part of the vessel and their impact on various different scenarios.

And I don't know if there's anyone here from Research who remembers that, but I do remember that they had a contract which --

MEMBER APOSTOLAKIS: When was this done? When was this done?

MR. CARUSO: Three or four years ago.

MEMBER APOSTOLAKIS: But that was before the failures.

MR. CARUSO: Yes. Yes, it was part of --

MEMBER APOSTOLAKIS: So now one can take that report and say, "Okay. This actually happened. Let me see now which scenarios are possible and what frequencies they have," right? And do an event-specific evaluation.

MR. CARUSO: I don't know. I don't remember the details of it. I remember being involved in it a little bit.

MEMBER APOSTOLAKIS: Yes, I understand

that.

MR. CARUSO: So I don't remember the details. Pardon?

MR. TERAO: I'm not sure that that was a Research report. There was a -- there is a report issued by the BWR VIP -- it's number 06 -- that deals with this type of failures of safety-related and non-safety-related components inside the vessel, including the steam dryer. And it looked at the impact of the loose parts and the steam dryer collapsing onto the steam separators.

MR. CARUSO: Right.

MR. TERAO: And the staff has reviewed that report. We are still looking at it for -- to see if it needs to be reevaluated in light of the recent steam dryer failures.

MR. CARUSO: I remember that the industry did it, but I also thought the staff had Research look at it, and they had a contractor do a study as part of their evaluation.

MEMBER APOSTOLAKIS: Wouldn't that be the first thing you would do? You would go to a report like that or the PRA and insert these failures and try to figure out what happens and how significant these things are? Instead of talking about -- this is non-

safety-related or it may affect a safety-related component. I mean, I would expect to see something like that today and say, you know, for these reasons we decided to keep studying it.

I mean, it's very consistent with what the reactor oversight process does, which goes to this phased approach to the significance determination and all that. And here you have a real failure. Anyway, I think we've said enough about this.

MR. SCARBROUGH: Well, we're still working on resolving this. Let me go on --

MEMBER APOSTOLAKIS: But one of the -- of the objectives is -- of the Commission is to maintain and even enhance public confidence in the agency. In the discussion of the last 10 minutes, I'm not sure how much it contributes to that.

MR. SCARBROUGH: I agree.

MEMBER APOSTOLAKIS: It's not just the CDF that bothers me. It's this appearance as well. You know, you guys are like Caesar's wife. You know what they said about her.

MEMBER SIEBER: We shouldn't talk about that.

(Laughter.)

MEMBER APOSTOLAKIS: I shouldn't talk

about Caesar.

MR. SCARBROUGH: Okay. Well, let me go on and -- the other examples we have. Dresden Unit 3 shut down in December, and this is where the staff actually was actively involved in convincing Exelon to shut down the unit to do an inspection. And they found a couple of four-inch throughwall cracks in the steam dryer, and they found two more sample probes that had problems.

And also, Dresden Unit 2 happened to shut down during that month, and they found one of their probes -- feedwater probes also missing. So that's where we were with that, with Dresden.

Now, this year Quad Cities Unit 2, in March, now they've had another eight months of operation, and they shut down for a refueling outage inspection, and they found numerous problems with their steam dryer. And part of it involved where they had done repairs in the past.

And if you can show the next slide there, you can see --

MEMBER LEITCH: This is eight months of operation. I'm just a little confused. Was this at the new 100 percent power level, this eight months?

MR. SCARBROUGH: No, this is back -- this

was back up to the EPU, 17 percent above the original --

MEMBER LEITCH: Yes. Okay.

MR. SCARBROUGH: So they went -- yes, they had eight more months of EPU operation.

MEMBER LEITCH: Yes, okay. thank you.

MR. SCARBROUGH: And so they found -- one of the areas they found problems was right here where they had installed these gusset plates, this piece of metal, and they had a disconnect here between the old half-inch and one-inch plates, and they had a disconnect there, and that -- and that failed.

They found several broken tie bars up in here. There's cracks like right in there. You can -- where those were coming apart, and then they -- they had a weld where there was a plate attached, and this right through this weld popped out from the vibration.

So, and then down here on the tip of the gusset -- I don't know if you can see it, but you can see there's a crack right down there. But part of the problem was they -- they were finding damage where they had made repairs in the past.

Now, there's a series of things that happened since then, and we have some slides on that.

Other steam dryer inspections that we've

had this year -- Nine Mile Point has a curve to a design, and they did find an 18-inch crack along a weld right where the curved hood sort of comes together. And they determined that was a fatigue type of crack caused by acoustic loading.

But they had been operating for several years, and so that's what they saw. They did -- there was some blow by through that crack.

Brunswick has been operating for a couple of years at 13 percent power uprate, and it has the -- sort of the slanted design, which is sort of the in between of the square and the curve. And they found some minor -- some minor cracks, fatigue cracks, in their steam dryer.

MEMBER LEITCH: Just as a matter of interest, Brunswick Number 1 just came out of a refueling outage where they preemptively beefed up, shall we say, the dryer, and they're now operating at the full new extended power uprate -- that is, the full approximately 120 percent of the original power rating. They've been at that rating now for about two weeks, and, you know, so far so good. But I don't -- it has only been two weeks, as I said.

MR. SCARBROUGH: Yes. When we talked to them, they said that they were putting some of those

gussets -- those very long gussets in to try to strengthen that -- those plates. And so -- and they said they were going to go up to 20 percent. But they are -- they are doing some extensive vibration monitoring and walkdowns, things of that nature, to try to be prepared to see if they have any problems.

MEMBER FORD: But following on from what Dr. Shack said at the very beginning, aren't we just chasing this problem? If we can't -- we don't understand it, just putting in gussets is not going to stop it, right?

MR. SCARBROUGH: Right. Yes, sir. And that's getting to where we're going with these slides.

MEMBER APOSTOLAKIS: But you told me earlier that when the Quad Cities -- the first incident occurred in 2002, they only had 90 days of power uprated operation. And when I asked about degradation, you said, "Well, gee, most likely that wasn't the problem, because they're forcing function."

Doesn't the experience of -- with Vermont Yankee contradict that? That they found numerous cracks at the original licensed power? Do we know that there were no -- no cracks in the Quad Cities case, or it was a combination perhaps of material degradation and forcing function underestimation?

MR. SCARBROUGH: Right. The first failures at Quad Cities, you never really know whether or not it was something that was there before that was aggravated.

MEMBER APOSTOLAKIS: Oh, okay.

MR. SCARBROUGH: Okay. But as they've done more and more inspections and they keep having more and more failures, you get to the point where they've inspected it sufficiently thoroughly so that they -- there weren't preexisting problems, that these really are EPU-related, and now these Vermont Yankee problems -- they didn't find them in the areas where the Quad Cities was failed. Not in those areas. They found them in other areas -- drain channels and welds, and things like that.

So they didn't find them in the areas that Quad Cities was failing. So we're not quite sure if those were related to this type of sort of full effect phenomenon, or was there something else happening there with those. We won't know yet on that, but we're still -- because we still don't really know what the forcing function was on these.

MEMBER APOSTOLAKIS: So we don't know, but we are convinced the risk is low, so we -- they can keep operating.

MR. SCARBROUGH: Well, for EPU, Quad Cities is not operating at EPU. I mean, they're not. That's -- you know, now Dresden is, but that's a different issue.

MEMBER FORD: All these minor and numerous cracks in this particular design, do we know how they occurred?

MR. SCARBROUGH: Some of them occurred by just stress corrosion cracking. They know that.

MEMBER FORD: Because the resolution to the stress corrosion cracking problem is completely different from that of fatigue.

MR. SCARBROUGH: Yes, sir.

MEMBER FORD: So if you go with what Professor Apostolakis is posing -- that many of these problems that we have which we see after power uprate are really just an acceleration of previous damage which occurred over the 20, 25 years of operation.

But I'm struggling to come away from the conclusion that this is not an isolated occurrence to just flat-topped BWR-3 designs. It could be over the whole BWR fleet, if they are all -- if they have all got prior damage from IGNCC or whatever.

MR. SCARBROUGH: Yes, we haven't limited the scope just to the square hood designs yet. I

mean, that's where we're seeing the severe problems, which is good that it's sort of focusing on the area. But we haven't said this is only a square hood. We're making sure this is a broad look at this issue before we say, "This is the scope."

And that's what -- that's what our concern is, that it -- the scope is not something very neat where you can say, "Okay. This is it. If we fix this, we're done." We just seem to have more problems.

Now, I was going to mention briefly some of these causes that we've had, and this is -- we've talked about this as we go along.

But high cycle fatigue -- the first Quad Cities Unit 2 failure in 2002 -- it was high cycle fatigue, and there was a high frequency of resonance that aligned with the coverplate, natural frequency, and, you know, all these sorts of things that said this was like a once in a sort of blue moon situation. But then we -- a year later we have Quad Cities Unit 2 with high cycle fatigue due to the low pressure pressuring loading -- low frequency pressure loading.

And then, in November, Quad Cities 1 -- we have the high cycle fatigue with a fluctuating pressure load with acoustics. And then we have the

Dresden feedwater probes with resonant frequency vibration. So they're all vibration fatigue-related, but they haven't really nailed down what it is.

But let me mention -- we've talked about the dryers themselves. There are basically three -- the BWRs have three dryer designs -- a square hood, the older type, and the slanted, and the curved. And GE has done an analysis of the various hood designs and has seen that the square hoods just have more stress for the same amount of flow than the slanted and the curved -- significantly different for those.

Quad Cities and Dresden have the disadvantage that they have smaller diameters, so their steam velocities are up around 200 feet per second compared to more the 150, 60, 70, sort of areas that we're seeing with the other plants. So they have a lot more flow, and then on top of that Quad Cities and Dresden have these higher power uprates where they're going up to 17 or so percent in the others. So they have a combination of problems.

Now, the other square hood designs -- Monticello, they've had six percent power uprate, and they've operated for five years without really any problem. Pilgrim only had that small 1.5 percent for about a year, and they haven't seen any problems.

Vermont Yankee now -- the other square hood design -- wants a 20 percent uprate. So that's --

MEMBER ROSEN: But they've already found numerous cracks -- Vermont Yankee.

MR. SCARBROUGH: Yes, they have found some. Right.

MEMBER ROSEN: So it presumes they would do something about that.

MR. SCARBROUGH: They will. They will. We will not grant that EPU uprate until we're satisfied that issue is soft, and we told the licensee that. And they know that, and they're here, and they're interacting with GE, and they know they have to learn --

MEMBER APOSTOLAKIS: The extended -- I'm sorry, go ahead.

MR. SCARBROUGH: They have to evaluate the lessons learned from Quad Cities before they determine that they've solved the problem for Vermont Yankee.

MEMBER APOSTOLAKIS: The Vermont Yankee power uprate has not been granted?

MR. SCARBROUGH: No, sir. They just came in just recently --

MEMBER APOSTOLAKIS: Okay.

MR. SCARBROUGH: -- with a request. And we have a series of RAI questions that have gone out to them regarding this issue and how they're going to resolve it.

MEMBER APOSTOLAKIS: So you will not include Vermont Yankee into this statement here -- Quad Cities and Dresden and Vermont Yankee?

MR. SCARBROUGH: They're included, because they have -- they're requesting --

MEMBER APOSTOLAKIS: They are not included.

MR. SCARBROUGH: Well, they're included in the sense that they have -- they have requested a 20 percent power uprate. Okay. They have a square hood design --

MEMBER APOSTOLAKIS: Yes.

MR. SCARBROUGH: -- and they have the smaller steam lines.

MEMBER APOSTOLAKIS: Right.

MR. SCARBROUGH: Okay. So they -- they are in the most susceptible group, despite the --

MEMBER APOSTOLAKIS: So, but that's what the slide says.

MR. SCARBROUGH: Right. And that's what I was adding on here.

MEMBER APOSTOLAKIS: So Vermont Yankee could be there.

MR. SCARBROUGH: Right.

MEMBER APOSTOLAKIS: Or would be there.

MR. SCARBROUGH: So if we granted it, they could be in that group.

MR. TERAO: So that's why we're looking at it more closely.

MR. SCARBROUGH: Now --

MEMBER LEITCH: Can I just go back again to the experience we had with these governor valves, these turbine governor valves, and stress that it was important that the configuration and dimensions of the main steam line, because that EHC system has to be tuned to get those valves to be stable.

And we found that at different plants -- you know, in some plants the head end of the turbine is near the reactor. In other plants, the generator is there, and it's a very long steam line, so it affects the dynamics of the situation and affects the tuning of that EHC system.

So I just keep -- it sounds to me like there is a distinct possibility, and you need to look into whether these governor valves are really stable or not. And it could vary quite a bit from plant to

plant, but depending upon the configuration and size of the main steam line, because it does affect the dynamics of that whole control loop.

MR. SCARBROUGH: Okay. Thank you. We'll raise that.

In January, GE has -- you know, has been looking at this issue, and they determined that there was a fluctuating pressure load in the acoustic range that they hadn't evaluated before, they hadn't really seen before, and they identified that to us.

Also, Exelon has been running vibration analyses of their steam line components, their ERVs and MOVs, HPSI MOVs, and etcetera. And they found that the vibrations were so severe they could not justify the ERVs as they were at Quad Cities for a full cycle. It was just a few months that they could only justify their operation at that vibration level.

So they've installed attachments to strengthen those -- those components to prevent them from having problems, at least until the next outage where they can refurbish them. So they're only on a one-cycle length of time before they have to refurbish these. So there is some severe vibration going on.

MEMBER ROSEN: Isn't that a bandaid fix? I mean, the real problem here is not -- is that the

vibration -- something is causing the vibration. And what they're doing is stiffening these components to resist the vibration. The right thing to do is to eliminate the vibration.

MR. SCARBROUGH: Right. Yes, sir. And that's going back to what's causing this, what's causing these problems.

MEMBER FORD: And part of that is -- is it says GE identifies. When we were visiting GE, they indicated that they were putting vibration monitors, or they had in the past, and continuing to do presumably, put vibration monitors onto the steam dryers. Is that true?

MR. SCARBROUGH: Not on the dryers themselves.

MEMBER APOSTOLAKIS: That was the indication.

MR. SCARBROUGH: Not in the plants. Now maybe in their separate effects testing or something that they were doing, but not in the plants themselves. And that's been a discussion that we've had.

Now, in a couple of the --

MEMBER FORD: My question was about to go on.

MR. SCARBROUGH: I'm sorry.

MEMBER FORD: How have you qualified these analyses? That was the end of my conversation.

MR. SCARBROUGH: Okay. And part of this is, you know, the staff is currently reviewing the Vermont Yankee request, and part of that review is going to be a detailed look at the GE analyses. And we're setting that up now.

I mean, that process to go and look at those analyses in detail is in the works. We just haven't set the time for when the experts -- and that's not me -- to go out and look at these analyses into a lot of detail and evaluate them. But the staff is getting a contractor to assist on that as well.

In March, the licensee was saying at Quad Cities 2 there was design problems with the gusset repair. There was a discontinuity there. There were some problems with, you know, the stresses and the tie bars, how they attached them, and how they attached the stiffener plate, where they clamped it down to -- and it popped out.

So there are some issues here. Part of it -- I mean, this is not code work, so, you know, it's not -- and it's very difficult work to do, you know, a lot of times under water and things of that nature.

So it's a difficult repair to make, and what their explanation was is there were some design problems. But that's not -- that's not solving the problem. That's just explaining what -- why they thought it occurred.

In terms of the corrective actions, a whole series -- and this is what you have brought up, and it's a good point. I mean, you start in July, you go from a quarter-inch thick plate to a half-inch plate, and then you go from July of 2003 and you go from a half to a one, install some gussets.

And then, in October, you know, Dresden 2 received a modification similar to that Quad Cities 2. And then -- and if you want to look at the next slide, we'll show you a little bit about what they're doing. And this is what -- where we showed what they installed -- they cut out this piece that broke, and they installed these gussets. But they left a little gap there where they went from a half-inch to a one-inch plate, and that discontinuity it just -- it wobbled on them, and it just broke, and --

MEMBER ROSEN: Now wait a minute. Wait a minute. They went in and put these gussets in. The obvious -- it seems to me one doesn't do that unless you have an analysis, an engineering design.

MR. SCARBROUGH: Right.

MEMBER ROSEN: So something -- they did draw it in the design.

MR. SCARBROUGH: Yes, sir. And they freely said they missed it now that they say -- they still -- now what they've done, if we flip on -- you can see the plates -- go to the next one. It gives you a little closer look.

You can see where -- right there, you'll see right where it --

MEMBER ROSEN: No. They missed -- what did they miss? They missed the forcing function, what they were designing against, what was the strain to the materials they installed. We need some detailed analysis of what this is, and to do that, of course, you need engineering drawings -- my earlier point.

MR. SCARBROUGH: Right.

MEMBER ROSEN: That these cartoons don't do it for me.

MR. SCARBROUGH: Right. Right. Right. I know. That's been part of our problem is getting the details.

MEMBER ROSEN: Why is it your problem? Why don't you just require them to deliver these -- this information to you and where the analysis and

engineering that you can review -- you have the capability within the agency to do that.

MR. SCARBROUGH: Right.

MEMBER ROSEN: To ask them, what are the forces they're designing to resist, and what -- from what phenomena do those forces arise? And having once concluded that they've got the phenomena correct and the forces are right, then you can decide whether the structural fixes make any sense.

MR. SCARBROUGH: Right.

MEMBER ROSEN: I mean, there's a process. We all learn it in college.

MR. SCARBROUGH: Right. I agree. And the staff just missed this. I mean, we had a special inspection team that went out in July of 2003 to the plant and looked at what they did, and whatever we saw we agreed that it was acceptable.

MEMBER ROSEN: Well, now you know better.

MR. SCARBROUGH: And we know better.

MEMBER RANSOM: Well, is there any attempt to understand the flow dynamic forces that are causing this problem?

MR. SCARBROUGH: Oh, absolutely.

MEMBER RANSOM: Either by CFD-type calculations or wind tunnel-type experimentation?

MR. SCARBROUGH: Right.

MEMBER RANSOM: Is there anything going on in that area?

MR. SCARBROUGH: Absolutely. The Owner's Group is looking at this. The staff is looking at this. We've asked Research to evaluate -- help us evaluate, step back. You know, we're sort of tired of being drug along here.

We've asked Research to help us step back, look at it from a sort of first principles, and decide what's going on with the CFD, what's going on with the model, try to, you know, do some confirmatory look at what's going on, so that when GE comes in again and says they've solved this problem we can really work from a knowledge base rather than sort of where we are now.

And so that's exactly what we're doing. We're trying to step back and solve this.

MEMBER RANSOM: Because once you understand the flow dynamic forces, it may turn out very simple things. We'll eliminate the -- stabilize the vortex shedding or --

MR. SCARBROUGH: Right.

MEMBER RANSOM: But you must understand it before you can do that.

MR. SCARBROUGH: Right. Yes, sir. We agree with that.

Let me go on to the next slide. Now, then, in March, you know, more failures. And if you want to flip to the next one, David, you'll see that now we've gone from -- now they've taken out the whole plate.

Now they're putting up these large gussets here, and so, you know -- and, you know, so now we have this one-inch plate, and then half-inch gussets going all the way up almost into the top and holding that in.

Now, we've asked some questions about the design in terms of, you know, what's going on with these edges over here. Do we have another discontinuity? We've been asking all those sorts of questions about what's going on, and they've strengthened those ERVs.

But that's part of what we'll talk about in a minute is what they have said to us in their letter coming in in terms of their commitments to us, to show us exactly that they've nailed down this issue.

MEMBER ROSEN: Now, these are like dramatic relief valves that are credited in the safety

analysis, correct?

MR. SCARBROUGH: Yes, sir.

MEMBER ROSEN: And they're now qualified, continue to be qualified to perform their safety-related functions with these new strengthening --

MR. SCARBROUGH: Yes.

MEMBER ROSEN: Have they tested them again or repeated the testing that they did that established their initial qualification?

MR. SCARBROUGH: I don't know that they've done flow-type testing. But I know they did a lot of shaker testing on these out -- that Exelon did --

MEMBER ROSEN: As modified.

MR. SCARBROUGH: -- to demonstrate, yes, that they would hold up their capability. So -- but that's only good for the next outage.

In this reactor, I mean --

MEMBER ROSEN: Well, the implication is that the forces they're worried about are forces for two years of duration. You said only good for two years.

MR. SCARBROUGH: Right. But --

MEMBER ROSEN: But what if they have an event in which the -- you know, the design basis event where these valves were expected to function. They

didn't test that.

MR. SCARBROUGH: I don't know if they went up to that high level. I don't know if -- I don't know if they did that or not.

MEMBER ROSEN: That was my initial question is these valves were initially qualified to perform a safety function during accidents in transit. They have been modified, right? Will they continue to perform their function during accidents in transit is the question.

MR. SCARBROUGH: The best of our knowledge, they will.

MEMBER ROSEN: Not a very satisfactory answer.

MR. SCARBROUGH: I know.

In terms of industry action, GE put out a SIL in August 2002, which talked about --

MEMBER APOSTOLAKIS: SIL? What's a SIL?

MR. SCARBROUGH: Oh. It's a services information letter. It's a voluntary --

MEMBER APOSTOLAKIS: I guess everybody knows that.

MR. SCARBROUGH: I'm sorry.

MEMBER APOSTOLAKIS: Except me.

MEMBER SIEBER: We sent you some a couple

weeks ago.

MEMBER APOSTOLAKIS: Okay. So that's why I threw it away. I didn't know what it was.

MR. SCARBROUGH: Okay. And it was focused on the Quad Cities Unit 2 event, the first one, so it only really dealt with square hood dryers, and it talked about monitoring moisture carryover and refueling outage inspections.

And then, after the next failure at Quad Cities 2, they put out a supplement which now it expanded to all of the BWRs at power uprate, but still focused on moisture carryover and refueling outage inspections, and mostly on external inspections for anything except the square hood design.

And then in February of this year, the Owner's Group took the lead. We had a meeting with them, and they took the lead in terms of evaluating the issue, and has a series of activities that they're doing, that they're going to be submitting a written plan. We asked for a written plan of what they're doing.

And then, in March, following the issues at Quad Cities Unit 2 again, Exelon did an evaluation of the Dresden plant to justify operating an EPU until their next fueling outages. And part of that was the

loads are much lower at Dresden than at Quad Cities in terms of the vibration effects.

MEMBER POWERS: Could I ask a couple of questions here?

MR. SCARBROUGH: Oh, sure.

MEMBER POWERS: When you say the loads are much lower, this is that difference between 200 and 157 feet per second?

MR. SCARBROUGH: Right. They still have high flow rates, but their loading that they determined, it's much -- I'd have to pull out the report that -- well, the slides that they sent us. We still ask for the report. They -- in their letter they sent to us in April -- on April 2nd, they just said that their contractor had provided an analysis, and we've asked for that contractor report to find out exactly how they did that evaluation and find out what the loads were smaller.

MEMBER POWERS: Okay. So you really only have an assertion from them when you say that.

MR. SCARBROUGH: Right. Yes, sir.

MEMBER POWERS: Okay. Could you also explain to me what you mean when you say the BWR Owner's Group assumes the industry lead for the EPU vibration issue?

MR. SCARBROUGH: Right. When we had a meeting with them in early February, we laid out what -- basically what we've told you here today, that our concerns with the scope of this issue, it kept expanding. We kept adding more metal onto these steam dryers. We kept having failures. It's into the feedwater lines, the steam lines, and there was no unified industry effort to try to solve this problem. And that's what we laid out.

And the Owner's Group came back at that same meeting and said they're going to take responsibility for solving this problem. They're going to coordinate with Exelon, which seems to have most of the problems, in terms of the vibration analysis. They're going to coordinate with GE as GE tries to get their arms around this issue and report back to the staff.

So they took the lead in terms of coordinating that. Rather than having us deal exclusively with licensees, that they would be the front people for evaluating this problem, and then they would coordinate that. And that's what I meant by they took the lead.

MEMBER POWERS: So if you want Mr. Rosen's drawings, you'd call BWR Owner's Group and they'll get

them for you?

MR. SCARBROUGH: I'm sorry. I didn't hear the question.

MEMBER POWERS: If you want Mr. Rosen -- provide Mr. Rosen the drawings he's asking for, you'll just call the Owner's Group?

MR. SCARBROUGH: That would be a way to do it, and we are -- we're trying to get more information ourselves as to these details. But the Owner's Group is taking the lead, and that would be a fair way to contact them.

MEMBER ROSEN: It seems astonishing to me that you don't have them already. I mean, after all, they had to build them. They have engineering drawings to build them.

MR. SCARBROUGH: Well, they have them.

MEMBER ROSEN: Yes. All you have to do is ask for them.

MR. SCARBROUGH: Asking for them and getting them are two different things.

MEMBER ROSEN: And then they may say, "Well, they're proprietary," and then you say, "Okay. Well, provide them."

MEMBER APOSTOLAKIS: I don't understand what you just said -- asking for them and getting them

are two different things.

MR. SCARBROUGH: Right. Well, you have to --

MEMBER APOSTOLAKIS: Why would they resist?

MR. SCARBROUGH: Well, I don't think they're resisting. I think they're evaluating it. And unless you send out a formal letter to evaluate it -- to ask for it, you know, it doesn't come.

MEMBER APOSTOLAKIS: Okay.

MR. SCARBROUGH: It's not satisfactory to us either. And it -- let's see, where are we? Okay. Next one.

Exelon. Exelon came in on April 2nd in response to all the failures at Quad Cities 2, and they said they would limit Quad Cities 1 and 2 to pre-EPU power, except for some testing that they were going to do for 72 hours. They also provided a test plan, which talked about pressure sampling, and we have some areas of concern in there.

They talked about strengthening these Quad Cities Unit 1 release valves.

MEMBER ROSEN: Excuse me. On pressure sampling, what did you mean by "pressure sampling"?

MR. SCARBROUGH: They were going to

measure pressure at various places in the steam lines and try to feed that back into a model that they were developing. Now, there's -- they are trying to develop --

MEMBER ROSEN: Is this pressure sampling going to give them a trace of the high frequency pressure of circumstances? Or is -- are they going to look to see if they're seeing pressure fluctuations? They've established the absolute pressure and see what the range around that absolute pressure is. Is the pressure increasing and decreasing? Is it doing so in some sinusoidal repeatable manner?

These are the kinds of things that force vibrations, if you find them. If you look for them, you may find them.

MR. SCARBROUGH: Right. And we have -- we raised some concerns with what their plan was, because we think it's -- it's so far removed from the steam dryer we're not sure that you're going to learn enough to be able to say what's happening with the steam dryer itself.

Now, they insisted that this would be a successful approach. Now, they have gathered data. They have gone up to EPU for a few hours with Quad Cities 2 and gathered this data, and they're supposed

to come in and talk to us about what they found.

MEMBER ROSEN: You need to know what the pressure is doing, what its absolute magnitude is, and how it is varying as a function of time to start. So that's what they should find out, and you need to know that several different places.

MR. SCARBROUGH: Right. And that's what they're supposed to be doing. So -- yes, so we're not convinced yet that they are going in the right direction.

MEMBER SIEBER: So you're making these measurements downstream of the dryer for the purpose of figuring out what's going on in the dryer?

MR. SCARBROUGH: Yes, sir. That was our reaction.

MEMBER SIEBER: Good luck.

MR. SCARBROUGH: And that's what they're doing. They also made some other commitments to us that they were going to send in a letter in early May, and this is sort of a laundry list of them, because we had written up some concerns with this April 2nd letter.

In it they have a summary of their Dresden EPU justification, which has this sort of contractor study referenced and some qualitative discussion -- a

summary. And so we've asked for that; we haven't gotten it yet.

And so these were some other areas, and I -- you know, I don't want to go through all of these with you, but basically you can see that we had some concerns regarding what they were telling us in terms of their commitments in terms of making sure that they capture this issue in a significantly detailed manner.

MEMBER LEITCH: Didn't they also shake off a limit switch down by the turbine stop and control valves?

MR. SCARBROUGH: Well, the limit switch they -- are you talking about like a valve limit switch for a valve?

MEMBER LEITCH: Yes.

MR. SCARBROUGH: Okay. The one they told us about was the HPSI steam line, what they call HPSI 4 and 5, which are the containment isolation valves. And they said that a limit switch was damaged for that valve. They said --

MEMBER LEITCH: I see. I was under the impression that was down by the turbine stop and control valve.

MR. SCARBROUGH: There might be one down there, too. We're getting information through slides

from them. I mean --

MEMBER SIEBER: Inside the containment?

MR. SCARBROUGH: Yes. I think this was one -- they didn't give me a number. I don't know if this is inside or outside. I can't say which one it was.

MEMBER SIEBER: But generally they're about six feet from the penetration, which -- and the penetration is pretty solid.

MR. SCARBROUGH: Yes. And they -- so this is an area we've asked for information on, and we're still -- and this is all part of -- before they take Quad Cities back up to EPU, they were -- part of that provision was they were going to give us all this information for us to evaluate it.

So right now they're still at the pre-EPU level, and so, you know, we'll just have to see if they want to go up to --

MEMBER SIEBER: Okay.

MR. SCARBROUGH: -- say where they are.

Okay. Where they're going from here with the Owner's Group, they've committed to submit a plan which describes these activities. GE and Exelon are working on operational improvement recommendations from all the vibration testing analyses they've done.

GE is working on a revision to the SIL, service information letter.

Once they complete the evaluation that they're doing to try to look at -- improve their structural evaluation of these, and then the BWR Vessel and Internals Project, once the -- it plans to complete their steam dryer inspection guidance, that licensee can implement in September.

So that's what their plan is, but we haven't seen it in writing. And they said they would submit it to us in May.

MEMBER FORD: If you look at it, it's September 2004, which is over two years since the first occurrence. And yet they're still talking about plans. Is there any motion or thoughts as to what the danger might be or the safety impact of just continuing to make plans and not do anything between -- over the last two years?

MR. SCARBROUGH: Right. Well, I think part of it is -- is, you know, right now, you know, Quad Cities 1 and 2 are at the old power level. I mean, so that's -- so they have that. But, you know, there is this -- and I've heard, and it's interesting that Dr. Rosen said it, because I've said it to licensees, too, because they would always lead off our

meetings with them and say, "This is a non-safety-related piece of equipment."

And I said the exact same thing to them. I said, "Stop telling us that. We know that." Because it has to maintain a structural integrity. And part of the concern is that -- that it's not.

Now what we've seen so far is that its focus on these particular plants -- Vermont Yankee is not going up yet, and the other plants are seeing relatively minor problems. So that's sort of where we are. But you're right, this is a longer schedule.

Now, we have indicated a long schedule, and this was a concern to us. And they emphasized to us that they're working as fast as they can to try to survey the BWR licensees to determine where they're going to go from here, and that sort of thing.

But you're right, this schedule is unsettling, because it's not really nailing this down. And part of it is we're fighting this issue that it's a non-safety-related piece of equipment, and you have to convince people that the loose parts -- and we have the VIP, the Vessel Internals Project that did the study, which said that all these pieces wouldn't cause a safety problem, and all of those issues.

But you're right, at some point you've got

to say this equipment has to maintain its structural integrity just from a common sense point of view.

MEMBER APOSTOLAKIS: And when is that point?

MR. SCARBROUGH: That's where we are now. I mean, that's where we are now in terms of, you know Quad Cities is staying where they are, and they're trying to solve this problem.

MEMBER ROSEN: Okay. So you've drawn the conclusion that it has to maintain its structural integrity. Good. Now, you've also got a --

MEMBER APOSTOLAKIS: What sort of conclusion is that?

MEMBER ROSEN: Well, let me say that it leads you to --

MEMBER APOSTOLAKIS: Could it be otherwise? I don't --

MEMBER ROSEN: Of course not, George. I'm just glad to hear that they have concluded that these things need to stay together.

Now, we've got a September 2004 inspection guidance. Once you've concluded structural integrity is needed, one can say one needs to inspect to set -- prove that these, in fact, are -- have structural integrity, correct? And one needs to do it soon if

you're going to continue operation. This isn't a question about uprate. This is a question about continued operation.

You're going to go in and inspect those machines, those dryers now, to say, "Yes, they look okay. Yes, they've got some minor hazing cracks on the surface, but they don't threaten the structural integrity." I mean, those are conclusions one would have to draw. Or the converse, one would say, "Oh, we've got lots of cracks we didn't know about. They do threaten structural integrity at current conditions or uprate," depending upon how -- what your calculations show. I mean, you have to go through this.

So I would say your September 2004 thing is long overdue, and that it's not -- not just a question of having guidance in 2004, in September, it's carrying out the inspections and reporting the results. So I don't want to wait another whole cycle until -- September is a good time to do it, because that's when the plants typically refuel, in the fall. Those are the ones that are going to refuel.

MR. SCARBROUGH: Right, right.

MEMBER ROSEN: They ought to get in and do the guidance. They ought to get in and perform the

inspections in September.

MR. SCARBROUGH: Right. And that's something we've emphasized to the Owner's Group.

MEMBER ROSEN: Now that's a question. Now I need an answer. Are you going to have them do the inspections, or are they going to provide you a book? You know, "Here's the guidance."

MR. SCARBROUGH: Right.

MEMBER ROSEN: Well, the guidance doesn't do you any good unless you use it.

MR. SCARBROUGH: That's right. That's right.

MEMBER ROSEN: So?

MR. SCARBROUGH: Yes. I don't make those decisions. Now, I would like to see them do those inspections in the fall. That's part of what we told the Owner's Group, that we would like to see the guidance sooner, so it could be implemented for the fall inspection.

MEMBER ROSEN: Good.

MR. SCARBROUGH: But that's higher pay grade than me. The --

MEMBER SIEBER: Actually, one round of inspections doesn't tell you much, because it doesn't give you the degradation rate. So you can't -- just

from one inspection, the only thing you can make a statement about is that instant in time, and you can't say that it's going to stay together until the next refueling, for example.

CHAIRMAN BONACA: Well, but the -- I mean, you're keeping these plans to run the pre-EPU power level.

MEMBER SIEBER: Just --

MR. SCARBROUGH: Quad Cities 1 and 2. The others are --

CHAIRMAN BONACA: So you won't learn much by inspecting them at that point. I mean --

MR. SCARBROUGH: At least we'll see if there's any cracks. Like, for example, at Dresden 3, when they came down in December, you know, they had those four-inch cracks in there. Their first reaction when we talked to them was they were going to keep running before they shut down.

And there was some pressure put on them by the staff --

CHAIRMAN BONACA: Right.

MR. SCARBROUGH: -- and they did shut down, and they found those cracks. And the question is problematic whether or not those cracks would have grown if they kept running at EPU. They did -- they

did a modification to their plant, and it's actually a little better than what the other -- the Quad Cities have.

So, you know, there has been some action taken, but it hasn't been maybe to the level that some would like to see on this.

MEMBER SIEBER: Well, one of the problems that you have is if you want to tell the licensees to go and do the inspection, you have to show that they're -- it's safety-related somehow or other. And so your argument needs to be pretty solid in that area.

MR. SCARBROUGH: Right.

MEMBER SIEBER: As to what the potential consequences of failure could be.

MR. SCARBROUGH: Right.

MEMBER SIEBER: And that gets back to Dr. Apostolakis' question, you know, if there's a safety impact, you ought to study it, write it down, and decide what it is.

CHAIRMAN BONACA: Whatever work they develop here will have to be convincing enough for you to allow them to go back again to EPU power.

MEMBER SIEBER: Yes.

CHAIRMAN BONACA: And have you looked at

what you need to make the determination?

MR. SCARBROUGH: That's one reason why we're bringing in the consultant, and we're bringing -- asking Research to go back and step back and say, you know, what is it that's happening here? What are the fundamentals here? And that -- because, yes, we've been sort of led along on this path with just more metal being slapped onto this dryer. And, you know -- and we've accepted it.

And at some point we've got to step back and say, "Okay. What's really happening here? Is more metal going to solve the problem, or do we need to do something, you know, just significantly different right from the outset in terms of solving this problem?" And maybe it's something, you know -- some adjustment of something needs to be made. We don't know.

MEMBER SIEBER: We've got to draw the line at about a three-inch plate, beyond a three-plate for --

MEMBER LEITCH: Yes. I really think you really need to look at these -- the steam line vibration, fluid vibration, because, I'll tell you, there is a guy who is probably 90 years old now at General Electric, and he -- you know, tell me the

volume of your steam lines between the outlet of the reactor and the turbine stop valves and your flow, and I'll give you a capacitor for this EHC system that will make it work in those situations.

And what I'm saying is I think that there's a distinct possibility that that piece of experience has been lost, and maybe we're looking at the wrong end of this pipe to try to solve the problem. And, I mean, we may even be looking organizationally incorrectly, because I don't know if that hypothetical guy resides in San Jose or Schenectady. That issue --

MEMBER ROSEN: I think I can testify that there is -- I have had in my background a similar problem with an aux feedwater and a pressurized water reactor, aux feedwater steam line with very high resonant vibrations, which had the effect of breaking off drain lines off the auxiliary feedwater steam line, which wasn't found until the line was -- the cause of it was not found until the line was instrumented with pressure recording equipment that could find the vibrations or forcing functions and deal -- and eliminate the forcing function, not stiffen the drain lines.

Because the more you stiffened them, they

just broke off sooner. These forcing functions are very, very intense. The idea is to eliminate them instead of trying to fight them.

MR. TERAO: I would like to point out --

MEMBER LEITCH: And we had experience with this operating fine at 80 percent. But when you came up to 100 percent, you got this, and that's essentially what we -- we're talking about doing here. So, I mean, I really think we really need to get them to look into that component of the problem.

MR. TERAO: I did want to point out that Exelon has retained the expertise of Fred Moody. I don't know if he's 90 years old, but he has retired from General Electric. But they are looking to have him look into this issue.

MEMBER LEITCH: Good.

MEMBER POWERS: He is not famous for his -- his expertise in vibrations, is he?

MR. TERAO: Heat transfer I think.

MEMBER SIEBER: Well, we may be getting too deeply involved in trying to solve the details of this problem now for -- for an overview presentation. So maybe we could just take all of our advice, go do it, and then we'll move on here and you can finish up.

MR. SCARBROUGH: Good. Well, we'll take

all the help you can give us.

MEMBER RANSOM: Do you have a date or a plan when either Research or the BWR Owner's Group is going to give you some information on -- from their research on the flow dynamic forces?

MR. SCARBROUGH: Well, they're going to start giving us the plan in May. It's over the summer, and then June there's more information coming in. And in September they're supposed to give us the results. So it's over this sort of timeframe that they're giving us the information.

Now, Research -- they have a schedule. They'll show you their schedule when they come up. But, yes, it's --

MEMBER SIEBER: Yes. You can skip over what you already did and get to --

MR. SCARBROUGH: Okay.

MEMBER SIEBER: -- where you are now.

MR. SCARBROUGH: Okay. All right. Let me skip over those. That's what we've done so far in terms of when we had some meetings with Research. We did send a letter back to Exelon, you know, indicating these concerns. I'm not trying to say that we have these problems solved, or even know how to solve them.

But we relayed our concerns to Exelon that

they didn't indicate that they were going to identify these forcing functions -- this forcing function. They did reverse engineering to back out what it took to break the metal, but they didn't know what the maximum level was.

I mean, so they don't -- they can't do that, so they're always working from reverse engineering here.

The test plan talked about this pressure pulse sampling, which we weren't clear was going to even get into the steam dryer or the potential fluid structure interactions that might be involved here. We made this -- high steam flows were into that range, so those concerns.

In terms of the Dresden EPU, we were concerned about -- there wasn't really a quantitative assessment of the loadings and stresses. They were referenced in this contractor study, and they didn't discuss any components except the steam dryer.

And so we relayed these concerns back to them in a letter on April 20th, and, you know, we'll see where that comes from.

MEMBER ROSEN: Well, that's much better. Now you're getting into the heart of the document.

MR. SCARBROUGH: Okay. Now, where we go

from here, we have -- still have to continue to review the Exelon information. That's going to be coming in, you know, on Quad Cities and Dresden, you know, to resolve this EPU operation for Dresden.

Now, regulatory communications -- we have a regulatory issue summary that we've been drafting to try to see if we want to try to inform licensees of all these activities that are ongoing, because it's a long, involved process that's hard to explain just in a short amount of time.

We've also been discussing a generic regulatory action, like a 50.54F letter, which might ask the other BWRs what they're doing to address this issue. That's something that's being discussed.

Vermont Yankee, in terms of the -- we're looking at these recent inspection findings from the steam dryer to see how they affect the power uprate request and what the similarities are between Dresden, Quad Cities, and Vermont Yankee. And that has to be dealt with before they get to power uprate.

And then we to go back and decide where we went wrong with our power uprate review standard and revise it to decide what -- how to avoid these future problems that we might have. That's where we are, and, you know, as you can tell we're just sort of

getting -- trying to get our arms around this issue, just like GE is, I mean, and so any assistance that ACRS can provide, we are certainly happy to take it to help resolve this.

MEMBER ROSEN: Well, I think these last few slides make me feel a little better that -- Tom, that you're now beginning to head in the right direction. I would comment, though, that this is not just about power uprate, because these forces and functions are there at full power as initially licensed. So let's not -- let's not put our blinders on about that.

MR. SCARBROUGH: Okay. Good. Thank you.

CHAIRMAN BONACA: Another comment I would like to make is I -- the one I started at the beginning. To me, this failure has put a cloud over the whole EPU. I think it's necessary that you look at it, because the increased flow rate has caused the failure. And I can't understand why increased blowdowns or whatever may happen as a result of accidents in -- in a powerplant which has been uprated may not come with surprises there.

MR. SCARBROUGH: Yes, sir.

CHAIRMAN BONACA: Challenging certain components. I mean, clearly here it may very well be

that these dryers already had cracks in them, and the failure has been accelerated by these vibrations, that they've been identified here.

And the questions raised two or three years ago was: are these components as good as new? Those which are inside the vessel, for example, internals, that will have to sustain certain forces during accidents? Comparisons were made. Assumption was made that the criteria to compare against were the original criteria, which is essentially component says no.

And so I think you have to review also that issue. That's just my thought.

MR. SCARBROUGH: Thank you.

MEMBER SIEBER: Now, according to your schedule here, you have Research involved in some of your activities.

MR. SCARBROUGH: Yes.

MEMBER SIEBER: Just what are they doing? Are they here to tell us?

MR. SCARBROUGH: Yes, they're going to give you a brief summary of --

MEMBER SIEBER: Okay. We have 15 minutes left, so maybe you can tell us in 15 minutes.

Thank you very much. Hope we weren't too

hard on you. On the other hand, it pays to be a little hard to keep you enthusiastic about pursuing this to a good endpoint.

MR. MALIK: Good morning. My name is Shah Malik. I'm in the Division of Engineering Technology, Office of Research. On my left side is Don Helton. He's in the Systems Analysis Division in the Office of Research, and we'll -- today we'd like to provide you a draft research plan, which at present we are discussing among Research at NRR to finalize it. So at the moment it is still a draft plan.

The object of the research are to try to identify and determine significance of basic phenomena that can cause adverse flow effects in a steam dryer and other components of steam and feedwater flow lines, and, again, apply those phenomena to characterize failure observed or potential failure that could happen in various components in the BWR plant under power uprate condition. And the discussion will also cover the existing power condition as well.

And determine, based on those experiences, try to determine potential implications that can be drawn from those results which we obtain, and assess -- finally, the assess the feasibility of a screening

tool that can be developed from this research and that can be used by NRR in reviewing those submittals.

And we'll continue to support NRR in any BWR submittal. And as a matter of fact, we've been in contact with the licensee as well to get more and more information to strengthen our product.

MEMBER APOSTOLAKIS: So in which bullet will you evaluate the risk significance of this number?

MR. MALIK: Risk significance is currently not a part of this project. It is being developed or being worked on in another project called Safety Module Project under the same division. I'm not sure or -- if there is some time we can look briefly on that as well.

MEMBER APOSTOLAKIS: But how can you determine relative significance and generic implications if we don't have PRA context? And why is that an issue of research? I mean, can't you just take a PRA and put -- like the accident sequence precursor program. Is that still in existence, by the way? ASP?

MR. LANIK: Yes.

MEMBER APOSTOLAKIS: So did they evaluate this?

MR. LANIK: I think they have it in a preliminary stage. I'm not part of that program, but in my discussions with them I think they actually got it entered as a preliminary but not -- they haven't done an analysis yet.

MEMBER APOSTOLAKIS: I mean, it shouldn't be that hard to do. I'm not saying it's a matter of an hour, but -- so the ASP will tell us soon.

MEMBER SIEBER: No. ASP is never soon.

MR. FLACK: I can't speak for the ASP analysis, but I would imagine that the risk is coming in in an indirect way through loose parts and things that could be generated and thrown through the core causing other events to happen.

But at this point, I don't know where they stand on the ASP analysis itself for just the failures of the dryers. It's going to be involving the implications and propogations -- it's going to be a difficult thing I think to quantify in the input.

MEMBER APOSTOLAKIS: Okay. Let's leave the ASP out. But, I mean, this research program should be able to do a quick calculation, especially if you are going to draw any generic implications. Don't you need to look at the accident sequence? You don't need a separate research program for that.

MEMBER SIEBER: I think you need that just to either grant or deny an EPU or to require a licensee to stay at the power level that he's at. You need to know what the risk is.

MEMBER APOSTOLAKIS: You need to know that.

MEMBER SIEBER: And if you don't know what it is, you don't have a basis to do it.

MEMBER APOSTOLAKIS: Okay.

MR. FLACK: And I think we agree that the risk is an important part of the equation.

MEMBER APOSTOLAKIS: Yes.

MR. MALIK: Okay. Next slide. This slide is the present subdivided into two phases. Phase 1 is essentially collecting data with the help of NRR from the licensee, as much data, plan data, and using those data to support our analysis. And the second major effort in this phase will be to procure a technical consultant in flow-induced vibration area, in particular in the CFD and flow fraction and computational structure, where we can combine all three effects.

MEMBER APOSTOLAKIS: Do you have in-house experts in these areas?

MR. MALIK: We have a CFD -- in the CFD

area we have, but not other two. Some expertise we have, but we'd like somebody who has more broad expertise, so we can combine them together.

MEMBER APOSTOLAKIS: Okay.

MEMBER RANSOM: Under your first bullet you have scale model test data. Does somebody have a scale model developed?

MEMBER SIEBER: Well, scale model is -- GE has some data we are trying to get. These are the kind of information we'd like to get from the licensee and their vendors.

MEMBER FORD: The presumption here is that the whole degradation process is flow-induced vibration. There's nothing here that presumes that in fact --

MR. MALIK: That is -- when we start looking at phenomena, we are looking to that -- the next phase of --

MEMBER FORD: Looking to what?

MR. MALIK: Yes.

MEMBER FORD: Into what? You said you -- in the next phase you're going to look into?

MR. MALIK: That the flow is what could cause this kind of phenomena.

MEMBER FORD: Well, it's not so much the

-- I think flow-induced vibration is probably the predominant one, but I'm thinking of the initiating event, which could be stress corrosion cracking.

MR. MALIK: Yes.

MEMBER FORD: Which has been occurring for 20-odd years.

MEMBER SIEBER: The way you expand your horizon, though, is if you fail at this approach, right? If you can show that it's flow-induced vibration, and that you can analyze it, then, for example, arguments like Mr. Leitch's would not be pursued, except by a licensee trying to tune up a plant.

MR. MALIK: Okay.

MEMBER SIEBER: I don't know whether that's right or -- the right way or the wrong way to attack the problem. I'd probably do it that way, but others would do it a different way.

Go ahead.

MR. MALIK: Okay. The phase 2, which is the -- where we are doing that, once we have a consultant or consultants on board. We're going to start looking at things that are of concern, such as thermal hydraulic models, and things such as stress corrosion cracking. And we'll use those in trying to

predict what kind of flow-induced vibration or other loading conditions can exist using thermal hydraulic models.

Also, in the process we will try to determine what is the significance of flow interaction with high flow velocity interacting with the components that are --

MEMBER APOSTOLAKIS: So this overlaps what degree with what the industry is doing?

MR. MALIK: It will be our introductory program, and it will go on a longer term basis, unless they come up within the six months to a nine month to a year timeframe of -- we are going to be doing it in a much more comprehensive way. Yes, there will be some overlap in that.

MEMBER APOSTOLAKIS: So you will have the benefit, then, of their work.

MR. MALIK: Yes. And we'll be interacting to get more and more data, and they'll benefit from us as well.

MEMBER APOSTOLAKIS: Fine. Fine.

MR. MALIK: Okay. Once we have determined flow-induced vibration and conditions, we'll apply those to current -- the model to perform analysis to find the stressors that are --

MEMBER SIEBER: Now --

MR. MALIK: -- things like that.

MEMBER SIEBER: Sir, you'll have to talk into the microphone.

MR. MALIK: Sorry.

MEMBER SIEBER: So the recorder can pick you up.

MR. MALIK: Thank you.

And based on those analyses, we'll try to predict component failure as well as operating condition and potential concern that may come up from those analyses results.

Okay. Then, the next step will be the task -- the next task will be for generic implication. As you can see, this plan is essentially on a deterministic basis, and we may have to modify it to bring the probabilistic aspects out of --

MEMBER APOSTOLAKIS: I noticed that. I agree with you.

MR. MALIK: Yes.

MEMBER APOSTOLAKIS: So you agree with me, too?

MR. MALIK: Yes.

MEMBER APOSTOLAKIS: Oh, that was quick.

(Laughter.)

The usual answer is, "We'll think about it."

MR. MALIK: No.

MEMBER APOSTOLAKIS: John?

MEMBER ROSEN: John, here you are presenting what looks to me like a -- you know, a cohesive plan to build -- to get the agency up to speed on something that's established technology. I mean, flow-induced vibration that -- these kinds of things, is not unknown. It's not a research subject.

MR. FLACK: Well, I would say it's applied research. We never learn enough about things as they age, so I wouldn't say necessarily it's -- it's not part of research.

MEMBER ROSEN: It's just the way we do business in the agency. We call this research, but people have been doing -- have known about flow-induced vibration for a long time. They've known about resonance and what resonances can do to powerplants, piping, aircraft wings, all kinds of things.

MEMBER APOSTOLAKIS: Yes. But this is regulatory research.

MEMBER SIEBER: Yes. This is --

MEMBER APOSTOLAKIS: Regulatory.

MEMBER SIEBER: -- probably rather new to the agency, because they ordinarily don't get involved in these kinds of work -- this kind of work.

MEMBER SHACK: Somebody has clearly been having a problem with the interfering of this problem.

MEMBER SIEBER: Everybody so far.

MEMBER APOSTOLAKIS: Well, presumably, you will review the literature and talk to other people's experience and build on it, right?

MR. MALIK: Yes.

MEMBER APOSTOLAKIS: Okay.

MEMBER SIEBER: Okay. Go ahead.

MR. MALIK: Okay. The final task under this phase would be development of a potential screening tool that NRR can use in reviewing those submittals.

Let me go on the next page. We will try to give a draft schedule for these activities.

MEMBER APOSTOLAKIS: So let me -- I can't -- fiscal year '06, develop potential screening tool. So you will be denying power uprate requests until then?

MR. MALIK: No. That's why we have put on the last bullet, "Continue providing additional guidance to NRR based on the information we collect up

to that point." So --

MEMBER APOSTOLAKIS: So it's conceivable, then, we'll approve an EPU in the next two months? Even though this research is going on? Yes, it is conceivable.

MR. MALIK: In the supplies for NRR, you know, how much they give --

MEMBER ROSEN: Perhaps if they come to us with a request for that kind of thing, am I to expect some questions in this area?

MEMBER APOSTOLAKIS: Do you think there will be some questions?

MEMBER ROSEN: I suspect it, yes.

MEMBER APOSTOLAKIS: I'm sorry. But it's a natural reaction.

MR. MALIK: Yes. I understand that. One other thing that's driving this schedule is that procuring -- if we can get within the DOE lab area, that will be a shorter period. Otherwise, it's showing up like for a six-month time from May 2004 to September 2004. Commercial contracts take that long to go through the process.

MEMBER APOSTOLAKIS: Of course, Dr. Paperiello told us yesterday that he would like to see most of the work in the Office of Research done in-

house.

MR. MALIK: Yes.

MEMBER APOSTOLAKIS: So I don't know how consistent that is with that.

MR. MALIK: Well, there will be a --

MEMBER APOSTOLAKIS: I'm sorry. Go ahead.

MR. HELTON: Some of this work is going to be done in-house. For instance, the CFD work that's on there is planned for in-house, and some of the finite element work is also planned for in-house. But there is some of it that will have to be contracted out.

MEMBER APOSTOLAKIS: Okay.

MR. MALIK: All right. Okay.

MEMBER POWERS: I think that's an important point. We have -- this flow-induced vibration is known technology. It is by no means trivial technology. And it's a highly specialized field.

MEMBER SIEBER: Right. Yes, it is.

MEMBER POWERS: You're not going to find people with expertise. And these gentlemen face a particular difficult problem, whereas you can do flow-induced vibration on a wall, or a structure, they have to look at the whole piping system as an integral

whole. And I --

MEMBER KRESS: It won't be an easy task. We are not going to --

MEMBER POWERS: Not by CFD it's not going to be an easy task.

MEMBER KRESS: It's not going to be easy to find the resonant frequency of the components.

MEMBER POWERS: Yes. Without some good --

MEMBER SIEBER: Not with that kind of geometry.

MEMBER POWERS: Without some good experimental data on the actual system of interest, they're going to get nowhere with this study.

MEMBER ROSEN: It seems to me that you've got your finger right on it. You need to do some measurements.

MEMBER KRESS: And that won't be easy.

MEMBER POWERS: I mean, they can -- they can learn their computer codes 'til the cows come home. They're not going to get anything out of this.

MEMBER SIEBER: Okay. Why don't we go on.

MR. MALIK: Okay. We say that the 2004 -- in early 2005 we'll be doing some of the initial scoping studies. And once we have the consultants on board, we are going to be trying to come up with

determining various mechanisms that could cause failure of flow-induced vibration.

And, again, in 2005, try to predict flow-induced vibration loading via thermal hydraulic analysis. And, similarly, fluid extraction as well as circulations will be done during FY05. And using all that information, during FY06, we will try to build up some generic implication as well as potential screening tools.

MEMBER APOSTOLAKIS: Very good.

MEMBER SIEBER: So the initial event occurred in 2002, and you're going to get the result in 2006?

MEMBER APOSTOLAKIS: That doesn't sound good. Doesn't sound good.

MEMBER SIEBER: Well, that's when you're going to decide --

MEMBER POWERS: It sounds vastly overly optimistic as a matter of fact.

MEMBER SIEBER: Yes. Which one you're going to decide whether you're giving more EPUs. But by then everybody will have one, right?

MEMBER POWERS: We presumably have the sump as a standard.

MEMBER SIEBER: Well, anyway --

MEMBER APOSTOLAKIS: I'm just curious, though.

MEMBER SIEBER: -- it's not swift.

MEMBER APOSTOLAKIS: When we do inspections and we find things, we have an action matrix.

CHAIRMAN BONACA: It is important.

MEMBER APOSTOLAKIS: When failures occur, do we have an action matrix? No. Should we? I don't understand --

MEMBER SHACK: It gets increased regulatory attention, George, even without an action matrix.

MEMBER APOSTOLAKIS: If this is increased regulatory attention, I would like to see what decreased attention is.

MEMBER SIEBER: Without the risk analysis, I'm not sure how you --

MEMBER APOSTOLAKIS: That's right.

MEMBER SIEBER: -- how you make increased --

MEMBER APOSTOLAKIS: You would need the --

MEMBER SIEBER: -- happen.

MEMBER APOSTOLAKIS: You would need the equivalent of a significance determination process.

MEMBER SIEBER: You would think.

MEMBER APOSTOLAKIS: That's it. Well --

MEMBER SIEBER: But this is pretty complex to put through that, particularly when you don't know what the consequences of all of these --

MEMBER ROSEN: Well, wait a minute, Jack. It's much simpler than that. You're making this --

MEMBER APOSTOLAKIS: It's much simpler than that, yes.

MEMBER ROSEN: You know the consequences, potential failure of the main steam isolation valves. That's one. Just take that. One can go into existing PRAs and conclude the importance of that.

MEMBER SIEBER: Well, yes, that's --

MEMBER APOSTOLAKIS: And then you may come to --

MEMBER SIEBER: That's a pretty gross way to do it, but there's all kinds of --

MEMBER APOSTOLAKIS: This should give it some --

MEMBER SIEBER: -- by design they fail different ways.

MEMBER ROSEN: Well, failure to close is what I'm talking about.

MEMBER SIEBER: Well, we're wasting time

on that. You guys knows how to do it.

MEMBER APOSTOLAKIS: This is not their job to do that.

MEMBER SIEBER: Right.

MEMBER APOSTOLAKIS: So we are not --

MEMBER SIEBER: Okay. Would you like to conclude?

MR. MALIK: Yes. We hope to continue getting more information from the industry, as much as possible, and that's the push we are trying to do to begin this program.

MEMBER SIEBER: Okay. Does anybody have any questions they'd like to ask the staff before we wrap this up?

Well, I'd like to thank the staff for making the presentation. This is important to us. It's a matter of concern. I think we ought to be thinking about a subcommittee meeting or maybe even the full committee prior to one of our regular meetings, so we can spend some more time to understand the details of the problem. And I think that the staff is getting their arms around it, but I think the problem is far from solved at this point.

So with that, Mr. Chairman, I would turn it back to you. And we're almost on schedule.

CHAIRMAN BONACA: Yes, thank you. Thank you to the presenters.

And at this point we will take a break of 15 minutes, and get back at 10 of 11:00.

(Whereupon, the proceedings in the foregoing matter went off the record at 10:34 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 512th Committee Meeting

Docket Number: n/a

Location: Rockville, MD

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

Rebecca Silberman

Rebecca Silberman
Official Reporter
Neal R. Gross & Co., Inc.

POTENTIAL ADVERSE FLOW EFFECTS FROM POWER UPRATES

David Terao
Thomas G. Scarbrough

Mechanical and Civil Engineering Branch
Division of Engineering
NRC Office of Nuclear Reactor Regulation

May 7, 2004

INTRODUCTION/BACKGROUND

- Since 1970s, licensees have been implementing power uprates to increase NPP electric output.

- Power uprates categorized as
  - Measurement Uncertainty Recapture (about 1.5%)
  - Stretch (about 6%)
  - Extended Power Uprate (up to about 20%).

- Cracking of RPV internals is long-standing issue in BWR plants without power uprates.

- Some NPPs experiencing additional problems with safety-related and non-safety related equipment during power uprate operation.

- Quad Cities Units 1 and 2 experienced catastrophic failures of steam dryers during EPU operation.

SCOPE OF ADVERSE FLOW EFFECTS FROM POWER UPRATE OPERATION

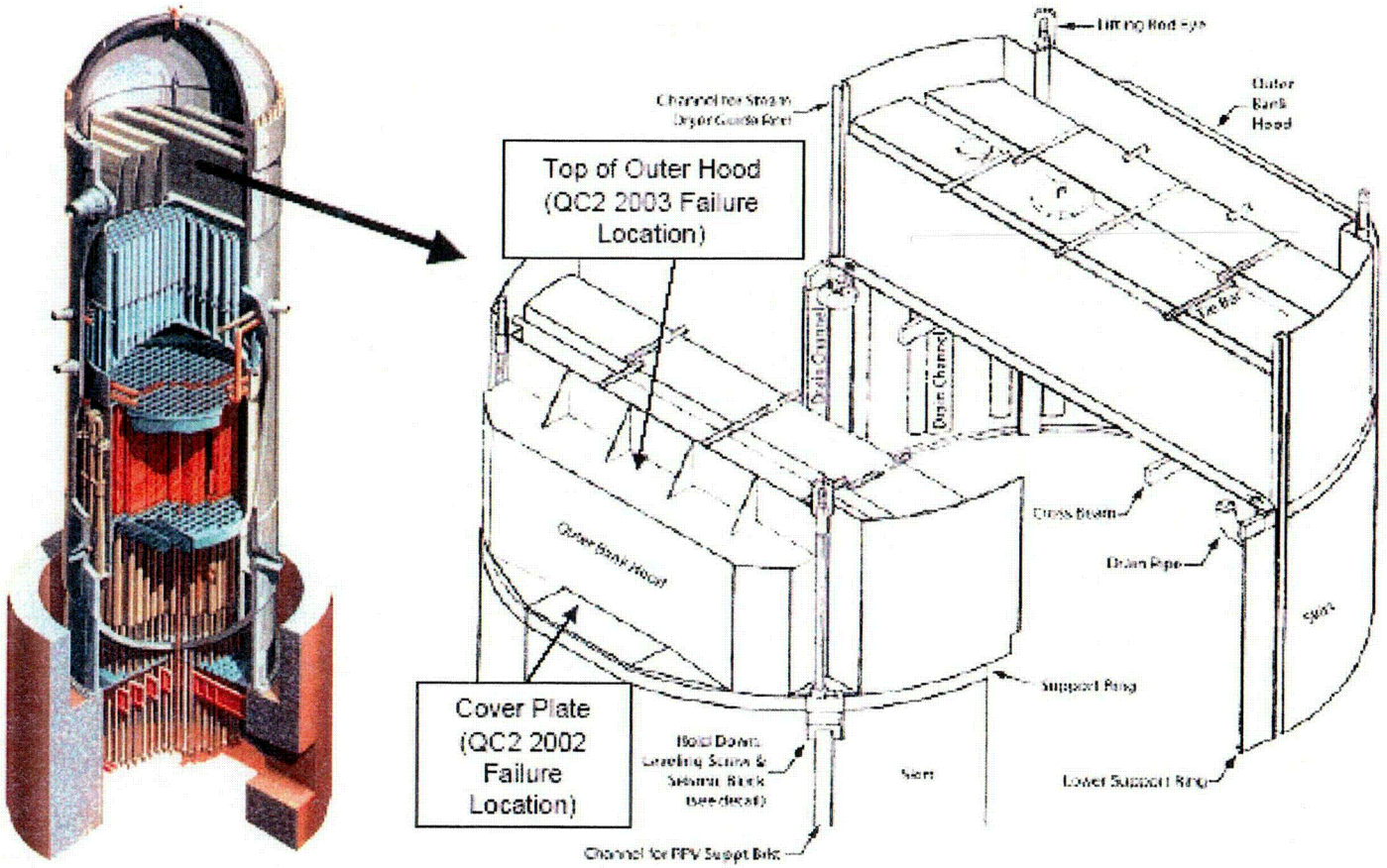
- Quad Cities Unit 2 - June 2002:

  After 90 days of EPU operation, steam dryer cover plate fails with pieces found on steam separators and in main steamline.

- Quad Cities Unit 2 - June 2003:

  After additional 300 days of EPU operation, steam dryer experiences failure of hood, internal braces, and tie bars.

QC2 Steam Dryer Failures 2002 and 2003



C01

SCOPE OF ADVERSE FLOW EFFECTS FROM POWER UPRATE OPERATION (continued)

- Dresden Unit 2 - October 2003:

  During RFO inspection after two years of EPU operation, 4-inch cracks identified in steam dryer hood panels.

  Holes found in feedwater sparger from broken sampling probe.

SCOPE OF ADVERSE FLOW EFFECTS FROM POWER UPRATE OPERATION (continued)

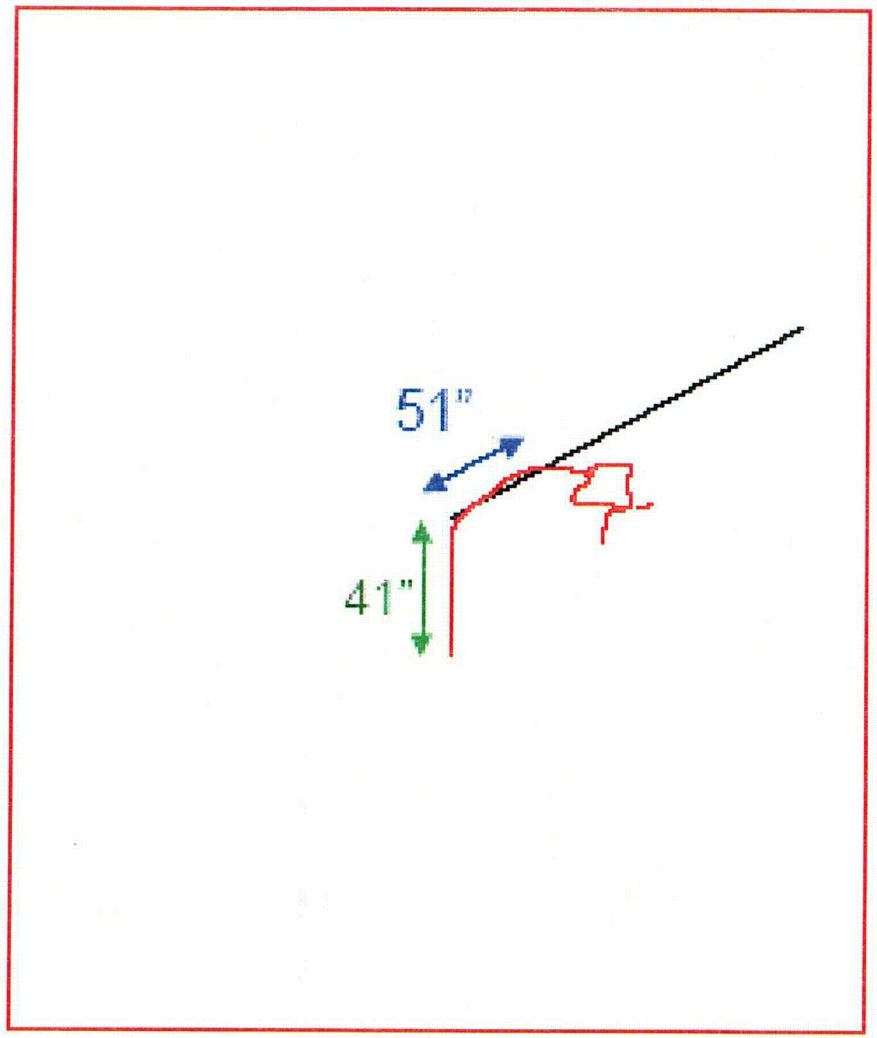
- Quad Cities Unit 1 - November 2003:

  After about one year of EPU operation, steam dryer hood experiences significant cracking with 6x9 inch piece of outer bank vertical plate missing.

  Damage also found to

  main steam electromatic relief valve (ERV),
  steamline supports, and
  HPCI steam supply motor-operated valve.

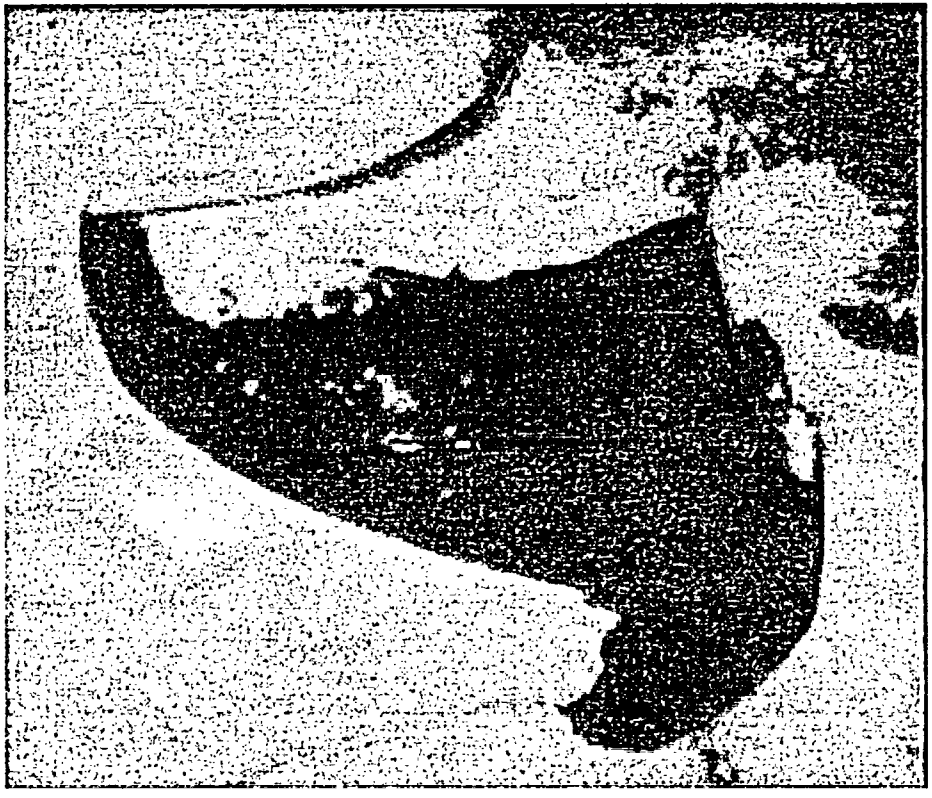
QC1 Steam Dryer Failure
November 2003



270° Side

C02

QC1 Steam Dryer Failure
November 2003
(close-up)



Missing portion of outer bank vertical plate, approx. 6 in. x 9 in.

SCOPE OF ADVERSE FLOW EFFECTS FROM POWER UPRATE OPERATION (continued)

- Dresden Unit 3 - Dec 2003:

  During shutdown inspection after about 10 months of EPU operation,

  two 4-inch through-wall cracks identified in steam dryer hood, and

  two FW sampling probes found in sparger.

  Licensee determines FW sampling probe missing from installed location.

SCOPE OF ADVERSE FLOW EFFECTS FROM POWER UPRATE OPERATION (continued)

- Quad Cities Unit 2 - March 2004:

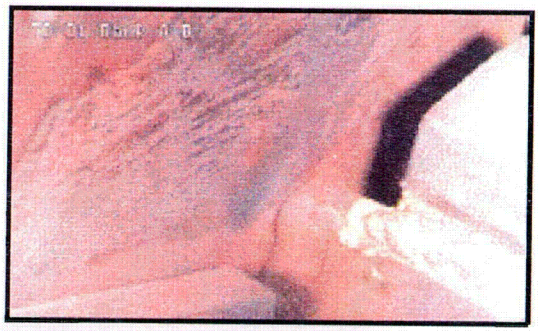
  After about 8 months of EPU operation, numerous steam dryer indications identified during refueling outage inspection including

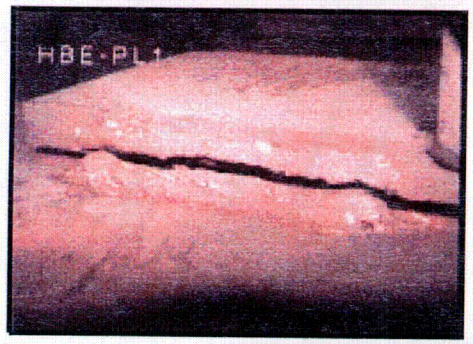
  cracking near gussets installed in 2003,

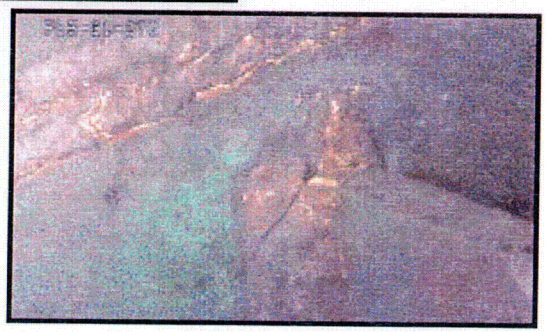
  broken tie bar welds, and

  damaged stiffener plate weld.

QC2 Steam Dryer Failure
March 2004

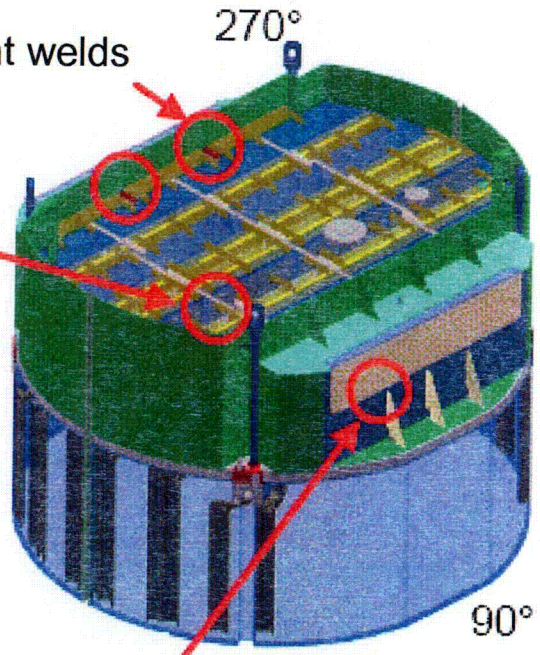






Tie bar to attachment welds

Plate attachment stitch weld



Tip of gusset plate

C03

SCOPE OF ADVERSE FLOW EFFECTS FROM POWER UPRATE OPERATION (continued)

- Other BWR steam dryer inspections in Spring 2004:
  - Nine Mile Point Unit 2 (curved hood steam dryer) finds a thin 18-inch crack along a weld after several years of operation at 4.3% power uprate.
  - Brunswick Unit 1 (slanted hood steam dryer) finds only minor cracks after 2 years of operation at 13% power uprate.
  - Vermont Yankee (square hood steam dryer) finds minor but numerous cracks after operation at original licensed power.

POTENTIAL CAUSES OF ADVERSE FLOW EFFECTS

- July 2002 QC 2 steam dryer cover plate:

  high cycle fatigue due to high frequency resonance (180 Hz) as a result of alignment of cover plate natural frequency, standing acoustic wave frequency, and vortex shedding frequency.

- July 2003 QC 2 steam dryer hood:

  high cycle fatigue due to low frequency pressure loading (0 - 50 Hz).

- November 2003 QC 1 steam dryer:

  high cycle fatigue from fluctuating pressure loading with acoustics.

- 2003 Dresden FW probes: resonance frequency vibration.

POTENTIAL CAUSES OF ADVERSE FLOW EFFECTS (continued)

- Quad Cities and Dresden more susceptible to adverse flow effects:

  Steam dryer with square hood experiences greater stress than slanted or curve hood design.

  Main steam lines with smaller diameter have higher steam velocity.

  EPU power uprate involves more significant changes from original power level.

POTENTIAL CAUSES OF ADVERSE FLOW EFFECTS (continued)

- January 2004:

  GE identifies fluctuating pressure load in acoustic range as potential failure cause of QC steam dryers.

  Exelon study of vibration effects determines QC ERVs unable to withstand EPU vibration for full cycle.

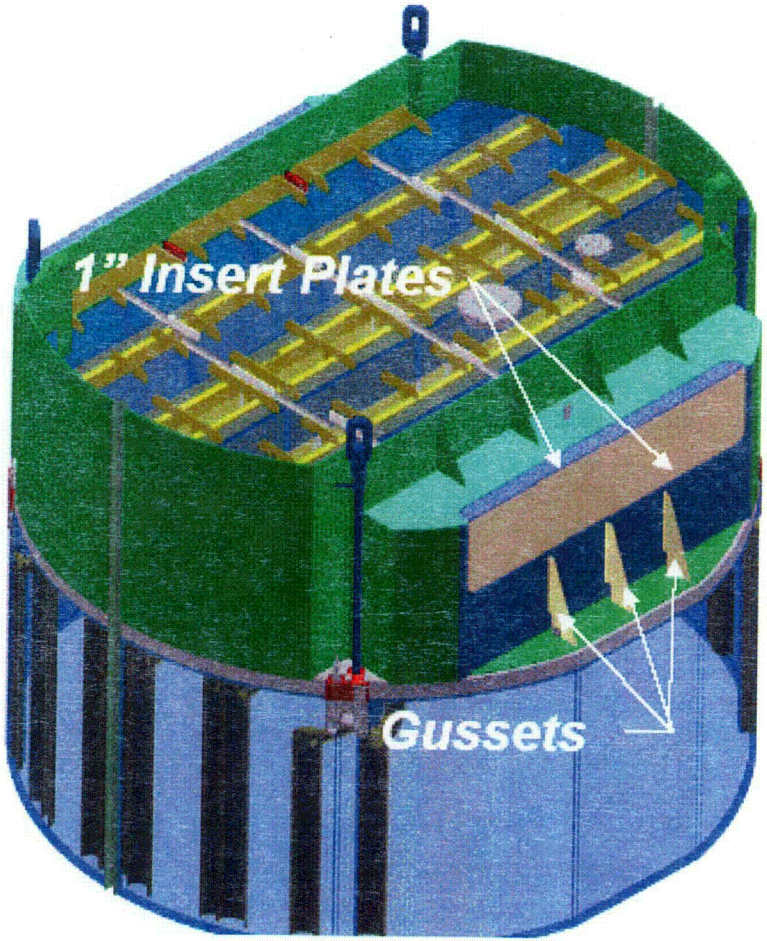
- March 2004 QC 2 steam dryer:

  inadequate design of previous gusset repair, movement of high stress point during tie bar repair, and poor installation practice for stiffener plate.

PLANT-SPECIFIC CORRECTIVE ACTIONS

- July 2002: QC 2 steam dryer cover plate increased from 0.25 to 0.5 inch.
- July 2003: QC 2 steam dryer outer hood plates increased from 0.5 to 1 inch with gussets installed and braces removed.
- Oct 2003: Dresden 2 steam dryer modified similar to QC 2 (July 2003).
- Nov 2003: QC 1 steam dryer modified similar to QC 2 (July 2003).
- Dec 2003: Dresden 3 steam dryer repair improved over QC 1 and 2.

QC1 Steam Dryer Repairs
November 2003

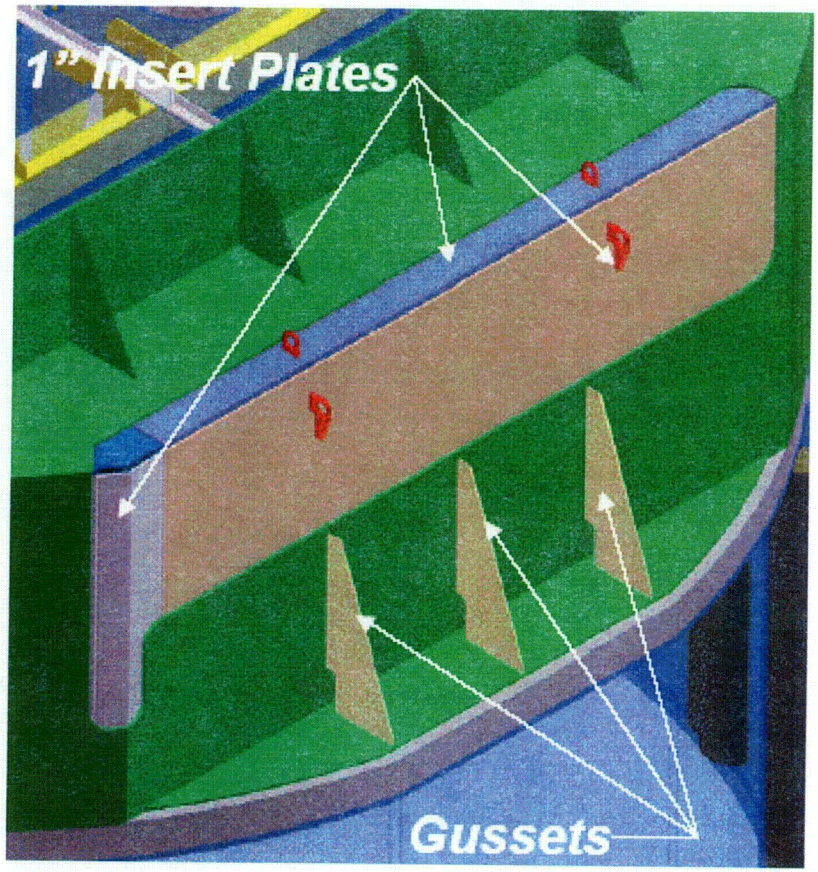


Similar to:
QC2 - June 2003
D2 - Oct 2003

C04

QC1 Steam Dryer Repairs
November 2003

(close-up)



C05

PLANT-SPECIFIC CORRECTIVE ACTIONS (continued)

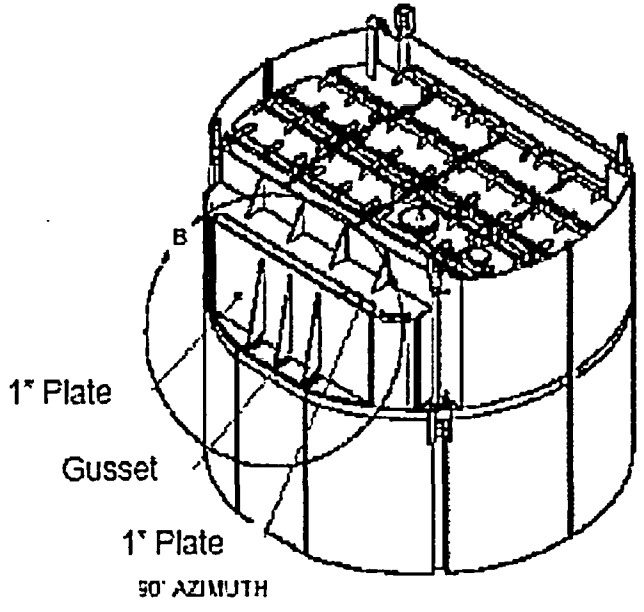
- Quad Cities Unit 2 - March 2004:

  Replacement of entire vertical plate of steam dryer hood.

  Installation of full-length gussets on vertical plate.

  ERVs strengthened to support 2-year operation.

QC2 Steam Dryer Repairs
March 2004



INDUSTRY ACTION

- Aug 2002: GE SIL 644 for square-hood steam dryers to monitor moisture carryover and RFO inspections.
- Sept 2003: Supplement 1 to SIL 644 to all BWRs with power uprates to monitor moisture carryover and RFO inspections.
- Feb 2004: BWROG assumes industry lead for EPU vibration issue.
- Mar 2004: Exelon evaluated Dresden EPU operation with RFOs for Unit 2 in Nov 2005 and Unit 3 in Nov 2004.

INDUSTRY ACTION (continued)

- Exelon Commitments - April 2, 2004:

  Limit QC 1 and 2 to pre-EPU power except for 72-hour testing.

  Modify QC 1 electromatic relief valves before long-term EPU operation.

  Provide specific commitments on

  obtaining NRC acceptance of QC 1 and 2 EPU operation;
  monitoring steam dryers and other components;
  criteria for prompt corrective action if needed;
  description of steam dryer loads;
  evaluation of QC 2 steam dryer repairs;
  independent review;
  reevaluation of flow-induced vibration assessments;
  EPU vulnerability team effort; and
  future steam dryer inspection plans.

PLANNED INDUSTRY ACTION

- May 2004: BWROG to submit plan and GE/Exelon to complete operational improvement recommendations.
- June 2004: GE to complete review of steam dryer and steam/feedwater components.
- Sept 2004: BWR Vessel and Internals Project to complete steam dryer inspection guidance.

NRC STAFF ACTION

- Sept 2002: Information Notice 2002-26 on QC 2 steam dryer cover plate failure.
- July 2003: NRC Special Inspection Team and Supplement 1 to IN 2002-26 in response to QC 2 steam dryer hood failure.
- Sept 2003: NRC letter (9/26) to BWROG with comments on SIL 644 (Supplement 1).
- Nov 2003: Public meeting (11/5) with BWROG.
- Nov 2003: NRC discussions with Exelon on QC 1 steam dryer repair and lost parts.

NRC STAFF ACTION (continued)

- Jan 2004: Supplement 2 to IN 2002-26 on QC 1 steam dryer and additional component failures.
- Feb/Mar: Public meetings (2/3 and 3/4) with BWROG.
- Mar: IN 2004-06 on loss of FW sampling probes at Dresden 2 and 3.
- Mar/Apr: NRR/RES meetings to discuss research support on adverse flow effects from power uprates.

NRC STAFF ACTION (continued)

- April: Acknowledgement letter (4/20) to Exelon:

  No problem with proceeding as described in April 2 letter.

  Concerns with plans to justify long-term EPU operation at Quad Cities and Dresden. Examples include:

  Licensee did not indicate that loads (forcing function) causing steam dryer damage will be identified.

  Quad Cities test plan not clear that sufficient data will be collected to assess dynamic loading on steam dryer and other components.

  Dresden EPU basis did not provide quantitative technical assessment of loadings and stresses that could fail steam dryer or other components.

FUTURE PLANS

- Review of Exelon information supporting Quad Cities and Dresden EPU operation.
- Regulatory communications being considered:
  - Regulatory Issue Summary on potential adverse flow effects from power uprates.
  - Generic regulatory action for other BWRs with power uprates.
- Review of Vermont Yankee power uprate request.
- Revision to power uprate review standard.

Draft Research Plan to Assess Potential Adverse Flow Effects During BWR Power Uprates

Shah Malik, MEB/DET/RES
Don Helton, SMSAB/DSARE/RES

ACRS Briefing
May 7, 2004
US NRC

Research Program Objectives

- Due to recent events at Quad Cities 1 & 2 and Dresden 2 & 3 plants, a research program is being planned in RES to address adverse flow effects due to power uprates in BWRs
- **Objectives of Research Program:**
  - Identify and determine relative significance of phenomena that cause adverse flow effects in steam dryers and other components in steam and feedwater flow paths leading to degradation and potential failures due to flow induced vibration (FIV) and high cycle fatigue
  - Apply these phenomena to characterize failures observed in BWR plants under power uprate conditions
  - Determine if there are any generic implications that can be drawn on the extent of the adverse flow effects
  - Assess feasibility of developing a screening tool that NRR can use to review submittals on BWR power uprates
  - Support NRR in evaluating BWR power uprate submittals

Research Plan (Draft)

- **2-Phase approach to understand and evaluate the adverse flow effects**
- **<u>Phase 1</u>:**
  - **With the assistance of NRR, acquire detailed plant data**
    - Affected components drawings and vibration monitoring data
    - Scaled-model test data, in-plant test data
    - Analytical modeling information (fluid and structural evaluations)
    - Licensee inspection information
  - **Procure tech. consultants in flow induced vibration (FIV)**
    - Computational fluid dynamics (CFD),
    - Fluid-structure interaction (FSI),
    - FIV computational structural dynamics analyses (FEA)
  - **Perform CFD feasibility studies to predict vortex shedding**
  - **Perform FEA structural dynamics studies (natural frequencies, mode shapes, ...)**

Research Plan (Contd.)

- **Phase 2:**
  - Determine what FIV mechanisms are of concern
    - Turbulent loading
    - Vortex shedding
    - Acoustic excitation
    - Any other mechanism
  - Predict FIV loadings via thermal-hydraulic models
  - Determine significance of fluid-structure interaction (FSI)
  - Apply FIV loadings on finite element structural dynamic models and perform analyses
  - Predict components' failure modes
  - Infer generic implications
  - Develop potential screening tools for NRR's use in review of submittals on power uprates

Research Plan Schedule (Draft)

- **Phase 1:**
  - Acquire detailed plant & analysis data: 05/2004 - 06/2004
  - Procure FIV technical consultants: 05/2004 - 09/2004
  - CFD feasibility study: 07/2004 - 02/2005
  - FEA structural dynamics studies: 07/2004 - 03/2005
- **Phase 2: (Tentative)**
  - FIV mechanisms determination: 10/2004 - 12/2004
  - Predict FIV loadings: FY05
  - Determine significance of fluid-structure interaction (FSI): FY05
  - Develop FEA structural dynamics models and perform analyses: FY05
  - Predict operating conditions and potential issues: FY05-FY06
  - Infer generic implications: FY06
  - Develop potential screening tools for assessing power uprate submittals: FY06
- **Continue providing additional guidance to NRR in reviewing submittals as soon as research information becomes available**