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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

February 10, 2005

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS (ACRS)

519TH MEETING

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THURSDAY,

FEBRUARY 10, 2005

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ROCKVILLE, MARYLAND

The Committee met at the Nuclear Regulatory Commission, Two White Flint North, Room T-2B3, 11545 Rockville Pike, at 8:30 a.m., Dr. Mario V. Bonaca, Chairman, Presiding.

COMMITTEE MEMBERS:

MARIO V. BONACA, Chairman

WILLIAM J. SHACK, Vice Chairman

JOHN D. SIEBER, Member-at-Large

GEORGE E. APOSTOLAKIS, Member

RICHARD S. DENNING, Member

F. PETER FORD, Member

DANA A. POWERS, Member

VICTOR H. RANSOM, Member

STEPHEN L. ROSEN, Member

GRAHAM B. WALLIS, Member

ACNW COMMITTEE MEMBER:

MICHAEL T. RYAN, Member

ACRS STAFF PRESENT:

JOHN T. LARKINS, Director

SAM DURAISWAMY, Designated Federal Official

NRC STAFF PRESENT:

FRANK ASKTULEWICZ

JOE GITTER, NMSS, FLSS, SPB

MIKE JOHNSON

STEVEN JONES, NRR, DSSA, SPLB

N. KALYANAM, NRR, DLPM, PDIV-1

STEWART MAGRUDER, NMSS, FCSS, SPB

TAD MARSH, NRR, DLPM

ALEX MURRAY, NMSS, FCSS, SPB

JAMES TATUM, NRR, DASSA, SPLB

LEN WARD, NRR, DSSA, SRXB

ALSO PRESENT:

KEN ASHE DCS

W I L L I A M L . B R O W N

Westinghouse

JOE CLEARY Westinghouse

DAVID CONSTANCE Entergy

BOB HAMMERSLEY Westinghouse

JERRY HOLMAN Entergy

ED LYMAN Union of Concerned Scientists

TIM MITCHELL Entergy

DON P. SISKA Westinghouse

SHARON STEELE DCS

JOSEPH VENABLE Entergy

A G E N D A

P R O C E E D I N G S

(8:31:38 a.m.)

DR. WALLIS: This is the first day of the 519th Meeting of the Advisory Committee on Reactor Safeguards. During today's meeting, the committee will consider the following: power uprate for Waterford Nuclear Plant, mixed oxide fuel fabrication facility, and the preparation of ACRS reports.

This meeting is being conducted in accordance with the provisions of the Federal Advisory Committee Act. Dr. John T. Larkins is the Designated Federal Official for the initial portion of the meeting.

We have received no written comments from members of the public regarding today's sessions. We have received a request from Mr. Lyman, Union of Concerned Scientists, for time to make oral statements regarding MOX fuel fabrication facility. That will be this afternoon.

A transcript of portions of the meeting is being kept, and it is requested that the speakers use one of the microphones, identify themselves, and speak with sufficient clarity and volume so that they can be readily heard.

I have a few items of current interest.

I'm very happy to announce that Erik Thornsbury has been selected as a Senior Staff Engineer for the ACRS, and he will be joining us soon. Since October, he's been assigned to the EDO's Nuclear Security Special Projects Team, and we've heard some of his presentations.

Prior to that, Erik spent eight years as a Reliability and Risk Engineer in the Office of Research. His recent activities have been focused on the assessment of potential vulnerabilities and mitigation strategies for nuclear power plants for security events. Erik also has significant risk assessment experience in pressurized thermal shock, digital instrumentation and control, and reliability analysis. Erik has a B.S. in mathematics and physics from Cumberland College, Kentucky; an M.S. in nuclear engineering from the Ohio State University, and is currently working toward a Ph.D. in reliability engineering at the University of Maryland, so please welcome Erik.

A few items of interest have been handed out. Notice that there are a few SRMs, press releases on the new commissioners, and you may have an interest in the draft program for the regulatory information conference.

I'd like to proceed with the meeting.

MR. DURAISWAMY: May I?

DR. WALLIS: Yes.

MR. DURAISWAMY: The proposed schedule for the Quadripartite Meeting, take a look at it.

DR. WALLIS: Oh, we have a handout. Please look at the schedule for Quadripartite Meeting suggested here. We will discuss that later today. Anything else, Sam?

MR. DURAISWAMY: That's it.

DR. WALLIS: Okay. Tad Marsh, would you get us going, please.

MR. MARSH: Yes. Good morning, Mr. Chairman. Thank you. My name is Tad Marsh, and I'm the Director of the Division of Licensing Project Management in the Office of Nuclear Reactor Regulation.

As you'll see, behind you we have a large contingent of staff and management here to support this meeting, and we are ready to discuss any issue that you'd so choose, but it's a full audience on this side.

The purpose of our briefing today is to present to you our review of Entergy's application for an extended power uprate for Waterford Unit 3. If the

8 percent uprate is approved, it will be the largest power uprate, although not the only power uprate for a PWR in the United States. Waterford 3 will be operating at a core power level of 3,716 megawatts thermal.

Our review of the proposed EPU for Waterford is the first one to be completed using the new review standard, RS-001. We have presented this to you several times in the last year, including the Standard Review Plan Section 14.2.1, which is a new Standard Review Plan Section associated with large transient testing.

The Staff's review of Waterford uprate application was challenging, and the Staff required a substantial amount of additional information from the licensee to complete its review. Even up to the last few days, we've been dialoguing with the licensee and the vendor on issues associated with this review.

Now this was the first review associated with large transient testing for a Pressurized Water Reactor, and the Staff set the standard high, and followed the SRP associated with this issue. You will hear more about that as we present to you the results of our review.

The review was thorough, and it followed

Waterford's application, and took a substantial amount of Staff resources and licensee's resources. We have come to resolution on the open issues which we described to you at the subcommittee. However, the licensee will need to supplement its application, and the Staff will need to amend its Draft Safety Evaluation to address these issues. You will hear today the information that will be contained in the amendment and the supplement safety evaluation itself.

Stepping back a little bit from Waterford EPU in particular, going to power uprate in general; as I said, this is the first application of the Review Standard, and we believe that the Review Standard is a very thorough, very complete document which helped us in our technical reviews. However, we did notice, and we discussed this at the subcommittee, that it required more Staff hours, and more interactions than we have seen before in past uprates. And this experience is borne out not just by Waterford, but by the other ongoing EPU applications which we are reviewing.

We believe this more than anticipated Staff hours was caused by a couple of things. First, this is a new Review Standard, and this is the first application or the first time the Staff has used the

Review Standard, so it's a thorough document, and it has guided us appropriately, and it has led us to more thorough, more complete documentation, so we believe that's an element.

We also believe that the industry is being guided by this first application of the Review Standard; that is, its thoroughness, and its completeness has led to more interactions needed with licensees. We are seeing that. We also have ongoing, stepping back even one step further, concerns expressed by the industry in general, not associated with power uprate, about RAIs, Request for Additional Information, and the extent to which maybe the licensing process needs to be looked at in terms of RAIs. That's another backdrop to this increased interactions.

We do believe that is a very thorough review, and it was complete, and we are satisfied with the extent that this Review Standard was developed and used. We intend on issuing, though, a Regulatory Issues Summary later this year to address thoroughness and completeness in applications associated with the Review Standard, so we could end up with a more efficient process.

Thank you very much for the attention and the introduction, and I'd like to turn the presentation over to the Project Manager for Review Standard, Kaly, who will be doing an introduction and also leading us in the presentation; unless there's any questions, sir.

MR. KALYANAM: Good morning. My name is Kaly Kalyanam. I'm the Project Manager for Waterford 3, and I'm going to make a brief presentation on the background and some of the open items we have from our last meeting.

Okay. The plant was originally licensed in 1985 for a reactor core power of 3390 megawatt thermal. And back in 2002, we granted a recapture uprate up 1-1/2 percent increase, not to exceed 3441 megawatt thermal. Now this current extended power uprate requests an increase of 8 percent power level, the core power now takes it 3716 megawatt thermal.

As Tad pointed out, this is the largest PWR increase to-date. And some of the major plant modifications that are planned are the high pressure turbine is being upgraded, and the main generator is being rewound and provided with the associated auxiliaries, install higher capacity circuit breakers, disconnect switches and press work, main transformer modifications are being done, and the control rods for the heater drain system and the reheat system safety valves have been done, and the condenser tubes are being stayed.

DR. WALLIS: You also have slightly more enriched fuel. Is that right?

MR. KALYANAM: No, I don't believe so.

DR. WALLIS: It's the same fuel?

MR. KALYANAM: Same fuel.

DR. WALLIS: And the same steam generators.

MR. KALYANAM: Yes, sir.

The EPU Implementation Schedule is as follows; plants implement this in one increment, and completion of plant modifications necessary to implement the EPU are planned prior to the end of the refueling outage 13 in the spring of 2005, another couple of months. With the approval of this license amendment request, the plant will be operated at the higher power level of 3716 megawatt thermal starting in Cycle 14.

We briefly discussed the Staff review approach. The first PWR EPU to follow the Review Standard 001, we replaced the Standard Review Plans and used acceptable codes and methodologies. There were requests for additional information. We received a total of 32 supplements, and we did perform audits and independent calculations in selected areas.

Now in the subcommittee briefing, we talked about four issues that were on consensus path and close to resolution, and let me briefly touch them. The first one is the alternate source term amendment, and the reviewer gave the presentation on that. And to summarize that, the review is proceeding on schedule, and we do not anticipate any surprises. And the AST amendment will be issued by mid-March, 2005. And it will be a prerequisite for EPU amendment issuance, and the EPU Safety Evaluation would reflect this, so we consider that this is no longer an open issue and it is closed.

The other three issues that were items referred as open last time were the three-second time delay between the steam generator tube rupture and the loss-of-offsite power, and potential aging effects on reactor vessel internals, the EPRI, MRP report and accounting for instrument uncertainty.

These three issues have been resolved and closed with either a commitment or condition in the amendment from the licensee which is on the docket. The staff essay will reflect this.

Now finally, as the agenda would indicate, we have the boron precipitation issue and the large transient testing issue which will be presented before the committee by the licensee, followed by the Staff review. Also, we have the licensee present the comparison between the Waterford 3 and Palo Verdi steam dryers. I believe this was an item of interest in the last subcommittee briefing.

With this, I hand it over to --

MR. MARSH: Mr. Mitchell.

MR. KALYANAM: Yes.

MR. MARSH: Okay. Thank you, Mr. Chairman.

DR. WALLIS: Thank you. Please go ahead when you're ready.

MR. VENABLE: Yes, sir. Thank you. Good morning, Mr. Chairman and Committee Members. My name is Joe Venable. Tim Mitchell will be following me. I am the Site Vice President at Waterford 3. I'll just take a minute to communicate my views on Waterford 3's power uprate, and then we'll get right into it with Mr. Mitchell.

First, I really appreciate the review process for this power uprate that we're undergoing. It has been, as Mr. Marsh said, challenging, systematic, and very thorough. We've incorporated industry lessons-learned, extended our Entergy and NRC reviews, and explored new areas affected by this power uprate. We have also addressed some longstanding issues, reactor-type specific, while doing this power uprate evaluation. We'll discuss some of those again today.

Waterford has performed focused reviews of this uprate with independent both internal and external assessments during the engineering evaluation and the design process. I am personally satisfied that this is a safe uprate for Waterford 3, and appropriate. This is important for Entergy Louisiana, and a benefit for our customers. It is a key part of the stabilization of the rates paid by our customers in our area, and as such it has key interest from our Public Service Commission.

Thank you for your attention, and I'll turn it over to Mr. Tim Mitchell, and we can discuss the issues at hand. Thank you.

MR. MITCHELL: Good morning. I'm Tim Mitchell. I'm Engineering Director at Waterford 3. I've been with Entergy about 15 years in various capacities, or a little over 15 years. I do have a previous SRO on a CE unit, and of significance, I was the Ops Manager during the ANO2 power uprate.

I'm going to provide a brief overview. Some of this will be redundant with what we provided in the subcommittee meeting, so I'll keep it at high level. We have a number of people here to support our presentation and answer questions, and I will go through and introduce the primary presenters. The introduction was provided by Joe Venable, and as I stated, I am providing the overview. Boron Precipitation, Mr. Jerry Holman will provide that presentation; Large Transient Testing will be then provided by David Constance; Steam Generator Dryers will be Don Siska. I'd also like to note as part of this introduction that we've had an extensive Staff review. I'd like to concur that that Staff review has been challenging and thorough, and I believe it has resulted in a better product as a result of that review.

A little bit on overview. This project has been a significant project for us. We've had the large resource commitment, and more than three years of commitment to this project has had a significant fleet involvement from Entergy, as well, so it is not just a single unit. We've got a lot of expertise within the fleet that we called in to support this project.

A significant benefit from this for us has been the improvement in our design basis, not only in understanding of the design basis, but also improvements in design basis, bringing it up to today's standards. We have focused a lot on oversight and rigor, we have a Director level, Project Manager or Project Lead for this, Mr. Ted Leonard. And we've had multiple corporate-led assessments to make sure that we were doing the right things. We kicked it off with what was called the Red Team Assessment to make sure that we started off with Lessons Learned from the ANO-2 power uprate.

Last October we had a large assessment to review our readiness, as well. It warrants noting. It was a 12-member team, 11 of which had previous uprate experience, and four were from outside Entergy. And we continued to monitor engineering product quality through this, and had several individual assessments on that product quality.

We have considered industry operating experience as part of this effort, and have gotten a lot of information through a number of sources, including INPO. And as I mentioned previously, we also learned from the Staff review. As Kaly noted, this submittal was per the Draft Review Standard, RS-

001, for extended power uprates.

Now I was going to cover a high-level description of the plant. Kaly has already pretty well hit this, but we are a combustion engineering plant, and we will be going to 3716 megawatts thermal with this project.

The project team included Entergy, and as I mentioned both Waterford people and fleet people, Westinghouse, Enercon, and then Siemens-Westinghouse for the turbine.

This is a repeat list of what Kaly went over of significant modifications associated with this effort; replacing the high pressure turbine steam path is the most significant of the modifications here. The rest of them, including the generator rewind, will address some issues with the plant and make the plant more reliable after a power uprate.

From engineering plant impacts, safety systems, you can see that we did not require changes to these systems. I do want to talk briefly about the fuel minimum requirement. We did need to raise the level in fuel oil tanks. As part of that, we have created an operator burden for the operators refueling the tanks, and we have made a commitment by December of 2006 to provide additional storage capacity.

From a safety analysis standpoint, we have globally revised the safety analysis for this effort for extended power uprate, and we have rewritten the safety analysis report. It was an extensive scope, and we've had intrusive reviews by the vendors.

DR. BONACA: Did you have to adjust your set points in the reactor protection system?

MR. MITCHELL: We had one set point in the reactor protection system, the steam generator low pressure, that was adjusted, and we have a tech spec change that has gone through on that.

DR. BONACA: Okay.

MR. MITCHELL: But only the one.

DR. BONACA: You have now less DNBR margin, a margin for loss of flow?

MR. MITCHELL: I'm sorry?

DR. BONACA: You have lower DNBR margin for loss of flow now?

MR. MITCHELL: Actually, I believe it stays relatively constant. Jerry Holman, can you answer that?

MR. HOLMAN: I'm Jerry Holman with Waterford 3. The DNBR margin for the loss of flow stays relatively constant. We did analyze that event explicitly, and it shows acceptable results.

MR. MITCHELL: Okay. Now a little bit about control room habitability. As previously mentioned, we are going to alternate source term. We did do the tracer gas test back in April of 2004. That submittal has been submitted, and is in review, and it does meet 10 CFR 50.67 and general design criteria, 19 acceptance criteria.

From a PRA standpoint, our conclusions from that PRA is the model elements reviewed for impact, we have a minor reduction in operator recovery times. From an external event standpoint, a slight increase in core damage frequency, but it did not change our operator response time.

DR. APOSTOLAKIS: Which times are you referring to; the reduction in operator recovery times?

MR. MITCHELL: Jerry, do you want to cover that.

MR. HOLMAN: Okay. I'm Jerry Holman from Waterford. The reduction in time is a function of the higher decay heat. It's really looking at a time to reach core uncovery following let's say a loss of all feedwater, so we changed — as a result of the higher decay heat, that time changed roughly from 83 minutes, I believe, to 68 minutes for power uprate.

DR. APOSTOLAKIS: For which action, for which sequence?

MR. HOLMAN: That would be for the time to recover off-site power or --

DR. APOSTOLAKIS: Off-site power.

MR. HOLMAN: That is the time for core uncovery that's used in that recovery time for off-site power.

MR. MITCHELL: Okay. A little bit I want to talk about from conclusions. We worked through the issues, as Kaly talked about --

DR. APOSTOLAKIS: Excuse me. Back to 12; so you're showing the Delta CDF and Delta LERF. What is the baseline CDF?

MR. MITCHELL: Baseline CDF, I'll let Jerry cover that also.

MR. HOLMAN: Baseline CDF for power uprate was 6 times 10 to the minus 6.

DR. APOSTOLAKIS: What do you mean "for power uprate"? That was before the uprate, right?

MR. MITCHELL: The question is before the uprate; what is it before the uprate?

MR. HOLMAN: I don't have that number off the top of my head, but I can get it for you.

DR. DENNING: You can see from that it

doesn't change.

DR. APOSTOLAKIS: I know.

MR. ROSEN: Can you talk about this slight increase in the fire CDF, as well?

MR. MITCHELL: Yes, sir.

MR. ROSEN: What is that?

MR. HOLMAN: The increase in the fire CDF was also driven by the very small changes in operator action times, and the change in time for core uncovery.

DR. POWERS: I guess what we're struggling a little bit with is if 3.5 times 10 to the minus 7 gets put on the slide, how small is a slight increase?

DR. KRESS: For the --

DR. POWERS: It must be less than that.

DR. KRESS: Yes. It was on the order of 10 to the minus 9, was the slight increase for fire CDF.

DR. POWERS: You have an extraordinarily precise fire analysis, obviously.

DR. KRESS: Do you ever do a level 3 PRA for this site?

MR. HOLMAN: No, we have not done a level 3 PRA.

DR. APOSTOLAKIS: Now your PRA has been

reviewed by the industry that went through the NEI --

MR. HOLMAN: Yes, we have gone through a certification review with the Owners Group.

MR. MITCHELL: Okay. Any other questions on PRA?

DR. BONACA: Well, I wasn't on the subcommittee. I wonder if you explored -- I mean, how complete is the PRA in addressing the effects of the power uprate? There are certain issues to do with the dryers and things which are discussed later. Possible frequency of failures of those components, or impact of those margins are not really included in this PRA. Right?

MR. HOLMAN: We looked at all of the major events for the PRA, including initiating events, failure rates of equipment. We looked at success criteria. We also did some more specific and detailed thermal hydraulic analyses to determine operator action times. So we've looked at all of those elements and folded those changes into the revised PRA model. As I mentioned before, the only changes were to the operator recovery time based on shorter time to core uncovery as a result of the higher decay heat.

MR. MITCHELL: And as an extension beyond the PRA, we've gone through and looked on a component level at various components throughout the plant to look at where their new operating ranges were, where valves would be opening or cycling at different positions, looked at maintenance histories, looked at what we need to do in this upcoming refueling outage to ensure their reliability, as well, so that's beyond the PRA.

DR. KRESS: Well, what would be a good number for an average population density around the site?

MR. MITCHELL: Within a five-mile radius, there's roughly 13,000 people. Within ten miles, it's a little larger. I don't have that exact number - we can get it. We have information.

DR. KRESS: How far away is New Orleans?

MR. MITCHELL: New Orleans - I think we discussed that in the subcommittee - it's roughly 30 miles away.

DR. BONACA: You gave us here a CDF increase, LERF increase. Is also late releases pretty much the same for the plant uprated, or is there an effect on that?

MR. MITCHELL: Do you understand the question, Jerry?

MR. HOLMAN: Yes. We concentrated our

evaluation on the large early release. We did not explicitly look at late releases. I would not expect to see much of a change there.

DR. BONACA: Yes. My line of questioning really is going in the direction of understanding to what extent the model truly represents a risk increase level in absolute, and whether or not there are elements that really are not modeled here. And I would daresay that there are some that are not modeled because some we don't have experience about operation of some components in this kind of regimes.

DR. DENNING: Let me make a comment. I think that you're absolutely right, Mario, that some of the things that concern us about the uprates that could lead to vibrations of components and things like that, they would not have been included in the initial PRA, and they're not included in the modified PRA.

DR. BONACA: Okay.

DR. DENNING: We've got latents I think that core damage frequency is a pretty good surrogate here for how big is the total impact.

DR. BONACA: Yes, and I agree with that.

MR. HOLMAN: We'll also be performing monitoring programs, so we'll be able to detect any changes as we update our PRA model, fold that into the updates.

MR. MITCHELL: And I think you'll see when we provide the presentation on the dryers, that we've looked at dryers, in particular, as well as a number of other components, but we will -- I think the dryers will be representative of what we looked at overall.

DR. WALLIS: Okay. Thank you.

MR. MITCHELL: Okay.

DR. RANSOM: I had asked a question last time about the pumps. You know, the pumps and motors are operating at about a 5 percent increase in power, and I'm wondering what effect does that have on the overall accident frequency?

MR. MITCHELL: You're talking reactor coolant pumps. Correct?

DR. RANSOM: Right.

MR. MITCHELL: Okay. Reactor coolant pumps, essentially their most severe load is in mode-5 operation when the density of the fluid in the reactor coolant system is cold, which is not affected by power uprates.

DR. RANSOM: That's where their maximum load is seen.

MR. MITCHELL: Right. So at full power, there's not a significant different in the motors, the loading on the motors or the pumps. There's only --

DR. RANSOM: About 5 percent, actually, just due to the density increase of the fluid.

MR. MITCHELL: There is a minimum RCS change, a flow number that we expect to change, or a number that we expect to change. Actually, the actual number we expect to change smaller than that 5 percent, so the change in reactor coolant pump performance is negligible. We will not see a significant difference from the old 100 percent to the new 100 percent.

DR. RANSOM: is there a basis for that, or experience, or what?

MR. MITCHELL: Predominantly, it's that the severest load is, like I said, under cold conditions when you're starting the pumps for the first time. Once they're up and running, and at full power densities, the Delta between those two is very small.

DR. RANSOM: Okay.

MR. MITCHELL: Ten-mile cumulative population is 91,116, so that's help with local population.

From a conclusion standpoint, we have worked through a number of issues. As stated, even up through yesterday, we've continued to have dialogue. We have commitments in place to address each. AST, Alternate Source Term, does remain on track for completion of Staff review on schedule, so with this presentation, we will show you that the uprate will be a benefit to the plant, and is safe to go forward.

Now I'm going to turn over the presentation to Mr. Jerry Holman for discussion of boric acid precipitation, consideration of voiding in this topic is not a new issue. It actually dates back some number of years. It's not really an error, but it was a conscious decision in that time frame to simplify the model. Jerry is going to talk through some additional work that we've shown to show the conservatism in the long-term cooling capabilities, and all this information has been submitted and docketed, and challenged by the Staff. Even though this information is on the docket, we will provide further clarification as an update to our licensing basis, our design basis. And Jerry is going to provide more details on that, so I'll turn it over to Jerry.

MR. MARSH: Jerry, this is Tad Marsh. Good morning. I just want to verify that there is no proprietary information that's being discussed here.

Is that right?

MR. HOLMAN: We have no proprietary information in the slides that we're going to present.

MR. MARSH: Thanks, Jerry.

MR. HOLMAN: Okay. Good morning. I'm Jerry Holman. I've been working at Waterford for 22 years. I'm going to talk about the boric acid precipitation issue. The long-term cooling analysis is done to determine the potential for boric acid precipitation after a large break LOCA. Boiling in the core leaves boron behind, causing the concentration of boric acid to increase in the core. The post-LOCA long-term cooling analysis is done to determine the time for operator actions in order to prevent boron precipitation.

DR. WALLIS: I have a question about this. When you say it's for the large-break LOCA only, you are concerned about this?

MR. HOLMAN: For the small breaks, you refill the RCS and distribute the boron to the core throughout the RCS.

DR. WALLIS: But during the small break, the core is uncovered for half an hour or something like that, and it seems to me that the liquid is splashing up onto these tubes. And presumably, when the steam goes off the liquid, what's left behind is boron, so the tubes return the region of both the pool, presumably gets spattered with boron over quite a period of time, don't they?

MR. HOLMAN: Joe, could you address that?

MR. CLEARY: My name is Joe Cleary, from Westinghouse. Yes, the observation is correct that that would be a phenomenon that would occurring during a small break LOCA, and that phenomenon, the general evaluation of boric acid precipitation for such small break LOCAs is not explicitly done. One of the major reasons for that is the high pressure associated with a small break LOCA is at the point where the boric acid solubility in the water would be essentially 100 percent, so within the two phase region there is no potential for boric acid precipitation prior to the reflood of the core. However, there has been, to my knowledge, no assessment of the amount of boric acid build-up on the fuel rods during the period of time for limiting small break LOCAs --

DR. WALLIS: Well, solubility doesn't really matter because if you're going to evaporate all the water, then what's left behind has to be the boric acid.

MR. CLEARY: I understand your --

DR. WALLIS: You have no concerns with this? You say it's not really considered, but this is something which happens. But has it not been a concern in the past? Does the Staff have any reaction to that?

MR. WARD: This is Len Ward from the Staff. The evaluation model, CENPD-254 that Westinghouse has developed addresses small breaks and large break LOCA. To give you some perspective, simultaneous injection is a mechanism that is designed to control a large break LOCA. That's where you split the high pressure safety injection between the hot side and the cold side, and it flushes it out for large breaks.

For small breaks, because you're at elevated pressures, when you switch to simultaneous injection, there isn't enough flow either into the hot side or the cold side to flush the core, so you have to do something else. So what you do is you do an analysis for a whole spectrum of breaks, and these — this is from a break size - the smallest break size where charging just is — where the break flow is just in excess of charging. That defines a really tiny break. WE analyze all the way up to a double-ended break.

Now like I said before, because small breaks remain at elevated pressures and we switch to simultaneous injection, simultaneous injection will not flush the core. So what you have to do is an analysis of system response, and what you can show is for the small breaks, and you run them out - these analyses are run out to six, seven, eight hours. The system will refill. For those breaks which cannot be flushed, they will refill, and you will re-establish single-phase natural circulation. That will mix the boric acid throughout the primary system, so you don't have to rely on simultaneous injection.

Now during these small breaks, 05 square feet and the range that's uncovering, you're not concentrating a lot. The injection into the system is from one high-pressure pump. The boil-off is really low. You are concentrating, and even if you do concentrate some fairly high values, because you're up at two and three hundred pounds, the saturation temperature is huge. You don't even get anywhere near the precipitation limit. And because the system refills and re-establishes single-phase natural circulation, it disburses the boron.

That analysis is key ingredient into this evaluation model. They have addressed small breaks.

The real issue is the large breaks where you're trying to define a time to simultaneous injection, and that's what we're focusing on here, is large break LOCA.

DR. WALLIS: I understand all of that, but you didn't answer my question about the spattering of borated water onto these rods, and the drying out of that, same things happen in the superheated tubes in the boiler, any kind of non-soluble material is left behind when you dry out this liquid which is deposited on the tubes. This, apparently, hasn't been a concern from NRC side or from vendors' side. Is that true?

MR. WARD: That's true.

DR. WALLIS: Is it something which should be looked at? I'd like to know how much of this boron is deposited during this period when -- a rather long period where the tubes are steam cooled. It's not really steam because it has liquid in it.

MR. WARD: Well, it's about a 45-minute period where the core is uncovered.

DR. WALLIS: That's right.

MR. WARD: That's the period where you're concerned with?

DR. WALLIS: That's right. And suppose that you plug up those tubes with boron deposits during that period, what happens when you then reflood then?

MR. WARD: Well, I guess I would ask -- we would need to ask ourselves how much boric acid do you need to plug the core.

DR. WALLIS: Yes, you would.

MR. WARD: And I don't think you're going to -- my initial reaction to that is there's not enough boron produced in 45-minutes to do that. If you look at the slides I'm going to show you on how much boron builds up in 45-minutes from the initial concentration, it's not very much.

MR. MARSH: Mr. Chairman, why don't --

DR. WALLIS: Yes.

MR. MARSH: This is Tad Marsh from the Staff. We understand this question. Why don't we table this for the moment, if we can.

DR. WALLIS: You'll give us an answer today?

MR. MARSH: Excuse me?

DR. WALLIS: Will you give us an answer today?

MR. MARSH: No, we won't give you an answer today.

DR. WALLIS: When will we get the answer?

MR. MARSH: What I'd like to do is table

this, if we can, until you hear his presentation.

DR. WALLIS: Okay.

MR. MARSH: And then we will discuss how to go forward generically.

DR. WALLIS: Sure.

MR. MARSH: Okay? Because this is not a plant-specific issue.

DR. WALLIS: I agree, it's a generic one.

MR. MARSH: Good. If we can do that, that would be great.

DR. WALLIS: Yes. Sure, that's fine. Let's move on then.

MR. HOLMAN: Okay. The Waterford 3 long-term cooling analysis currently uses a collapsed water volume from the bottom of the --

DR. WALLIS: I want to ask you about that, too. I'm sorry. I'm trying to understand. Does that mean that you include the fluid in the upper plenum? It all collapses down into the core?

MR. HOLMAN: That effectively is what it means, that we --

DR. WALLIS: The difference is that the NRC says you don't count the stuff in the upper plenum, you just count the liquid in the core. And you mix in that volume. Is that what the difference is?

MR. HOLMAN: That's correct. The NRC Staff Review focused on voiding in the core, and that assumption of the collapsed liquid volume.

DR. WALLIS: Why is it expected that the mixture on the upper plenum doesn't get involved in the mixing?

MR. HOLMAN: Well, I guess the assumption of the collapsed liquid volume was a simplification when the models were developed, and it was evaluated that that assumption was bounded by additional conservatisms. And in my presentation here today, we're going to quantify and show those conservatisms and demonstrate that --

DR. WALLIS: Actually, your case is going to be rested on the answer with lots of conservatism. You're not going to take credit for the conservatism. You're going to say everything is okay, and it's really better because.

MR. HOLMAN: That's correct. We intend to show that there remains conservatisms in the analysis.

DR. WALLIS: So you're going to throw away the mix, the fluid in the upper plenum. It's not going to take part in the mixing. Is that right?

MR. HOLMAN: The upper plenum will have

some of that boric acid, and it will contribute to the mixing volume.

DR. WALLIS: In your conservative analysis, you don't consider it.

MR. HOLMAN: In the conservative analysis, we do assume the mixing volume up to the top of the hot leg within the upper plenum.

DR. WALLIS: That's all. That's the only stuff which mixes.

MR. HOLMAN: We're including, obviously, the volume in the core, and we're going to talk about the volume in the lower plenum.

DR. WALLIS: The top of the hot leg.

MR. HOLMAN: Up to the top of the hot leg in the additional calculations that I'm going to describe today. The current existing licensing basis calculation assumes a collapsed liquid volume from the bottom of the core to the bottom of the hot leg.

DR. WALLIS: So you have to change your licensing basis somehow.

MR. HOLMAN: And we'll discuss that.

DR. WALLIS: Yes.

MR. HOLMAN: We performed some additional supplemental calculations and discussed that with the staff. These additional calculations explicitly account for voiding in the core. We account for mixing in the lower plenum, which we'll discuss some more in just a moment. We assume mixing of the boric acid makeup tank and the refueling water storage cool water before it reaches the core. We're using a best estimate 1979 ANS Decay Heat Values. We're also crediting containment pressure of 20 psi in order to elevate the -- precipitate the solubility limit, and we're also accounting for the effect of trisodium phosphate in increasing the solubility limit.

DR. WALLIS: Now the container pressure effect is on temperature, presumably; a saturation temperature. Is that its effect?

MR. HOLMAN: Yes.

DR. WALLIS: Only changes the solubility limit. It doesn't change the actual concentrating process.

MR. HOLMAN: There is a small secondary effect on the --

DR. WALLIS: But it's a small --

MR. HOLMAN: -- boil-off, but it is a very small effect. The primary effect of containment pressure is on the solubility limit.

Okay. With those assumptions, our supplemental calculations show that we reached a boric acid concentration of 17.2 wt% at three hours. Three hours is the longest time that the operator would have to take his actions to prevent boron precipitation. That 17.2 wt% compares to solubility limit of 40 wt%, so there's a large margin to the precipitation.

DR. WALLIS: The CE plan is equipped with injection in both hot and cold legs?

MR. HOLMAN: That is correct. Waterford has the capability to inject in both legs simultaneously.

DR. WALLIS: So it's up to the operator to manipulate this injection?

MR. HOLMAN: Yes.

DR. WALLIS: But he doesn't know what the boron concentration is. He just has to follow some procedures.

MR. HOLMAN: That's correct. He follows the time after a LOCA.

DR. POWERS: Where you have cited the solubility limit, did you know what the source of that is?

MR. HOLMAN: I'm sorry. Say again.

DR. POWERS: Do you know what the source on your solubility limit is?

MR. HOLMAN: Joe or Bob Hammersley.

MR. HAMMERSLEY: Bob Hammersley from Westinghouse. I think the question was what was the source of the solubility limit? The solubility limit was determined from experiments that we were doing to investigate the impact of TSP in solution with the boric acid.

MR. HOLMAN: We'll talk about how we determined the 40 wt% solubility limit in just a moment.

DR. SHACK: You're taking credit for those TSP.

MR. HAMMERSLEY: The basis is experiment.

DR. POWERS: I guess I was looking for a little more. It's an experiment I can examine, or is it one that was done in-house?

MR. HAMMERSLEY: It was an experiment that was done following the subcommittee meeting, when those questions were asked, so it's been done and documented since that meeting to before this meeting.

MR. HOLMAN: We'll provide a little more discussion of how we came up with that --

DR. WALLIS: So it's been done in the last couple of weeks?

MR. HOLMAN: The effect of the TSP has been --

DR. WALLIS: Determining the solubility limit? So you've been boiling boric acid mixtures?

MR. HOLMAN: That's correct.

DR. WALLIS: And did you also look at the effect of the concentration on the drift flux and the formability of this stuff as it gets concentrated?

MR. HOLMAN: Let me get to that part of the presentation, and we'll go over those questions.

DR. WALLIS: Okay. Thank you.

MR. ROSEN: Could I hold you here? It's instructive to me to look at your left diagram in relation to the discussion we had before about what you include are the upper plenum. In the upper plenum you said it's included up to the top of the hot leg, if I'm correct; which means it's included basically. Is that correct?

MR. HOLMAN: In the supplemental calculations, yes.

MR. ROSEN: Because the top of the hot leg is up at the top of the upper plenum almost.

MR. HOLMAN: That's correct.

MR. ROSEN: Okay.

MR. HOLMAN: Okay. As I mentioned, in our supplemental calculations we took credit for mixing in the lower plenum. That result comes primarily from the BACCHUS test results. Bill Brown from Westinghouse is here to talk a little bit more detail of the BACCHUS test results.

MR. BROWN: Bill Brown from Westinghouse.

DR. WALLIS: Welcome back, Bill. We've seen you before.

MR. BROWN: Hi guys. I'm a thermal engineer with Westinghouse. I've had about roughly 25 years of experience in testing design thermal hydraulics. Early years spent primarily with the Seawolf and Trident class submarine designs and testing, and Japanese PWRs, thereafter; most recently with this illustrious group with AP600 and AP1000 for the last 10 or 15 years.

I want to talk a little bit about the BACCHUS test facility, which was a test facility which was designed by Mitsubishi. They had interest in studying mixing within the reactor vessel, a PWR. They were looking primarily at the mixing between the core region relative to the lower plenum that was of specific interest, so what they did was they essentially have a slab-type geometry, which really represents a vertical slice through the reactor. It's full-scale, full-height. It's roughly 9 meters tall. The slices may be roughly a half a meter wide, represents roughly a fuel assembly. The fuel assemblies are fairly prototypic in their modeling, and as you notice in the diagram, we have a full simulation also of guide tubes and structures within the upper plenum, as well as within the lower plenum and the core. There is a downcomer. The hot leg off to one side with a separator to separate the phases, and there is instrumentation located in 24 locations throughout the facility to measure both temperature and boron.

DR. WALLIS: To understand, Bill, if you took the BACCHUS facility and put it in the core it would look like that little rectangle.

MR. BROWN: Yes. Right. Basically, this slice right here is what you're seeing. So essentially in this facility, you're not looking at measuring the circumferential effects. Primarily you're looking at the lateral or the radial, and primarily the vertical effects.

The anticipation was, which also the data indicates, that the primary mechanism being that it's really a density-driven, it's a really-type instability, so they were really concerned to make sure that they had everything in the vertical axial direction scaled as well as they possibly could.

DR. WALLIS: Why would mixing in a little thin slice like that be the same as mixing in a big vessel?

MR. BROWN: In the vertical region, in the axial plain, I guess, since it's essentially a density-driven phenomenon, I mean the only thing you're really missing here is anything that's primarily a circumferential mode, which I would not expect to be very large at all, and probably might even help. But, essentially, you're really talking about sort of a 2-D type of effect, and it's primarily driven by density.

Basically, the core boils off enough concentration of boron to the point where you offset the Delta T, and when you get to that balance where you overcome the density effect of the concentration, the boron starts to fall into the lower plenum.

DR. DENNING: And what do you think that cell size looks like? I mean, if it falls — it's a critical question, I think, as to what do you really picture in your mind as to what that cell size looks like over which the circulation occurs, because if it's going down one area, it's going up some other area. Right?

MR. BROWN: Yes. I mean, if you certainly picture this - I mean, it's similar to thinking what happens in ocean circulation, essentially replace the sun warming the surface of the water and evaporation with the core heat boiling that away, and replacing salt with boron. And in those situations, and certainly at moderate really numbers you would expect to see sulfinger type of patterns. But I think at the velocities and the high raily numbers, if you use the -- if you were to imagine the full length of the upper and lower plenum as a cell, you end up with some pretty high raily numbers, so I would expect at that point that it probably would actually transition into something that's certainly more turbulent than just sulfingers. It probably would get into another instability which would start to mix those, as well.

DR. WALLIS: I should point out to the full committee that we didn't see any of this at the subcommittee meeting. The reason we have such a long meeting this morning is that we're being presented with material which normally we would first see at the subcommittee meeting, but since we have the time, we're having it presented this morning.

DR. KRESS: Speaking as a member of the Thermal Hydraulics Subcommittee, I think you can be sure that a two-dimensional mockup of a threedimensional phenomena for mixing can be shown to be conservative.

MR. BROWN: Conservative, yes.

DR. KRESS: And I think that's the key part of what you said.

MR. BROWN: Right.

DR. KRESS: It actually might help if you had the three-dimensionals, but I think you haven't shown that. You're just setting that. I think I would like to see some analysis somehow. I think in a relatively simple analysis you can show that.

MR. BROWN: Yes. In thinking back, some of the AP presentations when we were looking at the containment, and we started off with the 2-D slices, and we went to the 3-D slices at the behest of Dr. Wallis, we showed that the mixing was, in fact, improved in additional modes where --

DR. KRESS: I recall that. That's why I said that, yes.

MR. BROWN: Yes. And I guess that's why I'm using that experience, as well, to --

DR. WALLIS: Are you going to take credit for this mixing process, or are you just going to say that it's an additional conservatism, and if we did take credit for it, things would be better? You're actually going to try to take credit for it.

MR. BROWN: The calculation is taking credit for --

DR. WALLIS: Is taking credit for --

MR. BROWN: Fifty percent of the lower plenum volume, not the entire lower plenum volume.

DR. WALLIS: And you need that in order to meet your solubility limit?

MR. BROWN: I'll let Jerry answer that question.

MR. HOLMAN: Crediting the volume in the lower plenum certainly increases the margin to the precipitation. If we were to not credit any of the lower plenum volume, it would still be less than precipitation --

DR. WALLIS: I thought that was your conclusion. Right. So you don't have to take credit for it. It's just reassuring that you've got a margin there.

MR. HOLMAN: Supplemental calculations that we present do take credit for 50 percent of the lower plenum --

DR. WALLIS: Okay. Well, we'll see those in a while, I guess.

MR. HOLMAN: Yes.

DR. WALLIS: But you don't have to take this credit.

MR. HOLMAN: Obviously, the margin is much reduced without credit for lower plenum mixing.

DR. WALLIS: But you still meet the requirements.

MR. HOLMAN: But it would still be below the precipitation level.

DR. RANSOM: In the test facility, where is the fluid injected?

MR. BROWN: Essentially, they start off filling the system from the top and filling the downcomer, and the lower plenum volumes.

DR. RANSOM: You continue to inject in the downcomer and then boil-off through the --

MR. BROWN: Yes, yes, yes. MHI ran actually two tests, primarily. One started off at a base condition of about 3000 PPM, and then they ran another test that was started off at around 9000 PPM, and both tests showed that when the Delta concentration - you can go to the next slide - in both the tests, when you hit about 8-1/2 percent weight, the balance, the critical density inversion point was reached, and you get to see both the thermal couples and all the thermal couples all the way through the entire lower plenum all the way to the bottom begin to mix, as well as the boric acid --

DR. WALLIS: Now they say that mixing occurs at some point. There's no criterion or something for that?

MR. BROWN: Well, if you really knew the link scale very well you could probably -- at MHI, we have tried to capture that with the raily number, and looking at cell size. Unfortunately, we do not actually have enough probably visual --

DR. WALLIS: So we don't know where to put these curves for a real reactor. We don't know where the same -- where to put this mixing initiates in a real reactor. We assume something similar happens, but we don't really know when mixing initiates, because we don't have a criterion.

MR. BROWN: Essentially, I'm saying this is the criteria. It's really --

DR. WALLIS: At a certain density difference will produce mixing?

MR. BROWN: Yes. And, in fact, I feel even stronger about this because when I've also looked previously at the Finn's that ran a VEERA facility, which is essentially a VDER-type scale, full-height, full-pressure, full-temperature-type facility;

interesting that the density difference when it reached I believe about 7-1/2 percent is what I see in that data - again, the same phenomena occurs that the entire lower plenum begins to mix. So again, it was primarily independent of the time in which you get there. You could take 100 hours to get there. It's really dependent on when you reach the critical concentration --

DR. WALLIS: It's, not just the concentration, it's temperature, too. The temperature is different in the lower plenum than in the core.

MR. BROWN: Yes, it is.

DR. WALLIS: So that affects the density, as well.

MR. BROWN: Yes, it is, and you have offsetting -- right. What you have to do is you have to get that point where you balance the --

DR. WALLIS: You have to overcome the temperature difference.

MR. BROWN: Right. That's right.

DR. WALLIS: Which is why it doesn't start at the beginning.

MR. BROWN: That's exactly right. That's where it is.

DR. WALLIS: So you think there would be

a criterion which says that Delta T, Delta Rho due to temperature, and Delta Rho due to Delta C have to somehow be in balance.

MR. BROWN: Yes, I have that on this slide that I pulled in here for just brevity of the presentation. Essentially, that's what I've got. So in the delta fluid due to the concentration differences is offset by that due to the temperature.

DR. WALLIS: Does that explain when mixing initiates?

MR. BROWN: Yes. Yes.

DR. WALLIS: Now you're giving us a physical argument.

MR. BROWN: Yes. Yes.

DR. WALLIS: Are you going to actually show us those numbers?

MR. BROWN: No, I'm not going to show you MHI's proprietary data. That's why I've drawn this nice little cartoon today. However, it is in the BACCHUS report, which the Staff has, if you're interested in looking at the actual data.

DR. WALLIS: So the number that says that the density difference due to temperature change is balanced by density difference due to —

MR. BROWN: Concentration, yes.

DR. WALLIS: It's in the report that we have here?

MR. BROWN: There is a summary of that in —

DR. WALLIS: It seemed to be all discussion. I didn't see numbers like that.

MR. BROWN: I don't know if you have the BACCHUS report there or not, but we've given that to the Staff.

DR. WALLIS: If we do, maybe you can point to it at the break.

MR. BROWN: Again, that document was primarily intended as a summary document to demonstrate to the Westinghouse Owners Group.

MR. MARSH: Mr. Chairman, this is Tad Marsh. I'm being told that we have provided that report to you.

DR. WALLIS: You have?

MR. MARSH: I'm being told that we have provided that to you. Is that right? Ralph is shaking his head yes.

DR. WALLIS: Okay. So when Ben gets up and presents he can cite a page which we can look at or something. Okay. We need to move on, but I think it would be very useful if there is some kind of quantitative criterion which is believable.

DR. DENNING: Can I ask another question, Graham?

DR. WALLIS: Yes.

DR. DENNING: The bypass region, based upon what you're saying here, your feeling is that that has no real significance towards this effect? What do you think is happening in that bypass region, and are you telling us that it's your belief that that really doesn't affect this mixing behavior?

MR. BROWN: I think that it has a second order effect compared to this mixing mechanism, and as well as any perhaps potential entrainment - while they may exist, I don't think they're the primary mechanisms. And again, looking at these different tests at different scales, there seem to be a fair amount of consistency with looking at the concentration density effect between the upper plenum core region relative —

DR. DENNING: Won't that bypass region be prototypic of Waterford? Does it look basically the same as it does in the MHI —

MR. BROWN: No. In this facility, I would say that the hot leg region does not reflect that. The focus was primarily on the core upper plenum with the guide tubes and the lower plenum, and the downcomer. That was the primary emphasis. It was not trying to demonstrate hot leg gap or entrainment, which certainly are present, but this mechanism seems to explain quite well both the BACCHUS test and the Finnish VEERA test.

DR. KRESS: This cartoon indicates to me that you have some sort of initial concentration in the lower plenum.

MR. BROWN: Yes, you have whatever the --

DR. WALLIS: Whatever the cold leg feeds into it.

MR. BROWN: That's right.

DR. WALLIS: That's where you get that.

MR. BROWN: That's right. And I said, in the one BACCHUS test, it was initially 3000 PPM, and then when they ran another one, it was 10,000 PPM.

DR. WALLIS: Okay.

MR. BROWN: They had very long switch-over times in Japan, so they were interested what happened very far out in a post LOCA environment.

DR. RANSOM: These experiments have a radial power distribution, I assume, similar to the --

MR. BROWN: Yes, they do have some.

DR. RANSOM: And boiling is going on, so

you think the boiling would be the major density difference in the system that would cause recirculation. I know you're assuming a collapsed level, but --

MR. BROWN: Well, within the core region, yes - but not necessarily the lower plenum. This is the mechanism that -- I mean, you could boil all day long and it isn't going to affect the lower plenum.

DR. RANSOM: The point is really you up-flow through some parts, and down-flow through other parts.

MR. BROWN: Yes.

DR. RANSOM: And that's what leads to the mixing in the lower plenum.

MR. BROWN: Once it gets started, I'm saying this is the initiating mechanism. Once that's started, this certainly enhances it, but this is what gets the ball rolling.

DR. WALLIS: Your slide is hibernating. Does it hibernate in the summer, too?

MR. ROSEN: There's a natural length of time that we can dwell on any subject.

DR. WALLIS: Are you going to proceed?

MR. BROWN: I think I've made my case, and I welcome any more questions.

DR. WALLIS: Are you going to talk about this TSP and the basis for your solubility limit?

MR. BROWN: No. My primary purpose is to discuss the BACCHUS test. Jerry will pick up the ret of the presentation after this.

DR. WALLIS: So we're supposed to believe that you have some criterion for the lower plenum to get involved in the mixing?

MR. BROWN: Yes.

DR. WALLIS: And we're not going to see any numbers?

MR. BROWN: Well, what you can do when you see the report is, for interest, MHI has actually tried to use this facility to benchmark a computer code they call EXLOBOCON, and they have used the raily number criteria and played with the length scale to try to match the data. And there is some plots within the BACCHUS test report that --

DR. WALLIS: Yes, I saw that. It's just that this is not a code which is approved by the NRC or anything?

MR. BROWN: No, right. This is purely MHI's code. You've never seen this before.

DR. WALLIS: Right. Could you explain to me what is going on technically now? The computer is being sabotaged by some software of some sort?

(Simultaneous speech.)

DR. DENNING: Could you restate basically your premise? I think your premise is that normal density in core region exceeds the density in the lower plenum that you mix. Is it that simple?

MR. BROWN: Well, it's really when the density effect due to the concentration of boron within the core region exceeds the temperature difference in that region relative to the lower plenum. The difference in density due to the temperature difference. When you hit that point, then you basically have a hot or cold situation. I mean, you could look at it in a crude sense as even when you have a situation that raily originally looked at when you had essentially a cold surface over a hot surface, and you initiate rule cells, for example, in that type evaluation like that. And what's happening here is it takes some time to get enough boil-off to increase the density due to the concentration of boron acid solution with the water to get to that point where you actually are unstable, and you get that disability mechanism.

DR. DENNING: Well, I think what you just said is there are two components to the density; one is temperature, and the other is —

MR. BROWN: Yes, and the other is concentration. That's correct.

DR. DENNING: But you say taking those into account, when the density is greater in the core than it is in the lower plenum, then you mix.

MR. BROWN: Yes, absolutely.

DR. DENNING: But you do that for collapsed water level. Is that a true statement, as opposed to accounting for some boil-up frothing —

MR. BROWN: You're referring to the calculation.

DR. DENNING: Yes, the calculation. When you determine the density in the core region —

MR. BROWN: Well, I would say at this point in time, we're probably - keep in mind, we're in a large break LOCA. Our pressures are rather low, and our pressure differences going out the vessel are relatively small, so we're almost to the point of a static balance, and so whatever void fraction that you have, whatever water level you have above the core essentially is going to be dominated by what's in the lower plenum, so there's not a big impact as far as the gravity head is concerned. It certainly will affect the mixture level that you have, which I'm sure is --

DR. WALLIS: I think what you really are saying is that they're above the holes in the plate there, and there's liquid. It's not totally a mixture.

MR. BROWN: That's right.

DR. WALLIS: So if that's heavier than the liquid below, it's going to go down.

MR. BROWN: It drops. That's right.

DR. KRESS: When you make this NITSDI calculation in the upper plenum, do you assume any of the boric acid goes with the steam as it goes out, or do you just leave it all behind?

MR. BROWN: Well, I didn't make that calculation, but I think in the calculations, I believe you probably assume that the --

MR. HOLMAN: The calculations do not credit any boron acid removal --

MR. BROWN: Right, with the steam. Right. So it's basically steam.

DR. KRESS: I'm worried about that because it's not a credit, it's a debit, because it affects this density calculation you're making in the upper plenum.

MR. BROWN: I would say in the case of

BACCHUS, we certainly got the real fluid --

DR. KRESS: Oh, I'm sorry. I was thinking about the calculation.

MR. BROWN: Yes, I'm saying --

DR. KRESS: You did add the energy.

MR. BROWN: Right. And I'm saying, with respect to --

DR. KRESS: So did the BACCHUS experiment properly do it at the right pressure?

MR. BROWN: Yes. What I'm saying, this is a full-height, full-temperature, full-pressure boric acid solution test.

DR. KRESS: Okay.

MR. BROWN: Yes. That's why I'm saying that the real stuff is in there --

DR. KRESS: It would show up in the --

MR. BROWN: Yes. And I would say the same thing about any drift flux questions that may come about, as well, possibly from some --

DR. WALLIS: Oh, yes. We're going to ask that question, too. Now do we have to move on before the computer gremlin decided to hibernate things again?

MR. BROWN: Do you have any more questions?

DR. WALLIS: We may come back to you. Let's move on for now.

MR. BROWN: Okay. Thank you.

MR. HOLMAN: All right. Let's move on and talk about the solubility limit. Trisodium phosphate is used in the Waterford 3 containment in the sump water to control pH post LOCA to a value near 7. It's stored in granular form in baskets in the floor of the containment in the Waterford 3 containment.

We performed tests with a TSP concentration that's representative of what would exist at Waterford 3. We added boric acid and brought the solution to a boiling temperature, continued to add boric acid until we reached the solubility limit, and determined that that limit was at a concentration of 36 wt%. That's at atmospheric pressure.

DR. POWERS: Let me ask a question. It's my experience extraordinarily difficult to tell when you've saturated when you have a concatenating NI and a liquid that roughly 11 molal, and they're two difficulties that you encounter; one is that the solution can superheat if you have it in glass vessels when you're doing this kind of experiment, glass or silici, either one. And the second is that you can't visually tell that you've formed colloids before you think precipitation has occurred. So when you say you went up to saturation, how did you determine what saturation was?

MR. HOLMAN: Bob Hammersley, can you answer that?

MR. HAMMERSLEY: The experiment was performed by starting with a mass of boric acid that corresponded to the solubility limit in water at 100 degrees C, say a standard reference. So we started by putting that in the flash in the water, put it on a heat plate and brought it up to temperature of 100 degrees C. During that time, we had a stirrer, stirring or agitating the solution until we could get all the boric acid crystals dissolved, so it took some time, of course, one - to heat the fluid, and two, to get all the crystals dissolved.

At that point, we added the amount of Trisodium phosphate, the solution was crystal clear. The Trisodium phosphate went immediately into solution. We continued to heat the solution until we get to the normal boiling point. This was all done at atmospheric pressure.

DR. POWERS: When you say it was crystal clear, was that based just on visual observation, or did you do a Tyndall effect on it?

MR. HAMMERSLEY: We did that by visual observation.

DR. POWERS: So you couldn't tell if there were colloidal suspensions in there.

MR. HAMMERSLEY: Not with my eyes, no. We did take Tyndall measurements during the entire testing sequence. Once we had the TSP in solution, we now started to add additional boric acid in controlled amounts of mass.

DR. WALLIS: Why did you keep adding boric acid? Why didn't you add more TSP?

MR. HAMMERSLEY: Because we wanted to see the increase in the solubility limit of boric acid in the presence of TSP at the normal boiling point. We were able to add additional boric acid that --

DR. WALLIS: So you used a round of initial TSP as a variable in this, several experiments?

MR. HAMMERSLEY: We did repeatability tests. We did two tests at the TSP concentrations that would be expected in containment. We did one at a reduced concentration of TSP.

DR. WALLIS: The TSP and the boric acid are all mixed up together in the containment, aren't they?

MR. HAMMERSLEY: Yes.

DR. WALLIS: Then you just keep putting in a bit more of each and boiling off. Isn't that what happens in the reactor?

MR. HAMMERSLEY: No, the TSP, there's a fixed amount that's in containment that goes into solution.

DR. WALLIS: Yes.

MR. HAMMERSLEY: That's all that's available during the entire transient. Likewise, the boron, once the primary system and the water storage tank and the accumulators have all exhausted, then there's no addition of the chemical species.

DR. WALLIS: So you just put this in a beaker and keep boiling it until it changes color. Is that what happened?

MR. HAMMERSLEY: That's right.

DR. WALLIS: Is that what you do? Just put it in a beaker and boil it until it changes color?

MR. HAMMERSLEY: Well, we put more and more boric acid until it would go into solution.

DR. WALLIS: You kept trying to dissolve more solid boric acid in it?

MR. HAMMERSLEY: Yes.

DR. WALLIS: So you did a reversal. You

didn't boil it down until it precipitated, you kept building it up until it wouldn't dissolve any more.

MR. HAMMERSLEY: That's correct.

DR. WALLIS: Is that the same experiment?

MR. HAMMERSLEY: That's the experiment we ran.

MR. HOLMAN: That should show the same behavior.

MR. HAMMERSLEY: Right.

MR. HOLMAN: We're not modeling the actual behavior in the core in this test. We're just trying to determine the solubility limit in the presence of TSP. And you can see from this picture --

DR. WALLIS: So you dissolved it. Did you boil it while you were dissolving it, or you just had some hot water, and you put crystals in and stirred until they dissolved?

MR. HAMMERSLEY: We boiled it as we added more crystals.

DR. WALLIS: You boiled it as you were adding.

MR. HAMMERSLEY: This is a photograph that actually the surface that that beaker is sitting on is the hot plate. There is a magnetic stirrer bar in the bottom there. Of course, we turned it off to try to get a picture. Boiling is actually going on there. It's hard to see some of the bubbles that are rising up along that, but this is the solution near the solubility limit with the additional boric acid beyond the normal concentration that you would expect, that has now been concentrated to the solubility limit in the core and we've added additional boric acid beyond that and TSP. So this is a mixture of the boric acid and the TSP at boiling near the solubility point.

DR. WALLIS: So you're doing an experiment that I was tempted to do in my kitchen.

DR. POWERS: Well, hopefully you wouldn't spill so much as is spilled here. I presume that's what they are.

DR. WALLIS: So you're boiling, you're heating this thing from the bottom.

MR. HAMMERSLEY: Right. During that process we have the stirrer bar mixing it. And we've monitored the temperature, of course, as we go along. And the other thing that we wanted to observe from this is that there's no — we didn't observe any foaming tendency of this solution.

DR. RANSOM: What was the solubility noted at zero TSP?

MR. HAMMERSLEY: The solubility when we

started out is like 27.5 wt% boric acid.

DR. DENNING: If you continue to add TSP, does the solubility improve? Because as Graham was pointing out, in a real system you not only concentrate boric acid, you also concentrate TSP.

MR. HAMMERSLEY: In this experiment, we've concentrated TSP the same amount that the boric acid would have been concentrated in the boil-off process in the core.

DR. WALLIS: And you said something about foaming, it didn't foam?

MR. HAMMERSLEY: This actually undergoing boiling in this photograph. There's no tendency for it to foam.

MR. HOLMAN: This is near the precipitation limit.

MR. HAMMERSLEY: Yes.

DR. WALLIS: So you don't know what happens when you boil it to the point where it begins to precipitate.

MR. HAMMERSLEY: We do. We continued to add boric acid until we got to that point. When it simply wouldn't dissolve all the crystals, the solution would get cloudy, and you would actually start to form some crystals or — especially on the surface where probably the temperature grading was such that it would tend to do that.

DR. WALLIS: You built up a skin on the surface?

MR. HAMMERSLEY: Yes, we called it a scum. Yes.

DR. KRESS: This is an atmospheric pressure test?

MR. HAMMERSLEY: That's correct.

MR. ROSEN: That's a question I was going to ask. On your slide 20, you talk about a minimum containment pressure of 20 psia. That's five-pounds gauge. That has the effect of increasing the solubility by 4wt%.

MR. HAMMERSLEY: Correct.

MR. ROSEN: Now is this the only place where you take credit for containment over-pressure, or in your LOCA analysis?

MR. HOLMAN: In the supplemental calculations, the primary effect is to elevate the solubility limit. There is a secondary impact on the calculation of the scheming rate and the voids.

MR. ROSEN: No, but I was talking more generally, globally. Is the degree to which you take credit for containment over-pressure limited to this analysis, or is it typically taken in other parts of the --

MR. HOLMAN: In other analyses?

MR. ROSEN: -- plant's analysis, yes.

MR. HOLMAN: Specifically, we do not credit over-pressure for net positive suction. There is a pressure that's calculated for ECCS performance peak clad temperature in accordance with the approved models.

MR. ROSEN: Though in the peak clad temperature calculations, but not MPSH calculations for the sump.

MR. HOLMAN: That's correct.

MR. ROSEN: So there's some precedent here at Waterford for taking credit for over-pressure. And here's another case where you have to do it to get the solubility limits high enough, not to have this --

MR. HOLMAN: In our supplemental calculations only we're showing that margin. In the licensing basis analyses, we do not credit that over-pressure.

DR. WALLIS: How is this heated? What is the source of heat?

MR. HOLMAN: There's a hot plate.

DR. WALLIS: It's a hot plate. And it's

a glass beaker, so there are very few nucleation sites. You probably get large bubbles from one or two nucleation sites. It doesn't seem to me this is typical of boiling on a host of fuel rods.

MR. HOLMAN: Again, what we were trying --

DR. WALLIS: Were you asked to extrapolate t his experiment to what happens in boiling?

MR. HOLMAN: What we're trying to do here is determine the solubility limit --

DR. WALLIS: So you're saying here there was no foaming, and there was no -- you don't think there was a change in the drift flux, and so on.

MR. HOLMAN: That's correct.

DR. WALLIS: You've got a very special case. You're boiling in a glass beaker with very few nucleation sites. You don't have a possibility to make a lot of small bubbles.

MR. HOLMAN: We don't see that behavior in this result. We would not expect that behavior.

DR. WALLIS: You didn't boil it in an aluminum pan or something, or some sort of material with lots of nucleation sites. It's an interesting experiment. It just seems to be an extraordinarily crude one on which to hang a licensing decision.

MR. ROSEN: And as you say, it's inverted.

It's not the situation we're really dealing with.

DR. WALLIS: Okay. Well, maybe you should move on. Are you going to show us a picture of it?

MR. HOLMAN: Okay. Let me talk a little about our calculations. Our calculations that were done to address the margins that are available assume 50 percent of the lower plenum in the mixing volume as supported by the BACCHUS test. We calculated an upper plenum level, two-phase level that existed up to the top of the hot leg at three-hours. Our calculated average void fraction in the core was 0.66, and we're using a 1979 Best Estimate ANS Decay Heat values.

With those assumptions, we calculated a boric acid concentration --

DR. WALLIS: Well, the void fraction in your little beaker was nothing like 66 percent.

MR. HOLMAN: That's correct. With those assumptions, we calculated a boric acid concentration of 17.2 wt% at three-hours. That compares --

DR. WALLIS: I thought you were going to tell us that you didn't need to assume this 50 percent involvement of the lower plenum.

MR. HOLMAN: If we were to assume no credit for lower plenum mixing, we would still come in below the 40 wt% --

DR. WALLIS: What is the number you get with no lower plenum mixing?

MR. HOLMAN: Joe, do you have that number?

MR. CLEARY: This is Joe Cleary from Westinghouse. At three-hours post LOCA with zero credit for mixing in the lower plenum, the concentration in the mixing volume was approximately 32 wt% with the Appendix K Decay Heat curve. With the Best Estimate Decay Heat curve, it was approximately 27 wt%.

DR. WALLIS: Are you going to show us some graphs or something which gives us all these comparisons so we can see these results?

MR. HOLMAN: I don't have those graphs with me in this presentation. However, they were in the report that we've docketed with NRC.

DR. WALLIS: So should we have them somewhere?

MR. HOLMAN: I believe the ACRS does have that information.

DR. WALLIS: Because I think we might be interested in looking at sort of the worst case assumptions or something else, so we're not just looking at your number of 17.2.

MR. HOLMAN: What we're trying to show

here is that there exists on a Best Estimate basis, significant margin between the calculated boron concentration at the time the operator would take action and the precipitation limit. There's a large margin there, and that's the point of these calculations.

DR. DENNING: And again, three hours is the point in time in the emergency procedures in which it switches over. Is that --

MR. HOLMAN: Yes. The emergency procedures require the operator to switch-over anywhere between two and three hours, so three hours is the latest time.

Okay. We've submitted to the NRC and docketed these supplemental calculations that we've discussed. We intend to clarify that the Waterford 3 updated licensing basis long-term cooling analysis will be based on these supplemental calculations. The updated licensing basis analysis will include these assumptions; will include explicitly voiding the core. We used 50 percent of the lower plenum mixing volume for mixing the boric acid makeup tank with the refueling water storage pool water. Also taking credit for the effect of TSP on the solubility limit. That concludes the presentation. Are there any other questions?

DR. DENNING: Question about range of LOCA sizes, and is it clear that the specific conditions over which — I mean, there's a large LOCA and then there are intermediate LOCAs. Is it clear that you really have the most limiting case with regards to when you'd switch over to sump recirculation, all those things? Have you looked in some sense at that?

MR. HOLMAN: The long-term cooling analysis does look at the whole spectrum of break sizes.

DR. WALLIS: So the only thing you have on effects of concentration on when you're boiling, on drift flux and so on is this little beaker experiment?

MR. HOLMAN: We did some additional sensitivity calculations on the effect of drift flux and --

DR. WALLIS: You also submitted, I think, a Fauske report, Fauske bubbled air through boric acid. Those were very dilute mixtures, only 3000 PPM.

MR. HOLMAN: That's correct.

DR. WALLIS: That doesn't tell us anything about what happens at 30,000 PPM.

MR. HOLMAN: That's correct.

DR. WALLIS: And so the suspicion — if I

boil a surface solution or something down, I would eventually get to boil over, because it would simply froth up. But boric acid boils differently?

MR. HOLMAN: We did not see any evidence of frothing from the tests that we did. It was a clear mixture right up the solubility limit.

DR. WALLIS: I think it depends on the rate of boiling and the nucleation characteristics, and all sorts of stuff.

DR. RANSOM: Also, the amount of embedded structure, too. I mean, it's different in a rod than in a beaker.

DR. WALLIS: So we still don't have a very good answer to what happens in terms of drift flux, as you boil the concentration of this material on the surface of the bubbles, because as water evaporates, it leaves behind the skin.

MR. HOLMAN: Joe, could you describe the sensitivity calculations that we did with varying drift velocity?

MR. CLEARY: Yes. This does get to the heart of the question about what the effect of increasing concentrations are on the drift velocity, but it may shed some light on the situation. What I did was perform some sensitivity studies to determine what the effect of a change in the drift velocity is on the calculated concentration. And in a sense, this could be looked at as the effect of change in any parameter that affects the void fraction within the mixing volume. It was convenient to do it in terms of a multiplier on the drift velocity. And the conclusion of the study was that any reasonable change in drift velocity has an affect on the maximum boric acid concentration at three-hours. That's small in comparison to the margin that the supplemental calculation is showing to the solubility limit.

With that very qualitative statement, let me give you a specific example. And I could pull off more from the curves I have if you would like.

DR. WALLIS: When you boil up a sugar solution and reach a point where it froths up with very small bubbles. If it's maple syrup, the sugar is all brown and you get frothy stuff, and if you don't do something pretty darned quickly, you lose the whole thing because it boils over, and it doesn't detach, and the bubbles don't burst, and the whole thing just froths up and is gone. Now if this happened in the core, presumably you'd be carrying over large quantities of liquid. It wouldn't just be a drift flux phenomenon, it would be a foaming-type phenomenon.

MR. HOLMAN: From the tests and the calculations that we've done, we state that the operator action would be well in advance of reaching the precipitation limit, and would prevent any of those types of behaviors.

DR. WALLIS: Well, I know with my experience with boiling over the maple syrup, that if you boil more rapidly, it's more likely to boil over. If you boil very gently you just get a few bubbles, then you could be okay. So it's not independent of how rapidly you're boiling. I hate to say this stuff is like maple syrup. I don't know that it is. It's just that I don't think you've really done very convincing tests.

MR. HOLMAN: From the tests that we did, we did not see that type of change in viscosity. It would look very much like just boiling water, so we would not expect to see those types of behaviors. The calculations that we've done show a large amount of margin.

DR. WALLIS: Now there is no experimental basis, and there's nowhere in the literature or NRC that someone has actually boiled concentrated boric acid solutions at different rates and observed what happens?

MR. HOLMAN: Not that I'm aware of.

DR. DENNING: I think, Graham, we are wandering into a generic issue area that's not their responsibility to meet.

DR. WALLIS: Yes, I think that it may be appropriate for the committee to draw attention to this as a generic problem. That's my feeling, too. I think we may have identified something generic, but I just don't know what we do about its implications for this particular application.

MR. HOLMAN: For Waterford, we believe we've shown significant margins to the solubility limit. We have operator actions that will occur well in advance of the time that we would approach the solubility limit --

DR. WALLIS: You obey the regulations using the methods which have been used up to now.

MR. HOLMAN: Well, further than that, we have quantified the conservatisms and demonstrated the margins that do exist, so we believe our actions will absolutely prevent boron precipitation.

DR. WALLIS: Will absolutely prevent, so do you want to take a bet on what happens if you do the right experiment? Can we move on to the Staff conclusion here?

MR. HOLMAN: Okay.

DR. WALLIS: Thank you very much.

MR. HOLMAN: Okay. Len Ward is going to be discussing the Staff Review.

MR. WARD: If it's okay with the Chairman, I would prefer to use the overhead, because if I need to jump around with slides --

DR. WALLIS: You can use whatever visual aide, just as long as we can read it.

MR. WARD: I remembered you asked for bigger letters, so I did that.

DR. WALLIS: Which is why we have a complete blank in terms of our handout from you, or is it somewhere else?

MR. WARD: It will follow. It's in this.

DR. WALLIS: So we also have the benefit of the hard copy version we can look at.

DR. KRESS: Page 7.

DR. WALLIS: You're on page 7. That's not very good. Can we turn off the computer so we don't get that big shadow on there. Now when you presented to the subcommittee, we asked you to increase your font size. Did you get that message?

MR. WARD: That's not big enough?

DR. WALLIS: Well, it's better.

MR. WARD: I'm starting off on the wrong foot already. Well, my name is Len Ward. I'm with Reactor Systems Branch. What I want to do is show you some calculations that we did to give us a feeling for what the difference between a licensing calculation is and where we think this situation really is.

DR. WALLIS: But you base your licensing decisions on licensing calculations, presumably.

MR. WARD: Yes. That's right. I'll get to that. In the subcommittee meeting, I talked about feed line break calculations and small break LOCA, but because questions were on boric acid precipitation, I'm just going to focus on that one. So we're just going to talk about boric acid precip.

Now as Jerry mentioned, post LOCA long-term cooling, the purpose of that is to identify when you would precipitate. And I'm just talking about large break LOCA here. This is the double-ended break. This is the one that's going to boil the fastest because you get to the Decay Heat curve earliest.

DR. WALLIS: The criterion is initiation, it's not how much precipitation. It's initiation of precipitation.

MR. WARD: Right. It's -- yes.

DR. WALLIS: Whereas, in the small break LOCA when you've got deposits of boric acid on the tubes due to splashing and drying out, that has already initiated, and your argument was well, there isn't going to be much of it.

MR. WARD: Well, if you remember that core uncovery transient, it was uncovered for 45-minutes. I mean, that's alarming. But remember, that's an Appendix K calculation. If I get rid of the 20 percent Decay Heat, the two-phase level is up near the top of the core. It's only uncovered for maybe 15-minutes. If I have two HPSI pumps on, which is probably what's going to happen, there's no uncovery at all. You don't see it, it goes away. So I mean, maybe I could help you with a little perspective on that.

DR. WALLIS: I don't know. If I'm using the regulations, I should probably use Appendix K. That's what's being used. And the fact that the reality is different and the regulatory world is irrelevant.

MR. WARD: Well, the way to look at these calculations is the Appendix K analysis is -- what it's really going to do, it's going to allow you to identify the earliest time you can switch to simultaneous injection. And from a safety standpoint that's really good, because what happens, the concentrations are really low. And I'm going to show you some curves. I mean, we've talked about mixing volumes and Decay Heat, and all these different various plenums that can contribute. I'm going to show you what effect they have on the calculations just so you can get an idea of — when you're up here in licensing - well, you're really down here in the best judgment world. And that's what I hope to show you. I want to show you that. We're pretty far away still. Even though there was a non-conservative input, it can be compensated for other items, and I can show you what they're worth. And that's what I hope to accomplish.

Now what happened was, I was doing a calculation to try to predict the boron concentration in the Westinghouse licensing calculation, and they were showing a precipitation time of about four-hours in the licensing calculation. In order to predict that, I had to steadily increase the amount of liquid in the core until I assumed zero liquid, and then I predicted their calculation. But when I put in the void fraction that's consistent with the amount of steam in the core at three-hours, there's about 35 percent liquid in the core, it shifts the precipitation time to one-hour. Now this is a licensing calculation, and it's alarming but bear with me. Let me get through this to get to the meat, because I know I alarmed you last time, and this is alarming.

Let me show you what I just said, what it looks like. This is the licensing calculation with zero liquid fraction. And, basically, what I did is I used their licensing --

DR. WALLIS: Zero void fraction.

MR. WARD: I mean, I'm sorry. It's pure liquid. Pure liquid.

DR. WALLIS: At the collapsed level?

MR. WARD: Well, the whole mixing volume is full of liquid, and that included --

DR. WALLIS: All full of liquid.

MR. WARD: That's what they assume.

DR. WALLIS: No bubbles in there at all?

MR. WARD: No bubbles. I mean, that's --

DR. WALLIS: A very strange assumption. Just look at it.

MR. ROSEN: If it looks right to you, it'll be right.

MR. WARD: Okay. There we go. What they assumed, the mixing volume consisted of the core and the upper plenum below the bottom of the hot leg, so just mixing it -- we're just mixing in this region.

DR. WALLIS: And it was all solid liquid?

MR. WARD: And it was all pure liquid. Okay.

DR. WALLIS: How did they ever get away with that?

MR. WARD: Well, it was a non-conservative input. We found it. Let's wait until we get to the --

DR. WALLIS: I'm not sure they did that. I thought they used the collapse level.

MR. WARD: Well, that's the way they characterized it. I mean, the mixing volume was full of liquid. I mean, I can't control what they're calling it.

DR. WALLIS: Okay.

MR. WARD: So now when you put the correct void fraction in, it shifts us back to here. And this is precipitating in an hour. Now this is a licensing calculation.

DR. WALLIS: Simply because there's less liquid.

MR. WARD: Yes, that's right. That's right. So it's going to shift it to the earlier time.

DR. WALLIS: No core flushing means that whatever comes in, evaporates and doesn't flow out.

MR. WARD: That's right. Everything is concentrated in there. Now Westinghouse has shown margins in their calculations, and what they did is they took credit for additional mixing volumes to show that there's still a lot of margin there. And basically, if I can list what they did, this is consistent with Jerry Holman's slide. They took credit for lower plenum mixing, half of it, the core includes the upper plenum up to the top of the hot leg, near the top of the hot leg. Okay. They're raising the containment pressure to 20 pounds and that is based on a GOTHIC calculation, that's their license containment calculation. They ran it in a minimum pressure mode. And when you do that, and if I look at their results in that report that you have - I extrapolated it to include the entire lower plenum, and that's what I have in one of my slides. And I'm only mentioning this because I want to show that what they would calculate is consistent with what I — we're in the same ballpark on that curve, and I'll show you that curve in a minute. But it's just for a reference point to show consistency between our margins.

Now the calculations that I'm going to show you --

DR. WALLIS: In the licensing world, aren't there specific rules about what you're allowed to consider to be mixed here?

MR. WARD: It's not specific.

DR. WALLIS: No specific --

MR. WARD: What you justify --

DR. WALLIS: -- regulation that says you should not consider the lower plenum or anything like that?

MR. WARD: Nothing says that.

DR. WALLIS: Okay.

MR. WARD: I mean, it hasn't been -- vendors do different things. It's a generic issue that we want to settle, but everybody makes different assumptions based on what they justify.

MR. MARSH: Just a little clarification. This is Tad Marsh. There's a topical report that's approved. That gives an approved methodology.

MR. WARD: That's correct. This is based on CENPD-254, which was approved.

MR. MARSH: So licensees follow that

topical report and the guidelines thereof.

MR. WARD: That's right.

MR. MARSH: They can take exception to what's in the topical report, as long as they justify it.

MR. WARD: That's right. That's right.

MR. CLEARY: This is Joe Cleary from Westinghouse. I'd like to expand upon the procedure we used in applying our CENPD-254 methodology. The topical report in question is not explicit in what physical volume constitutes the mixing volume. It merely states that a conservative value is used. In recent years, that conservative value has come into question with the NRC Staff during previous reviews. And questioned specifically was the fact that we historically had credited 100 percent participation of the lower plenum in the mixing volume.

For Waterford, we did not do that, but rather taking a cue from an NRC evaluation of another power uprate, which explicitly allowed crediting of the collapsed liquid level in the core and upper plenum to the bottom of the hot leg, we used the same definition of the mixing volume in the Waterford calculation, i.e., a collapsed liquid volume from the bottom of the core to the bottom of the hot leg elevation inside the reactor vessel.

MR. WARD: Well, what I want to do is show you some of the calculations that the Staff did. I want to show the effect of the additional mixing volumes, we've got hot legs, upper plenum regions, lower plenum regions. What's the affect of the higher containment pressure? What's the affect of the Decay Heat multiplier, just to show you how the concentration profile with time changes.

Now all the calculations that I did had a multiplier of 1.2 during the whole transient. There's no credit for liquid entrainment. During the injection phase, you've thrown out a lot of mass, and probably for the first 15 or 30 minutes, you're not going to see much of a concentration rise at all because it's all going out. We're assuming it stays in there and it increases during that first half-hour. No credit for anything going in the bypass.

Now, also, what I did, the boric acid makeup tanks, and these concentrations in these tanks are twice the RWST; 6187 PPM. What I assumed is that went directly into the core, didn't mix anywhere, and then what — any additional boil-off —

DR. WALLIS: Where was that injected? It's not injected —

MR. WARD: It's injected into the cold legs.

DR. WALLIS: So it mixes with all the material on --

MR. WARD: It would go in the downcomer, lower plenum before it gets in the core. It's going to spread out, so I've got --

DR. WALLIS: You're assuming that what goes into the bottom of the core, comes down the downcomer, 6187 --

MR. WARD: Yes. I'm assuming that the three charging pumps pumping in that concentration directly into the core. And then the rest is made up by the RWST, which is 3000 PPM.

DR. WALLIS: Now there was a GSI 185 that looked at boron mixing and more realistic.

MR. WARD: Well, I mean, I could -- I'm going to --

DR. WALLIS: It seems to me that the NRC doesn't have some sort of accepted way of doing it right. You're inventing something --

MR. WARD: I'm making a conservative.

DR. WALLIS: PSI 185, something else was done, and the vendors were allowed to do whatever they want to do.

MR. WARD: I'm just doing this conservative. This is the worst situation. It's not going to be this. I'm going to make it concentrate fast, as quick as I can.

DR. WALLIS: Okay.

MR. WARD: I mean, I'm off to the extreme here. I'm not real in that regard. The upper plenum pressure is going to be higher than the containment pressure by the loop pressure drop, and during this transient out to three-hours, that's anywhere from about 6 or 7 psi to about 2.8 to 3. The water during the injection phase is sub-cooled. There's a sub-cool level at the bottom of the core. There's pure liquid down there in about the bottom quarter. I'm assuming it's going in saturated. Okay.

So these are the assumptions that I made that I'll make in the calculations that I did. And just to describe this slide, if we separate these curves here, these are what I call licensing-type calculations. I mean, the Decay Heat multiplier is 1.2. Down here since these have multiplier of 1.0, let's try to call these best judgment, more towards where I really would expect we really are.

DR. WALLIS: Oh, I don't understand this business of the circles and the squares, containment pressure 14.7 —

MR. WARD: Okay. Well, I'll get to that.

DR. WALLIS: Because we asked the Westinghouse folks, and they said there's no effect, very little effect of containment pressure on the mixing processes and the concentration. It's all in its effect on saturation temperature. That's what your horizontal line —

MR. WARD: Those are the two lines there.

DR. WALLIS: You seem to be showing an effect on the entire transient.

MR. WARD: Well, there is an effect there, because what they do is they're assuming the mixing volume is fixed during the whole event. And what I'm doing is, I'm trying to do it right. I'm balancing the hydrostatic heads between the downcomer and the core with the loop pressure drop. So in the beginning when your steaming is high, the two-phase level is in the middle of the core. This is the start of this reflood transient. And as the Decay Heat drops, the two-phase level will move up the core into the upper plenum. And it gets up into that region around 1-1/2 hours. Okay. Between one and 1-1/2 hours, so as long as the two-phase level is up there synonymous with their licensing calculation, we're consistent, but before that, we're not.

DR. WALLIS: What I read in the Westinghouse, this report on BACCHUS, is the conclusion that says it's expected that containment pressure assumption would have only a small impact on the calculated core region boron concentration transient. That's a different conclusion than you're reaching.

MR. WARD: Yes.

DR. WALLIS: You have a huge impact.

MR. WARD: Well, here is the licensing-type calculation with the non-conservative assumption replaced, nothing else, same mixing volume. Now if we assume -- if we go to a 20 psi containment, I'm assuming 20 psi in the upper plenum. It's really higher than that, because it's a loop pressure drop, but let's assume it's 20. That shifts the curve down to here. Okay. That gives this result right here.

Now all of that -- this just includes the core and the upper plenum up to a region near the top of the hot leg. I'm staying about a half a foot below the top of the hot leg because the steam that you're producing is going to bleed out there. And once it reaches that point, I just leave it there, even though the loop pressure continues to drop.

DR. WALLIS: We haven't studied the basis of Westinghouse's statement that containment pressure has no effect. We haven't studied your analysis which has a big effect, so I don't know who to believe.

MR. WARD: I don't think they need to take credit for that in the long run, but let's -- you may not even ask that question when we see where we're going here. If now I throw in the hot leg in the mixing volume, I've got more volume to mix. The two-phase level is now near the top of the hot leg. It's going to delay the precipitation time, and if we look at three-hours, I mean, we're down around 24 percent. And if we're using a 14.7 limit, a 20 psi limit, or with the TSP, the limit is up here.

Now this is a licensing-type cal. Okay. Now if we remove the hot leg mixing volume, and now go from the base case and just throw lower plenum mixing in --

DR. WALLIS: That's the entire lower plenum?

MR. WARD: That's the entire lower plenum. I mean, you're here. Now if I go to a Decay Heat multiplier of one, I'm here. Now if I fill the hot leg in there in addition, so I have the hot leg, the lower plenum, this is about as best as you're going to get, let's say. I mean, I'm not taking credit for subcooling entrainment. If I did that, this curve would shift over here, shift this down maybe another 30-minutes.

The point I'm trying to make is, here's where we are, somewhere in this band in here. Okay. Based on what Jerry Holman gave for a list of assumptions that he's taken credit for half the lower plenum, they're going to be somewhere in here. I would expect their calculation when they submit it is going to show something in this range. Now if we take the TSP, what is that - that's beyond six hours. We're switching back here two to three hours, when the concentrations, even without the 20 psia, you're still okay for the containment.

DR. WALLIS: You said something about the Westinghouse - I guess it's the Westinghouse calculation that when they submit it, so they have not yet submitted that?

MR. WARD: Well, they're going to submit an analysis of record.

DR. WALLIS: So we're going to make the decision based on something which has not yet been submitted?

MR. WARD: Well, I'm — if I look at their assumptions --

MR. MARSH: Well, let me interrupt. The answer is no, Mr. Chairman, we're not going to make a decision based on something that's not docketed. No, we'll get it docketed. We'll look at it. And as I said, we'll supplement the safety evaluation too. This is the information that we've heard over the telephone, in meetings, in raw form. We need to get the information docketed to look at it.

DR. WALLIS: I'm just a little concerned about this committee making a decision that everything is okay when so much seems to be work-in-progress.

MR. CLEARY: This is Joe Cleary from Westinghouse. Entergy has docketed the supplemental calculation, and what we will be doing is identifying one of the specific points in that calculation as the new licensing basis calculation for the Waterford uprate. The point that credits the appropriate amount of conservatisms and removing some of the other conservatisms that we relaxed over the full range of calculations, that is identified in the supplemental information.

MR. WARD: Well, all I want to do is show you an envelope, and based on their list, we expect they're going to fall somewhere in here. I mean, that remains to be seen, but I wanted to give you an idea of where they are. And this is about where they are.

DR. WALLIS: How much of this is due to the uprate? We're talking about an uprate, and you seem to be talking about a generic problem with all such systems, which this doesn't address the question of what's the effect of the uprate on all this. Does the uprate make any difference to these curves? That's what we're talking about is a power uprate. WE're not talking about --

MR. WARD: That's correct.

DR. WALLIS: -- whether or not there's some kind of a glitch in the way in which this boron mixing is evaluated. Do you have it in the perspective of the power uprate decision?

MR. CLEARY: The power uprate has a relatively small effect on all of this. You could determine that from looking at the effect of changing the Decay Heat multipliers from realistic to Best Estimate. Any percent change in Decay Heat would effectively represent the effect of the power uprate on this topic.

DR. WALLIS: So we should have a DH multiplier of 1.08 or something, and that would do it?

DR. DENNING: I thought we also had a

higher boron concentration?

MR. CLEARY: The maximum values used in boric acid precipitation analysis did not change in the power uprate, some of the minimum values I believe in the plant increased.

DR. WALLIS: I think it had more boron in the tanks than before.

MR. CLEARY: Actually, for the large break LOCA analysis, as a result of that analysis, we're decreasing the maximum level of the safety injection tanks in order to get more nitrogen and to increase the initial flow rate. That was addressed at the subcommittee meeting two weeks ago.

DR. WALLIS: So is it conceivable that with the power uprate you're better off?

MR. CLEARY: The safety injection tank contribute to the boric acid precipitation analysis or the change in the maximum level is very, very small, and I would consider it insignificant.

MR. HOLMAN: The long-term cooling analysis done for power uprate uses maximum boron concentrations in all of the tanks. Those really did not change.

MR. ROSEN: So for me, the bottom line of this is, you're showing, maybe if I don't want to credit over-pressure, you're showing they read the 14.7 psia limit - I don't know where you put your - maybe five hours.

MR. WARD: Yes, right. Five hours.

MR. ROSEN: And they switch over by operator action in three hours.

MR. WARD: Two to three. In this range here.

MR. ROSEN: So I have a margin when I switch-over of we say a factor of two in time.

MR. WARD: Right. I mean, if this stuff was up here, then we wouldn't be talking right now. Okay.

MR. CLEARY: Len, I'd make one clarifying statement. Maybe it's an obvious statement.

MR. WARD: Okay.

MR. CLEARY: All these calculations are obviously using Decay Heat based on the uprated power. I believe Len's fourth and fifth lines are the down point to triangles and the diamonds show the effect of change in Decay Heat multiplier of either 10 percent or 20 percent, depending upon the downward pointing triangles, so that would be the effect of — more than the effect of the power uprate.

DR. WALLIS: So with all these curves,

what is your official position on which curve is acceptable?

MR. WARD: Well, they need to show a licensing calculation that precipitates beyond their switch time. And based on their assumptions, if I take that, they're going to be somewhere in here. And that's acceptable. That says they're switching early when the concentrations are really low, but not too early. I can't switch before two hours, because then the injection can't match the boil-off, so you don't want to go beyond that. But after that point, the earliest time you switch is going to be the safest because the concentrations are the lowest. And remember, I haven't taken credit for subcooling or entrainment, or anything. That's going to bring these curves down even more.

DR. WALLIS: Is there any downside to switching too early?

MR. WARD: Yes. If you switch too early when the Decay Heat is too high, you can't make -- then you're losing half of your high pressure injection. The other half better match boil-off.

DR. WALLIS: So there's something that the operators are told that --

MR. WARD: Two to three hours they switch.

DR. WALLIS: Two to three hours?

MR. WARD: Right here, during this time frame.

DR. WALLIS: That goes for all break sizes?

MR. WARD: That's right.

DR. WALLIS: They must not switch before two hours, but they must switch before three, in-between two and three hours.

MR. WARD: Between two and three hours. To maintain those margins, yes. That's right.

MR. HOLMAN: This Jerry Holman. That's correct, and that's the way the emergency operating procedures are written.

MR. WARD: So I guess what I --

MR. HOLMAN: In terms -- this is Jerry Holman again. In terms of the updated licensing basis analysis, the last slide that I presented provides some of the assumptions that will go into what we're going to docket as our updated licensing basis analysis. And all of those calculations come from the supplemental calculations that have already been submitted and docketed in our report.

MR. MARSH: Mr. Chairman, this is Tad Marsh again. We look forward to that information to substantiate what we have heard, but we look also forward to it being made very clear what is the licensing basis calculation compared to what are supplemental calculations, which may show conservatisms. So that submittal needs to make it very clear what is the licensing basis, because these calculations that Len has showed you are confirmatory, and they're interesting, and the Staff's information. But what the licensee says on the docket is what we will count on for that decision.

MR. WARD: So I guess what I'm saying is the best judgment calculation shows about 14 wt%, and if you want to compare that to 14.7 at three-hours --

DR. WALLIS: At the time --

MR. WARD: At three hours, if you want to use 14.7, it's compared to 28. If you want to use 20 psi, whether that's the higher containment pressure or you're accounting for the loop pressure drop, you're close to that - it's 32. And then if you add the TSP, it's somewhere up near 40.

DR. WALLIS: Well, this is not a new question. Wasn't this resolved years ago, and how was it resolved? Was it resolved in the same way you've done it?

MR. WARD: Yes. Remember years ago,

precipitation - because plant power levels were lower, concentrations were lower, precipitation times were 10 to 15-hours. So if they were off two of three hours, it didn't matter. It was easy to balance some changes with precip times, I mean, because they were so late, and they're switching so much earlier. So now with these uprates and these higher powers, everything is pushed earlier, so when you have a -- you at least want to have a licensing calculation that's demonstrated to be conservative, that shows you're switching early enough so the concentration really is low, but not too early so that you uncover the core.

DR. WALLIS: Now is this an effect of the uprate, that in order to control radioactivity when you have a -- reactivity when you have a new core, you need to have more boron? Is that part of the problem you have, part of what makes this different?

MR. CLEARY: No, the maximum -- the analysis uses maximum values, tech spec values for the boric acid sources, and those maximum values have not increased as a result of the uprate.

DR. WALLIS: So it's not a question of the uprate increasing the need of boric acid and more of it if you have high reactivity at startup.

MR. HOLMAN: That is correct. This is not a phenomenon driven by power uprate. The only effect of the power uprate is the higher Decay Heat. That's correct. To answer your question previously, it hadn't come up in the past, and had been evaluated in a similar manner to show that there are conservatisms and margins that exist when you look at a more best estimate analysis.

MR. WARD: So these calculations show that you're at half the limit at the switch time, and they even show that you could — you don't need the higher containment pressure, and you could even almost go as far as to say if you look at those curves without lower plenum mixing, but with the hot legs, you're still beyond four hours, so it tells me there's some margin here. It's comforting.

DR. DENNING: In your model, what's the cause for the peak in the concentration? What's the phenomenon that —

MR. WARD: Well, what brings it back down is that's when the two-phase level gets up into the upper plenum, the area's factor of two larger than the core, so to balance the heads, you're going to get a lot of liquid in there, and it drops the concentration. There's a huge change in area.

DR. WALLIS: So you get more liquid coming in from the lower plenum.

MR. WARD: Right. I'm balancing the head with the loop pressure drop. And when it says I can go there, it also says I can have more liquid there. The void fraction decreases when you go into that larger area. It's about 70 percent at the top of the core. It decreases to about 61, 62 percent.

MR. HOLMAN: This is Jerry Holman again. I think that difference is one of the major conservatisms of why there's a difference in the effect of pressure between the Westinghouse model and Len's model. Len is doing a time-dependent two-phase level, which shows that dependence a little bit greater.

DR. WALLIS: Are we ready to wind up this presentation and take a break? I'd like to take a break until quarter to 11. We're 15-minutes late, but I think we can finish this morning. I hope we can. We've got a few more issues. This seemed to be the major one. Okay. So we'll take a break for 15-minutes and come back here at quarter to 11.

(Whereupon, the proceedings in the foregoing matter went off the record at 10:32 a.m. and went back on the record at 10:47 a.m.)

MEMBER WALLIS: Back into session. Could we have some quiet, please?

Go ahead.

MR. MITCHELL: Okay. I'm Tim Mitchell. I'm going to make just a couple closing points on the boron precipitation subject and the introduce the large transient testing.

I want to reinforce a couple of points -- that the original design for long-term cooling did include a simplification. However, I think what we've shown today is that there's a lot of conservatisms in that as well. We have docketed all of the information, the full range of information, and have agreed upon what point would be our future licensing basis, which would still be conservative with respect to some of the information that we've presented here.

MEMBER WALLIS: But you have not yet submitted your formal document?

MR. MITCHELL: We have presented all of the information. However, we do need to present a formal declaration of what -- which point is the licensing basis, even though we have agreed with the staff on what point that would be from the docketed information. And those are the points that Jerry Holman covered -- what assumptions we would include and not include, or what inputs would.

So, in conclusion, boron precipitation will not prevent adequate long-term cooling from all of the information that we have presented.

Now, with your permission, I'd like to proceed on to large transient tests. We had a lot of discussion during the subcommittee meeting, and we have prepared some more information. The staff has challenged us on this topic not once but actually three times, on three separate occasions. Entergy senior management also challenged us with the appropriateness of what testing we would go do. And, as I mentioned, the subcommittee also challenged us, and we have gone back and reevaluated our position with each challenge.

Our testing program we believe does adequately demonstrate proper operation of the EPU. One other thing I would like to reinforce -- in my time on a previous uprate as Ops Manager, we went through a lot of this same type of evaluation. But our presentation will demonstrate that a large transient test will provide minimal assurance of the modifications, does come with some risk, even though that risk is small.

And I'll turn it over to David, and we'll proceed with our presentation.

MR. CONSTANCE: Hello. I'm David Constance. I've been with Entergy for 17 years. I'm a Shift Technical Advisor, and I have a current Senior Reactor Operator license on the unit, and I'm here to talk about transient testing.

Let's start with talking about power ascension testing, so you get a flavor for the types of tests, retests --

MEMBER WALLIS: Where are we in the handout?

MR. CONSTANCE: I'm on slide 27.

MEMBER WALLIS: 27, okay. Thank you.

MR. CONSTANCE: You're welcome.

I'll begin with describing our post-modification testing program and power ascension testing program in relationship to the modifications and changes in the plant operating conditions that go along with extended power uprate.

Power ascension testing will consist of reactor engineering tests and power verification, transient and data state -- transient and steady state data record collection, post-modification testing, which I'll go into in more detail in the next slide, a plant maneuvering test from 100 percent to 90 percent, and post 100 percent testing, data collection, and surveys, and a vibration -- and vibration monitoring program.

Next slide.

What you see here is the plant power ascension. This power ascension profile includes seven power plateaus followed by a maneuvering transient test.

Next slide.

Startup testing begins with low power physics testing, which will remain unchanged for extended power uprate. We will be performing the same tests. We'll be performing more of them at different power levels, but it will still be essentially the same tests that we perform during every startup testing and essentially the same test program that was implemented during initial startup testing.

MEMBER POWERS: You do these every refueling.

MR. CONSTANCE: That's right. We'll just do them at -- at the power plateaus I had displayed up there.

MEMBER POWERS: Right.

MR. CONSTANCE: We'll repeat the same tests.

MEMBER WALLIS: I think we determined at the subcommittee meeting there was going to be an NRC inspector present for these tests.

MR. CONSTANCE: That's right. That's right. There was a discussion about guidance. There is some public guidance for the residents concerning power ascension testing and his participation in that.

Power ascension then commences with data set collections, which will be collected every 10 percent from 20 percent to 100 percent power. Also, it will be collected at seven power plateaus. We'll be monitoring approximately 1,000 parameters, and this data will be automatically collected and processed and will be automatically compared to predetermined acceptance criteria.

MEMBER WALLIS: Part of this data involves vibrations?

MR. CONSTANCE: That's correct. We have a vibration collection plan that extends from inside containment, main feed, main steam inside containment, all the way out through the plant into the transformer yard.

MEMBER RANSOM: Does that include the reactor coolant pumps?

MEMBER WALLIS: No.

MR. CONSTANCE: It does. We use -- we're using our installed equipment. We are going to monitor them. We don't expect any changes, but it is a two-degree drop in -- or two- to four-degree drop in T cold, so we are going to include the vibration monitoring using our installed spectrum analysis equipment that we have.

MEMBER RANSOM: Oh, okay.

MR. CONSTANCE: Plant Safety Subcommittee will convene to review the Results Report at every power plateau greater than 68 percent. This report will include the testing results, a list of any equipment out of service, the calculation of a Plant Safety Index.

The Plant Safety Subcommittee recommendation will then be needed for continued power ascension. The Plant Manager, Operations Manager, and Test Director approval is required for continued power ascension.

So that describes our structure of our post -- I'm sorry, our startup testing post EPU.

In considering a large transient test, we performed a review of the initial plant startup test, per our standard review plan 14.2.1. Of the initial large transient tests that were performed, only the turbine trip test, which was originally performed at 84 percent reactor trip power, was judged to be potentially applicable to the planned power uprate.

MEMBER ROSEN: Why was it only done at 84 percent rather than at full power?

MR. CONSTANCE: During initial plant startup, there was a small fire in the exciter cubicle, which resulted in a turbine trip by the operator, and we took credit for that and collected that data and used it to benchmark the codes that were used for transient analysis in initial plant design.

MEMBER ROSEN: That was not your intent. You intended to do it at full power, correct?

MR. CONSTANCE: That's correct.

MEMBER ROSEN: It goes with this fire in the exciter cubicle. The plant was tripped at 84 percent as a result of the fire.

MR. CONSTANCE: That's correct. The intention was to do it at 100 percent.

MEMBER ROSEN: But was it manually tripped, or did it automatically trip?

MR. CONSTANCE: I believe it was manually tripped. I'm not certain of that, but I believe it was manually tripped.

In considering use of this in a large

transient test, Entergy considered transient testing in relation to the full spectrum of activities which establish and maintain equipment operability. For EPU, this includes power ascension testing, post-modification testing, routine testing, surveillance, and trend programs, and continuous active monitoring of plant equipment.

The next two slides present these modifications, and the planned post-modification testing specifically, and then a determination of whether the system or component performance would be further demonstrated by a turbine trip test.

Beginning with the atmospheric dump valves and the low steam generator pressure, steam generator pressure trip setpoints -- setpoint, they will both be changed. These setpoints will both be changed for power uprate. The post-modification testing for each is a channel calibration to verify the setpoint is correct.

Upon a turbine trip, steam generator pressure is controlled by the steam bypass control system. The atmospheric dump valve will not be actuated on a turbine trip. Similarly, since steam generator pressure rises on the turbine trip, the low steam generator pressure setpoint will not be actuated. Thus, we concluded that these setpoint changes will not be further tested by a turbine trip.

Program constants will be changed for the feedwater, steam bypass, and reactor regulating control systems to establish new a plant operating point. The post-modification testing for these control systems will be channel calibration, transient and steady state data record collection, and a load change test following 100 percent power.

Certain features of the control -- yes, certain features of the control system -- let me rephrase that. These systems will be or can be somewhat tested by a turbine trip, partially tested by a turbine trip test. However, certain features of the control systems -- for example, reactor trip override, quick open block, and auto withdrawal prohibit -- will not be demonstrated by a turbine trip.

Additionally, the beginning of cycle turbine trip is not the most challenging initial condition for these -- for these control systems. Thus, a turbine trip will partially test these control systems, but not provide us with the complete test.

Moving on, the permissive setpoint for the reactor trip or turbine trip will be changed for an extended power uprate. The post-modification testing for this is a channel calibration. However, during the turbine trip, we will have reactor power cutback in service, so this system will not be in service and will not be tested on a turbine trip.

The high pressure turbine rotor will be replaced for extended power uprate. The post-modification testing for this change is a 120 percent rotor speed factory test, transient and steady state data record collection, and will validate the turbine first stage power constants, perform an overspeed trip test, perform vibration monitoring, and finally a thermal performance test.

MEMBER ROSEN: Now, the overspeed trip test is one you'll do at the plant.

MR. CONSTANCE: That's right, but it will be unloaded. In other words, we will just -- we will just spin the turbine up unloaded until we reach the trip setpoint and observe that the trip occurs.

MEMBER ROSEN: But, obviously, the turbine trip at full power is a loaded trip test. So you won't have that if your proposal to waive these tests is accepted until whenever it happens for the first time, to have a loaded trip of the overspeed trip test mechanisms.

MR. CONSTANCE: That's correct.

MEMBER ROSEN: The initial test -- I'm sorry.

MR. CONSTANCE: There is not an overspeed test at 100 percent. I'm not sure if I understood the question correctly, but with the generator tied to the grid you can't do an overspeed test. It has to be done with the generator breakers essentially open --

MEMBER ROSEN: Right.

MR. CONSTANCE: -- in order to speed it up.

MR. MITCHELL: Opening the generator breakers lets the generator -- lets the turbine accelerate and requires the closure of the turbine trip and throttle valves.

MEMBER ROSEN: That's the test that won't be done is what I understand your proposal is.

MR. CONSTANCE: Well, the question goes to -- will we be performing -- or has an opportunity to perform a test to demonstrate the turbine -- turbine overspeed/overshoot. All right. We will see this turbine trip at the trip setpoint, but it won't -- it won't overshoot it based upon a no-load turbine trip test, overspeed test, right? On the --

MEMBER ROSEN: It's an artificial circumstance in the sense that, yes, tripping it unloaded is -- is one thing you want to be sure it does.

MR. CONSTANCE: Right.

MEMBER ROSEN: But tripping it loaded is another -- another function of the test.

MR. CONSTANCE: Right.

MR. MITCHELL: Well, Dave, why don't you describe the normal turbine trip sequence, because the turbine trips first and then the generator trips, so let's make sure we're describing the actual trip sequence on a normal turbine trip.

MR. CONSTANCE: On the turbine trip that was performed during initial startup, it was initiated by tripping it --

MEMBER ROSEN: At 84 percent.

MR. CONSTANCE: -- at 84 percent. It was initiated by tripping the turbine, which means that the governor valves and throttle valves immediately go closed, and there is no turbine overspeed, and there is no turbine acceleration.

MEMBER ROSEN: There's a deceleration.

MR. CONSTANCE: There is only a deceleration, right.

We could propose a different test, for example, to open the exciter field breaker, which would create an overspeed. But it would not be a design basis overspeed, because there are several preemptory trips that would occur before the turbine overspeed trip. You open the generator field breaker, and that causes a loss of fuel which immediately trips the turbine. You would not reach the overspeed trip setpoint before you'd get the turbine trip signal.

So it would not be a complete test of that overspeed. There has been no complete test of an overspeed trip in the design condition, because it would require defeating several preemptory strikes which -- which is not consistent with nuclear safety.

So I've pretty much just described here where we feel that a turbine trip test would not further test a high pressure turbine rotor. On the turbine control DEH control system, we will change program constants for intended power uprate. The post-modification testing for these changes is a channel calibration, a transient and steady state data record collection, and a load change test.

On a turbine trip, it's initiated by closure of the governor and throttle valves, which is accomplished by a method which overrides the DEH control system. So the DEH control system plays no role in a turbine trip.

Next slide.

For extended power uprate, we will rewind the main generator. There is a whole slew of electrical tests for post-modification testing. There is also a transient/steady state data record, isophase bus temperature monitoring, vibration monitoring, and, finally, a generator capability test.

On a turbine trip, the main generator is automatically deenergized following a turbine trip by the automatic tripping of the exciter field breaker. This breaker, and the associated trip circuitry, is unchanged by power uprate. Therefore, a turbine trip does not further demonstrate or does not further test the main generator.

For power uprate, main transformer alpha will be replaced, and main transformer bravo will have enhanced cooling installed. Post-maintenance testing for this includes a 100 percent factory load test of main transformer alpha, synchronizing check -- I'm sorry, I skipped that -- temperature survey of connectors monitor transformer temperatures during power ascension and following power ascension, and also performing oil samples and analysis.

On the turbine trip, the main transformers are simply deenergized by opening of the -- of the generator output breakers. The circuitry and the breakers associated with deenergizing the main transformers except for the generator output breakers, which I'll get to, have not been changed by power uprate, and the transferring of the house loads to offsite power are also unchanged by power uprate. Therefore, the main transformers themselves are not further tested by a turbine trip.

The generator output breakers will be replaced for extended power uprate, and one has already been replaced. The post-maintenance testing for this is AC and DC acceptance test, synchronizing check calibration, power factor tests, and timing tests.

On a turbine trip, the generator output breakers are opened at near no-load conditions. The circuitry which opens the generator output breaker is not changed by extended power uprate. Therefore, a turbine trip does not further test the generator output breakers.

The valve trim will be replaced on the drain collection tank normal level control valves for extended power uprate. The post-modification testing for this is a channel calibration, transient/steady state data reactor, air operator valve testing, and a load change test.

On the turbine trip, these valves will modulate closed following the turbine trip. This is not a different function than is demonstrated during normal plant startup or shutdown. Therefore, the drain collection tank, normal level control valves, are not further tested during a turbine trip.

We will be installing connector tubes for additional support of the condenser tubes for extended power uprate. The post-modification testing for this is a circulating water tube leakage check, and to monitor secondary chemistry on power ascension.

MEMBER WALLIS: But that doesn't test whether the staking works or not.

MR. CONSTANCE: For vibration? We will also be performing an acoustic survey of the condenser at the current 100 percent power level prior to the outage, and then we'll be reperforming that at 100 percent post outage.

It was listed in a separate --

MEMBER WALLIS: As you do the power ascension, you will be monitoring the acoustic level in the condenser. Is that --

MR. CONSTANCE: We'll monitor that at the new 100 percent level.

On a turbine trip, the steam bypass control valves open, which will pass approximately 65 percent of current reactor trip -- I'm sorry -- of current rated thermal power. This compares to 100 percent EPU which will be tested at power -- during power ascension once we reach 100 percent power.

So performing any type of acoustic survey at that time is actually at a lesser steam flow than we have at 100 percent power. So we feel that testing at 100 percent power is the preferred testing and that a turbine trip doesn't provide any additional testing of the condenser tubes needed.

MEMBER WALLIS: Doesn't a turbine trip test whether everything sort of works together okay? I mean, you can do all these individual tests of things, but testing whether the whole system responds okay.

MR. CONSTANCE: Right.

MEMBER WALLIS: Doesn't that require a system test?

MR. CONSTANCE: Right. The question goes to an integrated system performance, whereas much of this post-modification testing is focused on testing individual components.

We covered that earlier, and I will

discuss that a little further. The area of integrated system performance where I think it might have its most benefit is for control system interactions and control system performance. One of the weaknesses of that is that you're only testing the integrated system performance in one transient sequence from one initial condition.

That really doesn't let us know that it's going to -- that really doesn't tell us anything about the performance of the control systems in an entire pantheon of transients and initial conditions, and we need to find another way to demonstrate that. Just that one test wouldn't satisfy our -- the level of quality that we need -- level of quality check that we need to ensure that that system will perform its function in an integrated manner for other transients.

The only thing I had left here is static cooling water alkalizer skid. We will be performing chemistry monitoring, post power uprate, as a post-modification test, and that system plays no role in the turbine trip, so it won't be tested on a turbine trip.

Next slide.

MEMBER SIEBER: What is that skid?

MR. CONSTANCE: It controls the pH of the static cooling water to limit the amount of corrosion we have in the static cooling water system.

MEMBER SIEBER: Static cooling water. Okay.

MR. CONSTANCE: That's right. Generator static cooling water.

MEMBER SIEBER: In some plants it's called holy water.

MR. CONSTANCE: Holy water?

MEMBER SIEBER: Yes.

(Laughter.)

MR. CONSTANCE: All right. From this detailed review of the specific modifications that we are performing, we observed that except for control systems a turbine trip test is not an effective test for demonstrating the performance of the modifications planned for the Waterford 3 extended power uprate.

MEMBER ROSEN: And your argument for that is that it's only at one condition, and there are many conditions from which -- initial conditions from which the control systems must control the shutdown, correct? And my feeling is that the weakness of that argument is that, although it's true, the weaknesses that most of the time the plant is operating, it is at the test conditions of full power. In other words --

MR. CONSTANCE: That's right.

MEMBER ROSEN: -- the test from full power tests the circumstances which are percentage-wise the conditions that the plant is most in.

MR. CONSTANCE: Do you want me to respond to that, or -- I think you're saying that there are other conditions, initial conditions, that -- that may be less likely. So perhaps when we look at it, we should look at -- we should weight it heavier for the 100 percent. It's still not complete.

MEMBER ROSEN: Yes, we all recognize that --

MR. CONSTANCE: Right.

MEMBER ROSEN: -- as you do, and I think your argument is a good one, that -- that the control systems have to work from 20 percent power, 40 percent power, all the --

MR. CONSTANCE: Right.

MEMBER ROSEN: But you're only at 20 percent power and 40 percent power for brief periods of time.

MR. CONSTANCE: Right. There's also initial condition effects of time and life also, but a bigger aspect is, what about other transients? What about loss of feed pump? What about loss of both feed pumps?

MEMBER ROSEN: You're arguing for more large transient testing, I think.

(Laughter.)

We might go easy -- go along with that.

MR. CONSTANCE: Well, what I think I'm arguing for is that we need to establish the performance and operability in the confidence level in these systems in some other manner other than challenging them in their design basis transient. If you think there's a flaw, that seems to be the poorest time to try to demonstrate that flaw.

Rather, we need -- what we're trying to demonstrate here is that we perform --

MEMBER ROSEN: No. We think the converse. We think there's not a flaw, but we need you to demonstrate that. That's a view that some of the members of the committee hold. And it goes back to some of the comments my esteemed colleague Dr. Apostolakis has made in another context about model uncertainty. And that is, you don't know what you don't know. So how can one conduct a test to find out those things. It's obviously not possible.

MR. CONSTANCE: That's right.

MEMBER ROSEN: So one needs to think about not being so certain that you know everything you know -- that you need to know about the plant, because there is always model uncertainty in both the calculations or by analogy here in the plant condition.

MR. MITCHELL: This is Tim Mitchell, and I guess I'd like to phrase it a little different. The act of going through low power on a powerplant tests things like feedwater control and steam dumps, and those type control systems in an integrated fashion, that is more challenging, in my opinion, than the active trip in the turbine.

So between the testing that we're doing and the power ascension program itself, I would argue that we are subjecting the systems to much more stringent testing than would be exhibited by a turbine trip.

MEMBER SIEBER: I think one could also reach a conclusion that a trip from any higher power level, from a control system standpoint, causes the controls to act the same as they would from the highest license power level.

In other words, if you trip the plant from 80 percent, most things will close except heater levels which modulate, and, you know, all your heater drain system valves close, your -- to limit the amount of stored energy that goes through the turbine.

And so to demonstrate that, you really don't need to do it at 100 percent power. What you do learn from a trip at 100 percent power is -- will a water hammer occur? Will pipe movements occur that will strain or damage pipe hangers? Things of that nature? And, of course, after a trip I'm sure your plant, like most I've been in, does a walkdown of all of these systems to make sure everything is taken care of.

So if you're looking at control systems, to me, I don't think that a trip from 100 percent power really tells you too much. On the other hand, it does tell you about the overall mechanical response of the plant, where the pipes move, where the hangers -- whether they -- the hangers and snubbers get bent, or something like that. And so there is some value in doing that.

But I would think that if you wanted to argue to say the licensee ought to do it, that should be the basis.

MR. CONSTANCE: If I can continue on --

MEMBER WALLIS: This is likely to occur anyway within the next few years, whether you test --

whether you plan it or not, isn't it?

MR. CONSTANCE: That's right. It is likely to occur. We expect it to occur sometime in the life of the plant. When we go through a refueling outage, any refueling outage, but especially during a power uprate refueling outage, and we put the plant online, we then go into a -- we then go in -- well, we then go into a -- we then enter into our routine surveillance and monitoring programs.

These programs have an opportunity to detect any degradations that might exist in the plant, before we reach a point where we might actually need them. So that trip may not occur for six months, it may not occur for five years, and in that period the operators and the engineers and the technicians have an opportunity through our routine monitoring and surveillance program to detect this degradation and correct it.

MR. MITCHELL: Plus, our post power ascension or our power ascension testing program will look for -- is piping and hangers -- are all thermal growths as predicted, and is it consistent with what we would expect? And we have looked at it from an analysis standpoint, what the effects would be.

MR. CONSTANCE: So if you are asking if I would rather take a turbine trip now than later, I'd have to say later. All right.

MEMBER SIEBER: Spoken like a true operator.

(Laughter.)

MEMBER ROSEN: Especially on somebody else's shift.

(Laughter.)

MR. CONSTANCE: We did discuss a little bit about the control systems, and for the control systems the turbine trip will provide a limited demonstration of system performance. However, a turbine trip represents only one transient of interest and is performed in only one initial condition. A turbine trip transient will not test all of the functions of these control systems, nor will the systems be tested in their most challenging conditions.

Rather, a control system performance is more rigorously evaluated using a calculational model. Utilizing the LTC code, 42 different scenarios have been evaluated representing six transients from multiple initial conditions, all with acceptable results.

MEMBER DENNING: One second. With regards to point simulator, would it make sense to -- and to what extent what -- is the integrated control system adequately modeled in the point simulator that you should run a series of tests with the point simulator to check the logical control system performance?

MR. CONSTANCE: The question is: to what extent can we use the plant simulator to model these transients? And we all have -- we have a commitment -- we covered this earlier at the subcommittee meeting, that we will train all operating crews that are in transient accident conditions on the simulator prior to -- prior to the refueling outage. So the simulator will be fully exercised under transient and accident conditions.

There is -- the simulators across the nation are of some, but limited, use. It usually works the other way around. You benchmark the simulator to the plant, or you benchmark the simulator to a more detailed model, like the LTC code. But we still use the simulator as a second check, a third check, but we recognize its limitations.

So the answer is, yes, we'll exercise it; yes, we'll look at it. If we find any -- any abhorrent behavior or abnormal results, we will certainly look into that further. But it is -- it's a tool, but it --

MEMBER ROSEN: Isn't that another argument for doing the turbine trip test at the new 108 percent power, so that you can get the data you need to tune the fidelity of the simulator?

MR. MITCHELL: We believe that we'll be able to get that data through the power ascension program also. They will be collecting data off the plant computer that will allow updating the simulator, and the simulator is a valuable tool. Everything David said is correct, but I can tell you during a previous power uprate, in my experience, we did find something -- running stuff on a simulator that would not have been found under a normal turbine trip dealing with feed pump speeds. So we were able to correct something based on the simulator data.

MEMBER DENNING: In Russia, there is a regulation that any new significant change in the control system has to be tested on a simulator before it is actually operated in the plant.

MR. CONSTANCE: I guess what I'm saying, the LTC code is a better simulation than what we have installed at Waterford, yes, which is a good simulator for training purposes.

MEMBER WALLIS: Can we move on?

MR. CONSTANCE: Yes. I wanted to point out that the LTC code has a long history of accurate -- accurate modeling of plant performance at numerous plants including being tested -- being used to model Appendix K power uprates and one extended power uprate. The LTC code has been well benchmarked at Waterford 3 using natural plant transients.

Next slide.

This slide lists the recent plant transients that were used to validate the LTC code. Benchmarking revealed good to excellent correlation between the calculational model and the actual plant response.

Note that in contrast -- in contrast to the original turbine trip transient, which was performed at 84 percent rated thermal power, the current benchmark load rejection transient is a 100 percent turbine trip, which is approximately 92.5 percent of the post power uprate rate at thermal power.

So we have a current benchmark which is closer to the one that was found acceptable in initial power startup testing.

Next slide.

After reviewing each planned

modification --

MEMBER WALLIS: Is this a summary of what you just told us?

MR. CONSTANCE: I think so. The only thing I wanted to add was that we -- we looked hard to find ways to validate the performance of this equipment and systems before we incur a transient, planned or not planned.

The reason for this is that a large transient from a high power level resulted in unnecessary and undesirable transient cycle and plant systems. And the risk associated with the intentional introduction of a transient initiator, while small, should not be incurred unnecessarily. The additional risk in the power grid, while not quantified, should also not be overlooked.

Based on this, we find that the value that is left in performing a large transient test doesn't justify the small increased -- small risk incurred due to a transient test, and it doesn't justify the transient on the plant equipment and the challenge to plant equipment systems.

We believe that our post-modification testing and our startup testing, and our continuous test program validates and verifies the operability of the systems required for extended power uprate.

MEMBER WALLIS: Does the committee have any more questions, or can we move on to the staff presentation? Thank you very much.

MR. CONSTANCE: All right. You're welcome.

MR. MARSH: Thank you, Mr. Chairman. I'd like to introduce Steve Jones, who is a Senior Reactor Engineer from Plant Systems Branch. Steve is an ex-Senior Resident Inspector of Millstone and has operational experience.

MR. JONES: Good morning. As Tad mentioned, I'm Senior Reactor Systems -- Steve Jones, Senior Reactor Systems Engineer at Plant Systems Branch, and currently Acting Section Chief of the Balance of Plant Section.

Briefly, I think you've seen the modification several times before. I just wanted to point out that they -- the physical modifications of plant as opposed to instrumentation setpoint changes are outside the safety-related or important to safety boundary near the steam generators.

Next slide, please.

As Tad mentioned earlier today, this is the first application of our new review standard, and also the first real challenge to the standard review plan Section 14.2.1. That guideline for extended power uprate test program does look initially at what the initial test program was for the plant and includes the large transient testing and the scope of that review standard.

Next slide, please.

Okay. The justification for eliminating large transient testing -- I'm sorry. The SRP provides supplemental guidance for evaluating the alternative approaches that might be used to justify elimination of large transient tests, and a lot of that is based on operating experience, the potential that the modifications might introduce a new or unexpected phenomena or system interaction, the validity of the analytical methods used for analyzing the plant response to transients at the EPU conditions, and the degree of margin reduction in the safety analysis.

MEMBER WALLIS: Well, that last bullet is something which is really quantified. So how do you decide what the degree of margin reduction is?

MR. JONES: I think --

MEMBER WALLIS: We all have a suspicion that as you start, you know, pushing the envelope and doing various things you may be reducing some margin, but we don't have some numbers for it.

MR. JONES: Well, there are certain transients that certainly show up, like the amount of auxiliary feedwater flow that's needed at post EPU may change what was needed before. But if it stays within the design capability of the degraded single AFU pump, you'll have an idea that the margin change is not all that great.

MEMBER WALLIS: So then you're looking at how close something is to the limit.

MR. JONES: In terms of the systems, we are largely discussing what the turbine trip or load rejection -- for instance, you don't -- that would not be testing those types of systems. So, in general, we don't -- we don't have that issue here. But that is included as one of the parameters to consider in the SRP review.

The initial application didn't address specifically or in great detail the SRP review criteria. The staff requested additional information in those several areas, and the justification provided by Waterford -- next slide, please -- included describing their test program in more detail and the monitoring of important parameters during EPU power ascension as Entergy just described.

Also, there are existing tech spec surveillance and post-modification testing that will be performed on modified components.

In addition to the operating experience that Entergy described at Waterford that was used to benchmark the code, they also provided information on use of that code at ANO-2 for a post uprate transient and the degree to -- that that code was able to successfully model the transient at ANO-2.

Let's see. Again, as Entergy mentioned, the code has been benchmarked to that operating expense for use at Waterford, and the scope of modifications likely to affect the transient response of the plant are limited to largely the setpoint changes, mostly having to do with the steam bypass control system and the feedwater control system.

One point we noted with the code used, the LTC code used to model plant responses, that it did model specifically the transmitter response, and that it could accept a setpoint change and look at the changes in the plant response based on that input.

Next slide, please.

The objectives for the test program are largely laid out in Reg. Guide 1.68, involves operator training and familiarization with the plant, confirmation that the design and installation of equipment is adequate, benchmarking of an analytical code to the plant is accurate, and confirming the adequacy of emergency and operating procedures.

We considered that many of those, or essentially all of those, objectives are satisfied based on the operating experience that the plant has recently had, and those -- that operating experience being used to benchmark the existing code.

Due to the limited extent of modifications, any benefit we would see from a large transient test here seems very limited to problems that may exist at -- you know, following any refueling outage essentially that could introduce --

MEMBER ROSEN: It's a curious word -- you use "limited" extent of modifications. I would have characterized the modification extent as significant. Why do you have a view that they're limited?

MR. JONES: Well, I mean, it didn't involve the, for instance, replacement of a feedwater pump, addition of a second atmospheric dump valve.

MEMBER ROSEN: It's got a whole new high pressure end to the turbine.

MR. JONES: I don't find that to be

significant with respect to reactor safety.

MEMBER ROSEN: There's a long list of things that -- you've been through that list and still believe that's a limited modification. I would say the engineers at Waterford probably don't think so, but --

MR. JONES: Compared to what I expect to see from other EPUs, this is a fairly limited scope of modification.

MR. MITCHELL: Waterford would agree with that. We don't feel that the modifications for this power uprate are that extensive. The HP turbine is the biggest of those, where we're changing the steam path. Again, we don't feel that a large transient test would provide any additional assurance of that modification.

MR. MARSH: But what I think Steve is saying -- this is Tad Marsh -- is no new structures, no new systems, no new instrumentations, no new trips being added to the plant, no new safety analyses, evaluating new types of events. This is basically taking the plant, modifying it safely, and analyzing the new plant to make sure that it's going to operate correctly.

MEMBER ROSEN: Analyzing but not testing.

MR. MARSH: True.

MR. JONES: But testing -- all of the equipment, as I had mentioned, has been tested from a plant trip at 92-1/2 percent of the uprated power. The only new device is really the high pressure turbine, and that's simply isolated at the time of the turbine trip. It's not -- it's not really going to be successfully tested by that transient.

MEMBER WALLIS: I wonder whether modification would be necessary in order for you to ever require a large transient test. What kind of modification would lead you to require a large transient test?

MR. JONES: Certainly if it came to the extent of adding new components that were never part of the plant before, or new accident analysis, something that would introduce a new accident, certainly --

MR. MARSH: Or if there were a plant that had been shut down for an extended period of time, and whose structures and systems hadn't been exercised, you know, that may be an opportunity to -- a point where it may be necessary.

Mr. Chairman, let me say something. This is -- as we tried to say before to the committee and to the subcommittee, this is not a clear-cut issue. This is nothing that is absolutely definitively you fall on one side. There are good arguments and points that need to be aired both sides on this -- on this point, and this is something that we -- we have done.

There are folks on the staff who feel differently about the conclusion that we have drawn, and we have ventilated those issues. So this is certainly not something that absolutely positively we're all, you know, on this side.

This is a close call, and this is one that we carefully consider. We believe we've made the right decision, justified by our own judgment. But there are good views to the -- on the opposite side, and we've heard some of those.

MEMBER WALLIS: Okay.

MR. JONES: Last slide, please.

Okay. Just to wrap it all up, the standard review plan, Section 14.2.1, laid out some specific justifications that staff has used in evaluating whether or not elimination of large transient tests is justified.

In response to the staff's RAIs related to this issue, Entergy provided substantial information in line with the SRP requirements, and we believe they provided adequate justification to eliminate the large transient tests. Did not believe the large transient tests would provide any new significant information that would enhance nuclear safety or really enhance their ability to model plant transients, given the existing operating experience of the plant.

And the fact that the existing equipment in the plant has been maintained, there is no -- no change in valve components or instrumentation that -- that would respond to a reactor trip or a load rejection transient.

MEMBER WALLIS: All right. Thank you very much.

Are we ready to move on to hear more about steam generator dryers?

MR. TATUM: Dr. Wallis, if I may, I have some clarifying comments I'd like to make on this large transient testing. My name is Jim Tatum. I'm Senior Reactor Engineer from the Plant Systems Branch.

And there's a couple of points that I think deserve clarification, because they don't really come out very well in the safety evaluation that we've written.

And I don't know to what extent that may have some bearing on the decision, but, first of all, the modeling of the secondary plant in the transients that are done -- the Licensee uses the LTC code, and based on what we've seen for the current power level operation, we would I think agree that the modeling has been done well, it's been benchmarked for the current 100 percent power level operation.

However, as far as the uprate goes, eight percent uprate -- and I think, you know, there's been a lot of discussion here about the specific modifications in question, but I would suggest we not lose sight of the fact that one of the modifications is, in fact, the eight percent uprate.

And the staff -- we have not looked or done any sort of a review of the LTC code to understand what are the sensitivities, what are the non-linearities in uprating eight percent, and, in fact, whether or not the plant would be adequately modeled at the eight percent uprate level such that the elimination of any transient testing is really warranted.

So that's one point that's not brought out. We did not do a detailed technical review of the LTC code, so we don't have that information. Our judgment is qualitative and it's based on what the Licensee has given us.

The other point that I would like to make is that -- and this is a clarification going back to the subcommittee. We had indicated that there have been a number of precedents set for the power uprates, and that's true. However, focusing specifically on a PWR uprate, the only other uprate that has been done for a PWR is ANO-2 back -- we approved that back in April of 2002.

Now, in that case, the Licensee had planned to do a 25 percent load rejection, at least to get some test data to confirm the adequacy of the modeling, and what not, the assumptions that had been done. So, you know, if we're talking about precedents, I think it's important to focus on PWRs versus PWRs and not the whole range of uprates that are out there, because PWRs are very different from boilers.

And as far as the LTC code, the staff typically, when we do reviews for the balance of plant systems for that part of the plant, we don't typically review those codes. We rely on the licensees to do that, and typically they do a good job, and we don't expect to see problems during transient testing.

However, because all the plants are different on the secondary side, it would be a monumental task for us to review in detail the codes and how they're applied in all cases in a manner similar to what Reactor Systems Branch does.

And so historically what we have done is we have relied upon transient testing. Granted, it may be a few data points, but what those data points do for you is it provides the Licensee an opportunity to go back and check the modeling that has been done and confirm that it -- at the uprated power level that, in fact, the predictions are satisfied for those specifics tests that were run.

And so it gives us some additional level of comfort, I would say, in demonstrating that the modeling was done properly, since we really don't do a detailed technical review of that.

And that -- those are the couple of points. I just wanted to make sure the committee was familiar with the extent of the staff review with regard to the modeling that's done. I wouldn't want you to have the wrong impression.

MEMBER ROSEN: Let me ask just one followup question. You did say that ANO-2 is the only precedent for this BWR uprate of this size?

MR. TATUM: In fact, it's the only one I'm familiar with, and it's not of this size. It's a smaller plant. Even now at the uprate condition I don't believe it operates at the power level that we're looking at here, and so the LTC code -- its use on ANO really would not reflect the higher power level that we're looking at here for Waterford.

MEMBER ROSEN: But staying with ANO now, did you say that ANO did a generator breaker opening test at 25 percent power?

MR. TATUM: They were -- as a result of the review, they had committed to do a 25 percent load rejection. The initial attempt for the load rejection was delayed due to some problems. They had rescheduled it for 90 percent power. They had some problems with the turbine control valves before they did the test and convinced the staff that they got enough data from that problem with the turbine control valves that they satisfied the 25 percent load rejection.

MEMBER ROSEN: So they never did the test.

MR. TATUM: Never did the test that I am aware of, other than -- and I don't know. I couldn't speak to what the actual load rejection might have been with the problem with the turbine control valves.

MEMBER ROSEN: Okay.

MR. TATUM: But I would agree with Tad

Marsh. I mean, reasonable people can agree to disagree, but I think we all should be working from the same facts.

MR. MARSH: Mr. Chairman?

MEMBER WALLIS: If the decision is equally balanced, maybe it's not too important.

MR. MARSH: Yes. Mr. Chairman, I just want to thank Jim for commenting, and this is -- this is demonstrating what we're saying, that there are good questions, good arguments, that can come out, and we appreciate these views. We did -- and Jim has more thoughts I know that we've talked about internally, and we have ventilated these up through our senior management.

And I'm not sure what you would like to do at this point, whether you would like to go point by point, or how you would like us to go --

MEMBER WALLIS: Let's just move on. I'd not sure the committee needs to --

MR. MARSH: Okay.

MEMBER WALLIS: -- although I'm happy with whatever way you wish to do so.

MR. MARSH: Right.

MEMBER WALLIS: My inclination is to move on to hear about steam dryers.

MEMBER ROSEN: Yes. I am, too, and I think I agree with Tad -- is that this is a question of -- I think we all have almost the same set of facts.

MR. MARSH: Right.

MEMBER ROSEN: I think it's a question where you come down on it.

MEMBER WALLIS: I think we've got the information. Thank you.

MR. MITCHELL: Just in closing up that section, I guess I can provide a couple more facts on ANO-2, because I was present for that. It was never a breaker open test. It was 25 percent load rejection from 100 percent was the original intent.

The control valve transient was about a 10 percent transient that did prove the transient, and subsequent ANO did have 100 percent -- had a reverse power relay fail that would have been a breaker open test. But it was an unplanned trip approximately six months into the cycle.

In that case, the LTC code, which is one of the pieces that we looked at heavily, did predict accurately the performance of ANO-2. And we have used ANO-2 data as well as our own data to make sure that our LTC code is also capable of predicting that performance.

MEMBER ROSEN: So it was a generator load reject of 25 percent from 100 percent is what they planned to do?

MR. MITCHELL: It was a generator load rejection, not a breaker open. It was a 25 percent transient. It was actually a turbine load reduction.

MEMBER ROSEN: So, yes, the plant would have ended up at 75 percent as tested and done successfully.

MR. MITCHELL: That was the original plan, that is correct.

MEMBER ROSEN: Okay.

MR. MITCHELL: Now, there were actually two incidents of the control valves going closed. It was due to a turbine control valve problem. That data did substantiate the LTC code, as well as six months later the plant tripped, as part of a reverse power relay failure.

So, in conclusion, I'd also like to stress that we have challenged ourselves internally and been challenged externally at looking at transient testing, and we have concluded what we presented today, really, that there is very little additional data provided over what we've been able to ascertain, and that the testing we do plan adequately proves the uprated plan.

Now we're going to shift towards the steam dryers, just a little bit of introduction. As we discussed in the subcommittee, past operating experience and inspections we believe proves our dryer performance. There are a number of differences between our dryers and those dryers on a boiling water reactor, and we do have some good comparisons with Palo Verde that we will be able to go through where the dryers see a higher loading than what we will experience with our power uprate.

So this -- it was also requested that we provide a visual comparison between the Waterford 3 dryers and the Palo Verde, and we will provide that. And we also had a lot of discussion on MSIV operations -- was there any way a loose part could impact the operation of the main steam isolation valves. We'll also talk about that.

So right now I'll turn it over to Don.

VICE CHAIRMAN SHACK: Just another question on the steam generator. What kind of plugging margin would you have left after the uprate?

MR. MITCHELL: We are analyzed to go to 1,000 tubes per generator. We are currently at roughly 1,000 total per generator. One is at I believe around 600, and the other one is a little under 400.

VICE CHAIRMAN SHACK: Fifty percent I guess that --

MR. MITCHELL: Don?

MR. SISKA: Good morning. My name is Don Siska. I worked at Combustion Engineering Westinghouse for a little over 28 years, about the last 13 years or so did primarily with operating steam generators. So I'm going to give a little discussion on the dryers that are currently in the Waterford steam generators.

As you can see, these things are really fairly small. They are only about 8-5/8 inches tall. There are 162 of them in the Waterford steam generators, arranged in about 12 rows across the upper steam drum.

MEMBER WALLIS: These are not safety-related components.

MR. SISKA: That is correct, sir.

Each dryer has 78 chevrons or corrugated plates on each side, so there is a total of 156 of these chevrons in each dryer. And you'll see in those little holes that they kind of put in there by hand, those represent half-inch bolts that connect each dryer to each other. So it's a total of four along the bottom and then one up about 3-1/2 inches up from the others. And those are on each side of the row.

So if you can imagine, each one of those connects to another and another and another, as many as 20 across one row.

What's not shown there is on the side underneath the chevrons. There are three slotted holes in which three more bolts -- half-inch bolts go in, so there's a total of three on each side.

MEMBER ROSEN: And those bolts are up and down?

MR. SISKA: Right. Those are also sideways. They're little U channels that come up, and they bolt sideways into it.

MEMBER ROSEN: So this is all to hold this massive -- all these modules, we'll call them, together.

MR. SISKA: Right. There are a total of 16 half-inch bolts in each dryer.

MEMBER ROSEN: And the steam flow direction is upward through the bottom?

MR. SISKA: It is up and then out in like a Y.

MEMBER ROSEN: Okay.

MR. SISKA: So these dryers individually are very small, you know, and have a very rigid -- rigid structure to them, very kind of robust and compact if you will.

MEMBER ROSEN: And they're made out of?

MR. SISKA: The sides are 3/16 carbon steel, and the top and bottom plate are 10-gauge carbon steel.

MEMBER ROSEN: The chevrons themselves are?

MR. SISKA: The chevrons themselves are 24-gauge carbon steel.

MEMBER ROSEN: These dryers are not unusual. They're the same dryers that have been in all original Combustion Engineering steam generators since CE started building steam generators. They are also -- they came really from the original history that Combustion Engineering had with the Fossil units. They're the same ones -- in fact, what's left of Combustion Engineering Fossil now puts in some of their units. They are very similar.

They have been used, really, since the 1940s. As I said, they are 8-5/8 inch tall, and they have at the base 12 -- essentially a one square foot entrance region for the steam. And they have a very,

very low pressure drop. So they're not designed to remove a whole lot of moisture, if you will. The pressure drop that we predict for Waterford goes up from about .2 to .25, so it's a very, very small change we expect in these dryers.

Now, back in the 1970s, these dryers --

MEMBER WALLIS: Is this steam slightly wetter with the uprate or --

MR. SISKA: It's possible, yes. We're predicting a slight increase in the moisture carryover.

MEMBER ROSEN: Can you quantify that? What is it now, and what would you --

MR. SISKA: Well, right now I believe the measured value is around .15, .18, in that region. We expect it to go up about --

MEMBER WALLIS: That's in percent?

MR. SISKA: In percent, yes.

MEMBER ROSEN: Finish your sentence. You expect it to go to?

MR. SISKA: About .22. But that value is -- is a calculated value. I believe Waterford is planning on running a moisture carryover test.

MR. MITCHELL: This is Tim Mitchell. We are doing a moisture carryover test early in the cycle, so --

MEMBER WALLIS: This is the moisture after the steam dryers or before?

MR. SISKA: After.

MEMBER WALLIS: So when it comes in, what sort of moisture is there?

MR. SISKA: Typically quite low. The separators output a value of around two to four percent, so the input to the dryers is very low moisture.

MEMBER WALLIS: But input is probably two percent, and then it dries it out to .2 percent.

MR. SISKA: To .2 about, right. That's a typical number.

MEMBER SIEBER: So underneath this is a steam separator?

MR. SISKA: Correct.

MEMBER SIEBER: Centrifugal?

MR. SISKA: Yes.

MEMBER SIEBER: Okay.

MR. SISKA: Back when Combustion Engineering was designing Palo Verde, there was some concern that these dryers would not be able to withstand the higher loadings, so we initiated a test program and ran typical loads of about 30- to 60,000 pounds per hour, also varied the pressure from about 600 psi to about 1,200 psi, and collected data on a number of things, primarily --

MEMBER WALLIS: You varied the wetness as well, varied the amount of moisture?

MR. SISKA: Well, it was -- yes, because it was a test of both separators and dryers. So the higher flows would see more moisture in some cases, and in some cases less. And essentially what we did is develop curves.

MEMBER WALLIS: So you covered the flow rate range and the moisture rate -- moisture range from Waterford?

MR. SISKA: Yes. And right now we expect the average flow through these dryers to be a little over 51,000 pounds per hour, so that's well within what we would see at -- in our test program.

This slide shows a comparison with Palo Verde, and I want to emphasize these are identical steam dryers. Palo Verde upper steam drum has a little smaller -- it's about 20 inches smaller, it's 232 inches versus Waterford, which is 253 inches. As a result, Palo Verde has 20 fewer dryers. It has 142 versus Waterford's --

MEMBER WALLIS: But they're the same dryer in units:

MR. SISKA: They're identical, correct.

Of course, you can also notice Palo Verde has two main steam nozzles. One other point I'd like to make about that is the distance, you know, from the dryers to the nozzles is rather significant. You know, the flow that comes up through the dryers, once it gets through the dryers, it's a very wide section of the steam drum, and really slows down. So the dryers do not see any of the real turbulent region in the steam drum.

MEMBER ROSEN: And there's nothing else up there.

MR. SISKA: Absolutely nothing. You can walk around up there. In fact, Waterford even has more room, because it's a -- it's a bigger head than Palo Verde. One other thing that Waterford --

MEMBER WALLIS: It's a short person if they're walking around at Palo Verde.

MR. SISKA: Well, at Palo Verde you would be, correct. But you could be fairly tall at Waterford.

Palo Verde also has two -- the two nozzles have Venturis in them. So actually the one nozzle in Waterford has more flow area than the two nozzles at

Palo Verde.

MEMBER FORD: So your CPI is that -- is very unlikely, even though a part of the steam dryer may become detached by corrosion fatigue or whatever. It is very unlikely that it could be going up that seven feet up into the main steam isolation valve, is that right?

MR. SISKA: That's correct. The flows are just too small. And I'll go into that in a little more --

MEMBER WALLIS: Okay.

MR. SISKA: -- detail. This slide I'd like to just go through quickly. It shows the comparison of Waterford to a typical BWR, and I'm certainly not going to be here to discuss the BWRs. But the one point I wanted to make is that in general in the BWRs the flow goes up, takes a 180-degree turn, and then takes another 90-degree turn to get out the nozzle.

And in that one region it's susceptible to -- it's a very high flow. It flows upwards of 100 feet per second and power -- or pressure fluctuations. And the only point I want to make with this slide is that the Waterford upper steam drum is a completely different animal.

MEMBER ROSEN: And the velocity is in Waterford? What do you --

MR. SISKA: Typically about nine feet per second.

MEMBER ROSEN: Versus 100 feet per second.

MR. SISKA: That's nine feet per second through the dryer. It then slows down after it goes back, and then as it goes towards the nozzle of course it speeds up again. But through the dryer, where we would expect to see the problems, it's about nine feet per second, 9.3 I think to be exact.

MEMBER SIEBER: What is the total steam flow to the turbine at Waterford from the first steam generator?

MR. SISKA: The first steam generator -- 8.3, 8.2996 times 10^6 to be exact.

MEMBER SIEBER: Okay. And so the number you quote here for the flow is per dryer.

MR. SISKA: Correct.

MEMBER SIEBER: Okay.

MR. SISKA: And, again, that's an average value.

MEMBER SIEBER: Yes, the 58 or 51,000.

MEMBER WALLIS: You tested one dryer at a time.

MEMBER FORD: When you did the testing, when you mentioned you had done some testing beforehand, what were the outputs from that test?

MR. SISKA: Primarily, we were looking for pressure drop and moisture content.

MEMBER FORD: But no vibration.

MR. SISKA: No. No. We were not looking at structural issues there. We did not consider that to be of concern.

MEMBER FORD: The reason why I guess that we keep bringing it up, it's of course hinged on the BWR performance.

MR. SISKA: Right.

MEMBER FORD: And you correctly point out that it's very different designs. But in the BWR performance, the unexpected failure that occurred at Quad Cities, etcetera, was because of not primary mode vibration but secondary and tertiary mode vibration.

So you don't really know -- and I'm just being devil's advocate here -- you don't really know that by increasing the flow rate through the steam dryer at Waterford that you are not increasing the vibration frequency amplitude.

MR. SISKA: We can't say for 100 percent sure. However, it is still bounded by the 20 years of operation at Palo Verde. They have higher steam flows than --

MEMBER FORD: But surely the aerodynamics at Palo Verde is not the same as at Waterford.

MR. SISKA: Probably not. I mean, they're not identical, but they're very, very close. I would expect because it's a smaller steam drum that the conditions at Palo Verde would be more severe.

MEMBER FORD: Yes.

MR. SISKA: But, you know, there's no way to say for sure. That would be my expectation.

MR. MITCHELL: I believe the testing that was done prior to them being used at Palo Verde also provides us data and assurance that we know the conditions post power uprate on our dryers.

MR. SISKA: During the last subcommittee meeting, there was also some discussion about loose parts. I wanted to include at least one slide on that. The first thing I wanted to say is that there has never been a dryer failure that we know of.

MEMBER SIEBER: Yet.

MR. SISKA: There has been over 200 reactor-years of operation. We believe the Palo Verde operation shows -- is more severe than what Waterford will experience during the uprate, or following the uprate.

The only failures, if there are any, that I could speak of are summertimes we have gone in during an outage to do an inspection and find a bolt missing. There are -- these nuts and bolts are almost all below the dryer deck, with the exception of those that have to attach to the channels and at the end.

And if you can imagine, to get to these dryers and to take them out, there's only one way to get to them and that's from underneath. So the nuts that are on the other side are all welded in place, and just the bolt will go in there. So even if one of those nuts fell off, they essentially just fall into the dryer drain channel. And there's almost no flow there.

So, really, all of the nuts, bolts, and lock washers are either below the dryer deck or, at worse, would fall into a dryer drain channel.

MEMBER ROSEN: Is there any way into that drain channel? And could you go in and look to see if you were losing --

MR. SISKA: Yes, by going -- and Waterford does, on a regular basis, not every outage, but they will take the -- several dryers out and go out and look above to make sure, you know, everything looks okay out there.

MEMBER ROSEN: So they actually can get a person in?

MR. SISKA: Yes. You have to take three or four dryers out, depending on the girth of the person.

MEMBER ROSEN: So what has been found? What has been found there?

MR. SISKA: To my knowledge, nothing.

MEMBER SIEBER: Have you ever had instances where nuts and bolts went down through the tube bundle through the separator?

MR. SISKA: We have certainly found nuts and bolts down on the tube bundle. I don't know --

MEMBER SIEBER: From the dryer.

MR. SISKA: Yes. I don't know if they, you know, were from the dryer.

MEMBER ROSEN: Can we hear from the applicant what you've seen if you have done those inspections?

MR. MITCHELL: The inspection program has never revealed anything. I can't say that we've never seen a bolt or a nut missing. Okay. I have validation. We have never found a nut or a bolt missing. While I agree that that is possible, I think it would be trapped up above and captured in the drain area, just from the physical --

MEMBER WALLIS: Never found a bolt missing or a missing bolt? And a bolt missing would be a hole with no bolt, but --

MR. MITCHELL: Right.

MEMBER WALLIS: -- a missing bolt would be a bolt with no place to go.

MR. MITCHELL: We have never found a bolt missing.

MR. SISKA: Yes. In another plant, I got a phone call one time and got a picture -- they sent me a picture of the missing bolt.

(Laughter.)

Which was actually -- was a --

MEMBER WALLIS: It may never have been a bolt.

MR. SISKA: Right. We did not find it anywhere. It was not --

MEMBER SIEBER: I think you have a slide like that in here.

MR. SISKA: I do. You're right.

MEMBER WALLIS: A missing slide?

MEMBER SIEBER: Yes.

MEMBER WALLIS: Okay. I would be more

concerned about flying louvers I think, but --

MR. SISKA: Yes, there's just no real --

MEMBER WALLIS: -- they rattle, and then they can break off, and -- but that has never happened.

MR. SISKA: We've never seen that, no.

MEMBER SIEBER: Can you tell us what the steam velocity and feet per second was through the loop?

MEMBER WALLIS: 1.3, I think you said.

MEMBER SIEBER: That's pretty low.

MR. SISKA: That's through the dryer vent.

MEMBER SIEBER: Yes, that's pretty slow.

VICE CHAIRMAN SHACK: And what's the velocity at Palo Verde?

MR. SISKA: Palo Verde is slightly less than that, but it has much higher pressures. Palo Verde I believe is 8.6.

MEMBER WALLIS: RV-squared might be more.

MR. SISKA: Right. So the Rowe V-squared or dynamic pressure is about 10 percent higher at Palo Verde.

MEMBER SIEBER: Okay.

MR. SISKA: So, in summary, you know, I -- I'm very comfortable saying that the EPU conditions at

Waterford are bothered both by the test program that we ran back in the 1970s and by 20 years of operation, or very close to 20 years of operation, by Palo Verde.

The flow loadings through these dryers are very, very small. You know, the absorbed energy that you get is very small, and it's really not significant to cause vibration. And any loose parts -- nuts, bolts, lock washers -- the only things we've ever seen and expect -- could not enter the main steam line.

MEMBER ROSEN: That's because they formed below? They would be below the dryers?

MR. SISKA: Right. Ninety-five percent of them would be below the --

MEMBER ROSEN: Well, what if one was above the dryer? Is there enough lift to get --

MR. SISKA: No. As I said, the only thing that's above are those nuts that are connected to the drain channels. And they're welded. If they happen to come off, they would just fall over. There's no flow right there.

MEMBER ROSEN: But even if you took 9.3 feet per second and took a nut or a bolt and dropped it, would it fly, or would it just fall down?

MR. SISKA: I'd have to look at it. My guess is it would just fall straight down. They would hardly even notice it.

MEMBER ROSEN: The only thing, as Chairman Wallis says, is the chevrons themselves if they came loose might -- might fly in that stream.

MR. SISKA: Those would make a pretty good wing.

MEMBER ROSEN: Yes.

MR. SISKA: I do not expect to see any kind of --

MEMBER ROSEN: But they are about that long, 10, 12 inches long?

MR. SISKA: No. They're about -- I think they're about seven inches long by some and four and some.

MEMBER SIEBER: That's why they have screens on the throttle valves.

MEMBER FORD: Could I just as a subsidiary question?

MR. SISKA: Certainly.

MEMBER FORD: Does Waterford have glass condensers?

MR. MITCHELL: Waterford has a stainless steel condenser.

MEMBER FORD: Okay. The reason for the question is it might impact on the value of the steam dryers.

MR. SISKA: Okay. We're talking tube material, correct?

MEMBER FORD: Pardon?

MR. SISKA: You question was tube material, right, in the condenser? Tube material? Yes, the main condenser has stainless steel tubes.

Okay. Thank you very much.

MEMBER WALLIS: Thank you.

Does the staff have any comment on steam dryers?

MR. KALYANAM: No, we are not going to present anything.

MEMBER WALLIS: So where are we? Are we at the end here and everyone is going to sum up?

MEMBER SIEBER: They must be. It's noon.

MEMBER WALLIS: Right. Are you going to sum up first or --

MR. MITCHELL: Mr. Chairman, I do have some updated or more precise information that -- tube plugging on the steam generators.

MEMBER WALLIS: Yes.

MR. MITCHELL: 571 on one generator, and 440 -- 484, excuse me, on the other steam generator. So the total number is roughly what I told you.

MEMBER WALLIS: I'd like to say that that discussion of the steam dryers was very responsive to the subcommittee's questions. Thank you.

MEMBER ROSEN: Joe, could I ask you a question before you start?

MR. VENABLE: Yes, sir.

MEMBER ROSEN: If for some reason this uprate was not: a) approved, or approved soon, what would -- what would you do at Waterford in terms of -- would you refuel and make mods anyway, and go back to existing power?

MR. VENABLE: Yes, sir. We have various contingency plans that we have already developed. The generator rewind pretty much does need to be done at Waterford. It's concurrent with the power uprate. We would probably continue and do the generator rewind. We'd replace our main transformer, we'd replace the output breakers, those things on the secondary side we felt we needed to do.

We'd definitely make a decision on the turbine rotor itself, and we'd have to do the -- execute the contingency planning for the fuel that we've already purchased and how that would interface with the plant. We do -- we are looking at that, and that is a viable option for us if it's not approved.

MEMBER ROSEN: Well, I'm not thinking it wouldn't be approved, but I'm just thinking what would the -- would the plant end up be sitting there forever?

MR. VENABLE: No. No, it would not. In fact, with the power uprated like this, you can imagine we just offloaded a 420-ton main transformer associated with the power uprate at our station. Had that transformer been damaged somehow and could not have been able to be used, we would have to fall back on the contingency plan again on what power level we'd go to and how we would do that.

MEMBER ROSEN: Okay.

MR. VENABLE: So I think all the way through the power uprate there is contingencies for us on what we should do here. Some of them may require more evaluation and decisionmaking.

Mr. Chairman, I first would like to thank this committee and the NRC staff for the work performed toward the Waterford 3 power uprate. It's pretty extensive work. We saw a lot of that here today. Again, this was a very challenging, systematic, and thorough approach to a power uprate, and I value that very much as the site vice president.

Entergy operates from multiple nuclear

sites, both BWR and PWR. We have a depth of our experience in our leadership team that we share and challenge every endeavor that we make.

Myself -- my background -- I didn't say that to begin with, but I'll give you a little bit today. I've been working with Entergy for 25 years. Prior to that, I was Navy Nuclear. I have been a Maintenance Superintendent in construction, went through initial startup and testing, normal power operations, refuelings at multiple sites, both BWR and PWR in my 25 years. Been at Waterford for about three years.

Been involved with this power uprate since the very first presentation to the Board of Directors. I made the presentation to our Board of Directors, looking and seeing if this power uprate were safe and appropriate for Waterford. We had quite a discussion there at our Board meeting on whether this was appropriate for our station.

Last week I personally challenged Westinghouse, Intercon, and Entergy engineers asking them if anyone had any reservation, whether it was margin that was too small, or something that they weren't comfortable with, that we should bring forward and either resolve or stop our power uprate.

I still have that question on the table for all of our engineers going forward, anything that may be discovered.

I got positive results from that. In fact, got letters from Westinghouse via e-mail right away, challenging -- they set engineers aside, asked open questions with nuclear safety as a priority. No economic questions, no pressure questions, just nuclear safety. They got very, very favorable and positive results.

I will tell you that we will continue to challenge, evaluate, and monitor all aspects of this power uprate, and we will do what's appropriate to assure that Waterford is operated safely and reliably. And, again, I'd like to personally thank the committee and the NRC staff for working so diligently with us to get to this point in this power uprate.

So I appreciate that, Mr. Chairman.

Any questions for me?

MEMBER WALLIS: Well, we seem to be mutually thanking each other, so I will thank you.

MR. VENABLE: Very good.

(Laughter.)

Thank you, sir.

MEMBER WALLIS: Do we have some final

words from the staff?

MR. MARSH: Yes. Thank you, Mr. Chairman. I guess I'm sorry, thank you, but --

(Laughter.)

I appreciate the conversation that we've had today, and I appreciate the dialogue we've had with the licensee. I hope you got a sense of the extent of the staff review, and also the necessity to keep looking at this review standard to make sure that we've got it in an appropriate place, to make sure that we've tuned it properly to issue whatever guidance we need to to the industry in terms of completeness and thoroughness of submittals.

Stepping kind of back through the presentations today, long presentations and a lot of discussion on born precipitation today, and I said we'd come back to that, especially the generic aspects of the boron precipitation. So I've asked Mike Johnson, who is the Deputy Director for the Division of Safety Systems and Assessment, to work with the staff and to perhaps summarize for us today where we think we need to go.

So, Mike?

MR. JOHNSON: Thanks, Tad. I was looking around to see if Frank Akstulewicz was in the room, and he's not. I guess we finished a little bit sooner than he anticipated.

Michael Johnson. Frank is in the room.

We will be responsive to the issues that are raised by the ACRS, and, of course, if you should recommend, we'll look into the generic aspects of this issue. And I won't go beyond what we've already said with respect to having looked specifically for Waterford and being comfortable with respect to our analysis on boron precipitation and being ready to move forward with respect to that.

MR. MARSH: Thank you, Mike.

Mr. Chairman, we are satisfied with the information that we've received from the licensee. Recognizing that there still is this docketing information that will come in, we are satisfied with what we have heard in the dialogues that we -- what we've gotten so far.

So you and I were chatting just before we reconvened about what -- what to do. I do request that a letter be written endorsing the staff's approach. Staff will not issue the amendment in final unless we are satisfied with the information that comes in. So that's a review that needs to take place.

But based on the dialogue that we have had, based on the -- what we have heard today, the dissertations today, we are satisfied, recognizing what Mike said, that we need to look at this generically to see what needs to be done with respect to the staff's approval of the topical report and whether we need to -- to think more carefully. But we do request a letter endorsing our approach.

MEMBER WALLIS: Now, this boron precipitation, I understand work was being done until a very short while ago in preparation for these presentations. And my experience of writing reports is that until I've written it down and reviewed it carefully, I don't have an opinion. I'm very careful about saying I decided until I've really decided.

So we're sort of waiting for the applicant to give its final word on what it wants to submit on the boron precipitation in terms of the final statement, and we're also waiting for your final review of that. Is that true?

MR. MARSH: True enough. We do not have in writing what we have said back and forth to each other. But we would not be recommending to you to approve what the staff is approaching, if we had concerns about the approach that we've heard thus far.

So we are satisfied.

We've heard verbally -- you are right -- we have to review in writing what we have heard to make sure that we get in writing what we thought we were going to get, and that's my commitment to you and to all of us that the amendment won't be issued unless we're satisfied with it. It would not.

If the committee is more comfortable waiting for the staff to give you a thumbs up that we've got in writing what we thought we heard, that's fine. We are comfortable with what we've heard verbally thus far.

MEMBER WALLIS: Are you comfortable with an experiment where materials are put in a beaker and it's observed but it's not really as a quality assurance test, it's sort of a very, very quick and --

MR. MARSH: To be honest with you, it was unclear to me the extent to which the licensee was relying on that for the licensing calculation. You know, it was -- it was unclear to me.

MEMBER WALLIS: It would seem to be the basis of this 40 percent number for solubility limit.

MR. MARSH: I'm not sure, to be honest with you. Staff could help on that? I mean, I'm not sure the extent to which those numbers came from that experiment.

MEMBER WALLIS: So you'd like a letter which says, "We think the staff is on the right track and there;s" --

MR. MARSH: Yes, sir.

MEMBER WALLIS: -- "one or two things to be resolved, but we believe they will be resolved"? Is that the sort of thing --

MR. MARSH: Yes.

MEMBER WALLIS: -- you'd like to hear?

MR. MARSH: Yes, I do.

MEMBER WALLIS: I guess I have to discuss that with my colleagues to see what they --

MR. MARSH: Sure.

MEMBER WALLIS: -- feel about that. But not at this point.

MR. HOLMAN: This is Jerry Holman from Waterford 3. We are relying on those tests to show the solubility limit elevation as a result of the TSP. That would result in a solubility limit of about 36 percent, compared to the 28 percent roughly that's used in the current analysis that does not credit any TSP or containment pressure.

MEMBER POWERS: A couple more questions about that solubility limit. You're looking at the effect of the trisodium phosphate on the solubility of boric acid in the water, and that trisodium phosphate comes from water dissolving dust pellets that you've put someplace.

That someplace, does it bring any additional contamination in -- in particular, things like dust?

MR. HOLMAN: The baskets that are filled with the TSP are located in the containment floor where they will be submerged with water. Obviously, there is the potential for debris that gets swept up in that sump water.

MEMBER POWERS: What I am concerned about is there are a variety of calcium borate/calcium phosphate compounds that have extraordinarily low solubilities. And if you would per chance incorporate into this some calcium carbonate or, worse, calcium hydroxide, would that cause precipitation of solids? And does that have any detrimental consequences? At what level would that start having detrimental consequences?

MR. MITCHELL: This is Tim Mitchell. We talked about insulation and containment as part of the sump debris discussion during a subcommittee. And we did report there that we don't have any calcium carbonate insulation in the containment, so that would be one of the primary sources of --

MEMBER POWERS: I guarantee you absolutely you've got calcium carbonate in that containment.

MEMBER WALLIS: Coming from the concrete.

MEMBER POWERS: That one I positively guarantee you.

MEMBER WALLIS: Concrete dust is the --

MR. MITCHELL: You said calcium carbonate insulation. Did you mean calcium silicate?

MEMBER POWERS: Yes. I'm sorry, I misspoke. You're correct.

But I would like to emphasize that the TSP piece is just one element of the conservatism that we were going over. So --

MEMBER WALLIS: Anything else? Are we ready to take a break for lunch?

MR. MARSH: Mr. Akstulewicz here was just showing some data which the staff has on -- with respect to solubility limits. I just want to make sure that you have that, which seems to agree with the data that we've heard today, you know, with respect to solubility limits. We'd be glad to share that with you, but --

MEMBER WALLIS: Is it something you could put up on the screen? Or just tell us the numbers. Can you tell us the numbers?

MR. AKSTULEWICZ: This is Frank Akstulewicz with the staff. There is a graph or a figure in the CENPD document itself which is the approved topical report that is a solubility curve with respect to temperature, and it's -- the source is the U.S. Borox and Chemical Corporation. So we'd be happy to provide this to the committee today, if it would help.

MEMBER WALLIS: Okay. Thank you.

MEMBER POWERS: Has the staff looked to see if there are precipitates perhaps involving iron? Involved with either the phosphate or the borate or the ternary system?

MR. AKSTULEWICZ: I don't know. This is Frank again. From the staff's perspective, we haven't looked at the effect of debris on boric acid precipitation. That's one area that is well beyond where we've been, so we don't have any real information to provide on that.

MR. MARSH: This is Ted Marsh again. That's probably part of the going forward that Mike Johnson was talking about -- issues of this sort, to see where we need to go, if we need to think about those things.

MEMBER POWERS: Do you have any idea of what -- what level of particulate would start to cause you a headache?

MR. MARSH: I'm sorry. What would cause as a headache precipitation -- I missed the first part. I'm sorry.

MEMBER POWERS: What concentration of particulate would start causing you a headache? Suppose you got flocculent precipitate.

MR. MARSH: I'm sorry. I don't. I'm sorry. I don't know that. I do not have any information one way or the other.

MEMBER POWERS: I don't either.

MR. MARSH: I just don't have a benchmark for myself. It sounds like we don't.

MEMBER WALLIS: Do you have any idea about when boron precipitates how it does it? Does it precipitate on the surfaces? Or does it just make sort of a mush of -- in the liquid, and, therefore, it doesn't really block anything.

MR. MARSH: These are good questions.

MEMBER WALLIS: Okay. There are a whole lot of questions scientifically about the basis for what happens with concentrated boron --

MR. MARSH: I understand.

MEMBER WALLIS: -- solution.

MR. MARSH: But I think that's -- these are questions the staff needs to think about in terms of the regulatory position, the licensing basis for this and other plants.

MEMBER SIEBER: There might even be some research done?

(Laugher.)

MR. MARSH: What should I say? There might be.

MEMBER WALLIS: Is there anything else on Waterford before we break for lunch? Anything else that committee members have on this Waterford uprate?

MR. MARSH: Thank you very much.

MEMBER WALLIS: Thank you. I propose that we take a break now, and that we break until 1:15, and then we'll take up the matter of the MOX fuel fabrication facility.

Thank you.

(Whereupon, at 12:17 p.m., the proceedings in the foregoing matter recessed for lunch.)

DR. WALLIS: On the record. We are going to take up the matter of the Mixed Oxide Fuel

Fabrication Facility and I will hand over to my esteemed colleague, Dana Powers, to lead us through that.

DR. POWERS: We'll talk about the Mixed Oxide Fuel Fabrication Facility. The Facility as you are aware is to fabricate fuel made with plutonium dioxide and uranium dioxide for use in a commercial nuclear power reactor. It is in the midst of a licensing approval process that involves two stages. This is the stage that involves the construction permit.

There is a subsequent stage that involves the license to possess and utilize special nuclear material. And as you are aware, the requirements for this stage are constrained and in your handout are the specific requirements. I'm sure the staff will touch upon the specific requirement for this stage.

But bear in mind the detailed quantification of the safety of this facility is not part of this stage. We are looking primarily of this stage and what are called the design bases, some aspects of the quality assurance program, some aspects of the definitions of structures, systems and components that help provide the functions at this stage.

We have had several meetings in connection with this particular facility as it's gone through some evolution in its mission. We did have a recent subcommittee meeting in which I think most of the members were in attendance. Those that were not, I hope we can catch you up to speed very quickly on the facility.

We are at the stage now where the staff has completed its safety evaluation report of the construction authorization request and they are looking for a letter from us saying that, I'm sure that they would like it to say that, they had done a wonderful and outstanding job and was complete in all details. We'll see how that comes out, but I know that's what their aspiration is and I believe it is our intention to produce a letter at this meeting.

With that introduction, I will say that we're going to talk primarily with the staff here today about their safety evaluation report. DCS has been enough to attend with an interest in answering any questions that we may have about details of the detail and their safety philosophy and I presume some of their plans for moving ahead into the next stage of operation if that comes up. So with that, I'll turn it over to Joe and you guys can go ahead and start unless there are any questions or comments the members would like to make.

DR. RANSOM: I have a real quick one. I think I read on some of the NRC home page material that this is only for processing excess plutonium from the U.S.

DR. POWERS: Yes.

DR. RANSOM: I thought originally it was part of the European or --

DR. POWERS: It is part of a cooperative treaty between ourselves and Russia. There is a parallel activity going on in Russia. The two activities are supposed to be moving along with some parallelism. I don't know exactly how parallel they are, but there will be occasional interruptions, I'm sure, as things don't become parallel none of which has any bearing on how we view this AP evaluation report.

DR. APOSTOLAKIS: We're not even using the whole amount of America plutonium. Right? Or MOX?

DR. POWERS: Absolutely down to the last gram and atom in this country. No. The system is handle about 37 tons.

DR. APOSTOLAKIS: I'm a bit confused about what is needed for the construction part.

DR. POWERS: We're going to talk about that.

DR. APOSTOLAKIS: It's a design basis analysis. Right? But the design basis includes the design basis accidents, doesn't it not?

DR. POWERS: Well design basis accidents is a term more peculiar to the reactors. Here you're looking at probable or potential accidents at the facility.

DR. APOSTOLAKIS: But are these part of the design basis? I mean we're not going beyond the design basis. Is there such a thing as beyond design basis?

DR. POWERS: I mean really. Clearly, you have accidents like meteorite strikes on the facility that we can safely assume are not included in the design basis. And I think this is more a process facility examination. It is a first look at what the safety philosophy of the facility is. They are required to look at things like difference in depth as strategies and not required to adopt them in other cases.

You're more likely looking at how they think they're going to approach it. There is a clear bias in the regulations for engineering controls in preference to administrative controls. That doesn't mean to the inclusion of administrative controls.

DR. APOSTOLAKIS: Yes.

DR. POWERS: So you're trying to look at what the mix is here between prevention and mitigation, what kinds of things that they are doing to protect the work force and the public, what kinds of hazards they are anticipating to take into account. You're not asking them what the risk of the facility is.

DR. DENNING: But, and George will be interested in this, there is a risk-based approach towards deciding how much has to be done, when things have to be done.

DR. POWERS: Yes, but we don't get into that until stage two.

DR. APOSTOLAKIS: Yes, that's what I'm saying but you still have now. This is not for the construction.

DR. POWERS: Look at this as the deterministic phase and a good PRA, George.

DR. APOSTOLAKIS: Yes.

MR. ROSEN: When we get into the other phase, do we call that the ISA?

DR. POWERS: Yes, right. Integrated

Safety Analysis and that's when George will lose whatever hair remains.

MR. ROSEN: And whatever degree of composure.

DR. WALLIS: Dana, I have a question for you. You said that this stage we have to be satisfied that the design will provide the function without going into the details. Now sometimes it is easy and even if it's a reactor which has been used before and it's being controlled from going into some unstable region by vents and cooling and all that, that's all state of the art and it's been done before. We don't need to go into the details. It's been done before and it provides a function.

But if we have a reactor where we're told it's going to provide the function by venting and cooling and we don't have enough evidence that it's been done this way before without going into the details, we don't know if it's going to work. So how do we assure ourselves something will provide the function.

DR. POWERS: The regulations involved here do require that there be some justification for values and what not in them. Now to say it hasn't been done before, I can think of nothing in a fuel fabrication facility that has not been done before multiple times, in multiple ways.

DR. WALLIS: Maybe that's where we get assurance, the suitable experience.

DR. POWERS: And this particular facility, in particular, is fairly well patterned after existing facilities.

DR. WALLIS: Well, maybe that needs to be emphasized.

DR. APOSTOLAKIS: So 10 CFR 70 has been used in other context.

DR. POWERS: Oh, no. Most fuel fabrication facility, processing facilities, fuel fabrication, yeah, that's done before, but fuel processing facilities have largely been done in this country in the DOE context where you use PUREX and things like that. And there have been a lot of those facilities set up, torn down, rebuilt, blown up.

DR. APOSTOLAKIS: So 10 CFR 70 is implemented here for the first time?

DR. POWERS: No, I don't think that's clear at all. There are some unique features being applied to the MOX facilities. Dave, do you want touch on that?

MR. BROWN: In my presentation, I'll

describe a little bit of the history of Part 70.

DR. APOSTOLAKIS: Okay.

MR. BROWN: And what parts of it are being applied for nearly the first time.

DR. APOSTOLAKIS: That's fine.

MR. GIITTER: We're currently applying Part 70 to the gas centrifuge licensing reviews for example.

DR. APOSTOLAKIS: Let me ask another. Okay. We'll come to that.

DR. WALLIS: Let me ask a question in terms of scope of what the British expect of us. If we have questions about the absolute completeness of the design basis parameters.

DR. POWERS: Option of what? I'm sorry.

DR. WALLIS: The design basis parameters.

DR. POWERS: Completeness.

DR. WALLIS: For instance the degree of process control or chemical control, the absolute values are put onto those lists. Is that within the scope of our expectations? What is the data? What is the analysis to come up with the voracity of that data and analyses to come up with those design basis parameters?

DR. POWERS: Let me say this. I can't

give you a completely generalized answer. What I can say is the question that you had posed to me is fair game.

DR. WALLIS: Okay.

DR. POWERS: The answer may not be entirely satisfactory to you.

DR. WALLIS: Right.

DR. POWERS: But the question that you have posed in writing is fair game for this briefing.

DR. WALLIS: Good.

DR. DENNING: Perhaps one area that is clear is the focus is on structure systems and compliments that provide safety. Have they identified really those? We ask this question in -- But with regard to set points, this is not the time when we worry about the set points. It's really a question of have they really identified the structures, systems and components that have to be incorporated into this.

DR. APOSTOLAKIS: I don't know what "identified" means.

DR. POWERS: That's a different question.

DR. DENNING: "Identified" is more than just identified. It's really they've characterized how they're going to include it. I mean we're talking about constructing --

DR. APOSTOLAKIS: And why.

DR. DENNING: Oh yes, and the why, absolutely. But that's really the question. Have they really provided for the structures, systems and components that will provide after they fine tune them and cut set points and stuff like that the level of safety that will ultimately have to be demonstrated at the operating point.

DR. APOSTOLAKIS: Okay.

DR. POWERS: Are there any other questions?

MR. GIITTER: Okay. Thank you, Dr. Powers. My name is Joe Giitter and I'm Chief of the Special Projects Branch in the NMSS Fuel Cycle Division. As Dr. Power explained, we are proposing to issue a construction permit for the Mixed Oxide Fuel Fabrication Facility and we've asked the Committee to write a letter in support of the staff's safety evaluation report. The road that we've traveled to get to this point hasn't always been free of curves, hills and an occasional chuckhole.

In 1998, Congress granted NRC authority to license the Department of Energy Mixed Oxide Fuel Fabrication Facility. At that time, DOE had completed its initial studies on the methods to dispose of surplus weapons grade plutonium and had selected its radiation of MOX fuel in commercial nuclear power plants as a viable disposition path.

NRC was faced with the possibility of reviewing its first plutonium facility license application in over 30 years. Two years later in September 2000, NRC staff completed a nine year effort to revise the Part 70 regulations for fuel cycle facilities. The Part 70 revision was one of several initiatives at NRC to risk inform its licensing regulations. The novel challenges of licensing a MOX facility were compounded by the challenge of implementing a new risk informed regulation.

To meet this new challenge of licensing a MOX facility, NMSS assembled a high performing team of specialists with the diversity of backgrounds and technical disciplines. Because it has been over 30 years since the NRC had conducted a safety review of plutonium facility, we worked with Los Alamos National Laboratory to develop and conduct a training course on topics relevant to the production of MOX fuel. We were also able --

DR. APOSTOLAKIS: Excuse me. I don't understand that. You hadn't done it for 30 years. Therefore Los Alamos comes into the picture. Why?

MR. GIITTER: To provide training to the staff. We want them familiar with plutonium technology.

DR. POWERS: Los Alamos operates TO55 which is a miniature facility that essentially does every one of the actions here. In addition, they have a long history of providing technical background for much of the plutonium activities within the DOE complex.

MR. GIITTER: Thank you. We were also able to send some of our key staff to the LaHague and Melox facilities in France which are the reference plants for the U.S. MOX design.

In early 2002 and again in late 2003, DOE decided to initiate major changes to the surplus plutonium disposition program which resulted in changes to the MOX facility. These program changes posed additional challenges to the staff by raising additional environmental and safety questions.

More recently in October 2004, the NRC suspended public access to the ADAMS On-line Library and some other parts of its website to review documents and remove any that could reasonably be expected to aid a potential terrorist. The considerable staff effort that was required to screen, redact and remove sensitive information and restore public access to ADAMS which has had an impact on several important licensing efforts including the MOX construction authorization review. As a result, the shutdown of ADAMS, we do anticipate completing, the preparation of the FSER and construction permit in February, but we do not anticipate completing the review in February, but we will make every effort to complete this review by mid March or perhaps the end of March.

To conclude, I'd like to tell the Committee that I appreciate all the hard work and quality efforts that my staff had put forth to complete the final safety evaluation report. This project has required a significant and sustained effort by a team of very talented scientists and engineers and I'm proud of what they've accomplished given all the obstacles before them. We're looking forward to your questions and comments and with that, I'd like Dave to start on the presentation and describe what we did on the FSER in more detail.

MR. BROWN: Good afternoon. I'm Dave Brown. I'm the Project Manager for the U.S. Mixed Oxide Fuel Project Licensing Project. I appreciate the time you're taking this afternoon to listen to our presentation. Am I being heard well? In the back? Okay?

DR. WALLIS: Yes.

MR. BROWN: What I'd like to do is just briefly summarize what I'll be doing this afternoon which is to first discuss the regulatory framework for the construction authorization which is a question that has already come up. Having established what's needed for a construction authorization, I'll also summarize what we're then expecting in a later license application and ISA summary.

I'll provide a description of the facility so that will provide you some context for understanding what DCS did in their safety assessment, what sorts of things they looked at as hazards. Then I'll provide an example of one of the hazards and how DCS implemented its safety assessment methodology and what are some of the things that the staff did to review that along the way. Then I'll summarize.

The purpose of this meeting is to just brief you on the construction authorization request review which we've already described. This is a flow chart we put together some time ago that describes this two-step licensing process. Along the top row this flow chart you see the construction authorization phase for this facility and along the bottom row you see the later phase that would be the review of the license application for possession and use of licensed material.

So where we are in this process, this is four years down the road, is the ACRS review of the construction authorization. The staff is reviewing the construction authorization request. We will then shortly issue the SER and then there'll be an opportunity for late filed contentions and the hearing, and there may be a hearing. Then having issued the construction permit, we would later review the license application. That starts a whole other stage of the review and of course, continuing, we anticipate, the ACRS involvement.

What I want to do though, having said that, just provide a little bit of historical context. Why are we doing it this way? In 1971, what was then the Atomic Energy Commission reviewed the safety at what were then eleven operating mixed oxide fuel facilities. This is not the first facility of its type to be built and operated in the U.S. In 1971, there were eleven operational facilities. They certainly weren't at this scale. They were small-scale operations, but there's a plant in New York, Pennsylvania, Oklahoma, Tennessee.

DR. WALLIS: Did these use the same basic chemical process as the one we're discussing today?

MR. BROWN: The plutonium would have been purified by a very similar chemical process, a PUREX type process and then in most cases, the fuel was produced for light water reactors. So it was the same pelletized in clad fuel and it was used in commercial nuclear power plants anyway. At that time, some of the fuel that was being produced was for different types of reactors such as the fast flux reactors. But many of the processes were similar.

At that time, the Atomic Energy Commission determined that these plants could not withstand natural phenomena events such as tornados or earthquakes. They were built to essentially uniform building code type standards and there would be considerable consequences if any of these plants suffered a severe natural phenomenon event.

At that time, they decided to revise the rule so that at that time AEC would first review and approve the design bases for principal structures, systems and components before a MOX facility could be built. It was required then that an applicant for such a facility would have to include this safety assessment of the design bases, a site description and a quality assurance plan. The staff would have to review that before construction could start.

The design bases is a term used in Part 70 but it's not defined there. So staff for the current purposes have adopted the Part 50 definition of design bases which are "the specific functions to be performed by a structure, system or component of a facility and the specific values or ranges of values chosen for controlling parameters as referenced balanced for design." And I think perhaps the best thing is just to use an example to go through that, but in the current --

DR. APOSTOLAKIS: Is this definition consistent with the definition in regulatory guide 1.174 or is it different?

MR. BROWN: I do not know.

MR. MAGRUDER: This is Stu Magruder of the staff. Actually I helped developed 1.174 and we worked directly from this 50.2 definition. So it is consistent.

DR. FORD: Can I ask a question? Further on in 50.2, it goes on "under the design basis description as determined by calculation and/or experiment." Most of your design basis parameters are based on calculation. At what point the qualification of the code associated with that calculation, at what point is there qualification of the code versus data? How important is this data?

MR. BROWN: In cases where, for example, for conception design basis for this facility, there were computer models used. For example for criticality of safety, we reviewed the criticality validation reports which were the documentation for those codes that were implementing the available physics if you will on criticality.

DR. FORD: There's also chemistry codes.

MR. BROWN: In the case of the chemistry codes review at this point what we've done is deferred some of the validation of that data to the ISA stage. For example for --

DR. FORD: You said the validation of that data. Did you mean that or do those validate the calculations?

MR. BROWN: No. The data is available. It's in a single published literature. For example, it supports the prevention of explosions involving hydroxylimine nitrate. Just an example. One of the things, and the data that's available is based on individual tests that were performed to achieve different goals. Now what in this case the applicant has done is integrated that data in a way that they've come up and shown that they can establish safe operating ranges based on a model that fits that data. We have accepted a commitment that they would validate that model with further testing experiments as part of the ISA.

DR. FORD: That validation is called the code. Clinical validations come at a later stage are you saying?

MR. BROWN: Yes.

DR. KRESS: That definition, the word control, is that an adjective or a verb?

MR. BROWN: That's a good question. I see it as an adjective. The parameters of -

DR. KRESS: That's the way I was reading it but I wasn't sure.

MR. BROWN: Okay. Let me just go through that example I mentioned before. For example, for criticality safety, one of the things that we're looking at closely now is what is the safe margin of subcriticality, for example, a K effective of 0.93. That is the controlling parameter for design at this point. The structure perhaps could be a vessel.

Having established a design basis and the principal SSC for example a vessel, I still have considerable flexibility in design, design alone. I can use neutron absorbers. I could use geometry controls. I could any number of different types of controls to maintain that subcritical margin. So that's the kind of thing we've had to establish as part of this review. Do we have an accepted design basis and have we allowed the flexibility in design for the applicant to later implement whatever kind of design they feel is necessary.

DR. WALLIS: Can we pursue this a little bit? Now if I have a reactor, presumably what you're looking for in the design basis is that it's operating in some range of pressure and temperature or something. That's what you mean by controlling parameter.

MR. BROWN: Yes.

DR. WALLIS: But that doesn't say how big it has to be or how big the vent valves have to be or how big the heat exchanger has to be to cool it. It simply says that it has some means of cooling and some means of venting. Is that what you understand at this point?

MR. BROWN: Yes.

DR. WALLIS: So we assume that that can be worked out later. Right?

DR. APOSTOLAKIS: That's why I was reminded of the 1.174 definition because there the words that are used are "the totality of the commitments." Isn't that what it is which would include all of them that the licensee has made which includes all these plus whatever else they have committed to? Or is there a difference between design basis and licensing basis?

DR. POWERS: Yes, there is.

DR. APOSTOLAKIS: What is it?

DR. POWERS: We won't see the licensing basis until we get to stage two.

MR. BROWN: Right. The design basis is a subset of the licensing basis.

DR. APOSTOLAKIS: It's a subset. Okay. That makes sense.

DR. POWERS: This is not going to be absolutely correct. I'm sure Joe's just going to cringe when I say that, but to my mind this is an opportunity for us to get a quick look at what's going to happen in this design, what the concerns are and there's going to be a lot of flexibility left in this thing. What you, what I want to come out of is is it possible to build a facility to do the function that's being asked at this site. Can you do it? Not so much have you done it, but can it be done. Okay.

DR. APOSTOLAKIS: It has to be done safe.

DR. POWERS: I mean there's just an enormous amount of work. This is setting a framework more than it is to say, "Okay, I'm going to build this particular silo" or something like that and it lays down kind of a philosophical approach. How am I going to approach this? Am I going to do this old double contingency kind of design? Am I going to take design basis? Am I going to use pressure vessel code throughout this thing? What's my philosophical basis? That's the way I look at it. It may not be precisely correct, but it served me well in trying to decide whether to lose my temper over something or say, "Oh, yeah, this is good."

MR. BROWN: I do want to say and add to that that there was always, I think, a propensity by the staff to look a little bit further beyond this to say, "Okay, I understand what your design basis is but can you really do this?" I think we asked the appropriate questions.

DR. POWERS: Yes, I mean if a guy comes in and says this is really easy to build, all I need is impervium, you probably are not going to accept that.

If you come in and say all I need is metallurgic engineering like they have at General Electric, you'd say, "Well, maybe you need something better than that."

DR. WALLIS: This is where having been done before would be very convincing to me. I mean if this reactor already has been built in France and it's already operated with these kinds of controlling parameters, then one can assume it can be built here. So we don't have to have all this reassurance of exactly modeling the chemistry and all that kind of stuff.

MR. BROWN: Right. So I just wanted to then summarize the two stages. What we've been looking at is the construction authorization which includes a site description, a safety assessment of the design bases and the quality assurance plan. What comes later are more detailed safety program descriptions, the ISA summary which as I'll point out in a minute grows from the safety assessment of the design bases and the other plans that are required in accordance with the regulations, security plans, FNMCP and the emergency plans for example

So that 1971 rulemaking established these two steps. Further, looking in the more recent history then in September 2000 after a near miss criticality event at a low enriched fuel fabrication facility in 1991, the staff began another rulemaking to institute these ISA requirements that fuel cycle facilities would identify potential accidents and the items relied on for safety to reduce the risk of those accidents, the measures that are required to maintain those items reliable and available, that sort of thing.

So that is the newer requirement which also instituted the risk informed part of what is now this Part 70 which establishes this paradigm if you will that in order to reduce the risk of accidents you first establish where are you using an unmitigated assessment. For example, a high consequence event with an unlike likelihood either needs to be prevented, to be made highly unlikely --

DR. WALLIS: Not unlikely means likely, does it?

MR. BROWN: Yes. I'm using the regulatory language. It does mean essentially likely.

DR. APOSTOLAKIS: Do there are no quantitative definitions of these terms, are there?

MR. BROWN: We have guidance that's in our standard review plan.

DR. APOSTOLAKIS: Can you tell us what it is?

DR. DENNING: Yes, we forced it out of them at the subcommittee meeting. You may as well tell them what you told us.

MR. BROWN: Okay. In the MOX Standard Review Plan, the quantitative guidance for these likelihoods is a likelihood -- Let me start at that bottom.

DR. APOSTOLAKIS: Yes.

MR. BROWN: This is less than 10^{-5} probability of the event per year is the upper bounds on highly unlikely. The next bound, the upper bound on unlikely, is $4(10^{-3})$.

DR. APOSTOLAKIS: Ten to the minus five to four times ten to the minus 3.

MR. BROWN: And then not unlikely is above that. Now what's interesting though is the regulation doesn't require a quantitative analysis of likelihood. A qualitative assessment is okay. What's important is that an applicant or a licensee make a distinction between highly unlikely and unlikely. That's really what is required at this point.

DR. APOSTOLAKIS: So this is the result of this revision in 2000?

MR. BROWN: Yes.

DR. APOSTOLAKIS: And surely by that time, everybody knew that this Agency is risk informing its regulations. So I don't understand the statement "quantitative estimates are not required."

MR. BROWN: Well, I'm not familiar with the history of the rulemaking. I'm merely stating the fact that that is what they've decided for these types of facilities. More generally, the risks are lower than for reactors for example.

DR. APOSTOLAKIS: Yes.

MR. GIITTER: This rule was written to provide flexibility. So we don't require licensees to do a quantitative or semi-quantitative analysis. They can do a qualitative one and many of them do.

DR. APOSTOLAKIS: I understand that. The thing I don't understand is why not.

MR. BROWN: I can't answer that.

DR. POWERS: And it's not a question that we're trying to address in this particular letter.

DR. APOSTOLAKIS: I understand that, too. The thing I don't want to do is two, three years from now to complain about something and have people say "But why didn't you say in February of 2005?"

MR. BROWN: I understand.

DR. APOSTOLAKIS: Okay.

MR. ROSEN: Well, the most encouraging thing I've heard said about that, George, in answer to why not is that all these facilities are different and all their components and all of that stuff operate differently and the data that would be needed to do a quantitative estimate unlike in reactors where you have lots of similar components is just not available.

MR. GIITTER: That's correct. I have also heard that explanation.

MR. ROSEN: I don't happen to agree with that, but that's the argument I've heard.

DR. APOSTOLAKIS: I completely disagree with that.

MR. ROSEN: That's as close as cogency as I've heard in response to that.

MR. GIITTER: I've also heard that.

DR. APOSTOLAKIS: But I think also mostly that these people are not reactor people so they don't do things like way.

MR. ROSEN: They don't know about -- secrets.

DR. APOSTOLAKIS: The reactor people didn't want to do these things. You remember that? There was a generic lab --

MR. ROSEN: I always was for this.

DR. APOSTOLAKIS: Yeah.

DR. POWERS: Let me interject here just a little bit on this is this particular regulation as it's written parallels very closely of what the American Institute of Chemical Engineers requires for chemical facilities and it is clear whether if the regulation was very familiar with that genre of safety. I should point out that where that has been applied they have an awfully good track record. So that it could well, and I know this is heresy, but it could well be just as effective as the Reg. Guide 1.174 in probabilistic risk assessment I know.

DR. KRESS: Let me point out something else to you, George, on that table we just saw. Those are sequence by sequence numbers. They're not the summations.

DR. APOSTOLAKIS: Which ones?

DR. KRESS: If you look at say any of the categories like high unlikely, you don't take all of the sequences that are in there.

DR. APOSTOLAKIS: No.

DR. KRESS: Each one of them has to conform to that. That's a different philosophy.

DR. APOSTOLAKIS: But this is fatal flaw.

DR. KRESS: Yes.

DR. APOSTOLAKIS: Because there's no definition of a sequence.

DR. KRESS: That's why I brought it out. It's a fatal flaw.

DR. APOSTOLAKIS: Okay.

DR. POWERS: Well, again I would point that they may find it flawed. I will stack up Dupont's safety record against anything you would like to bring forward including since the day worker injury incident is lower even than in offices of secretarial functions. They must do pretty well. So calling it a fatal flaw might be a little strong.

DR. KRESS: I would agree with that. Fatal flaw, you're right. We're going overboard.

MR. BROWN: One of the things I'm pointing out here too is this is the framework that's the generic framework. I'll also describe what DCS did to establish a qualitative definition when I get to that later in the presentation. But the point I want to make here is that so we have the two step licensing. We need to have a safety assessment of the design basis first and the new ISA requirements that would apply to this facility. So it was only natural then to develop a paradigm if you will that the safety assessment of the design basis is just a first step in establishing your complete ISA and that those performance requirements I listed earlier then are the decision levels if you will for when do you establish what's a PSSC or not. That's how we've rolled those two new requirements or the two requirements together.

In addition to those, DCS will be expected to address the baseline design criteria which are part of the revised Part 70 that was instituted in September 2000. What this is is just a list of criteria that DCS must show that it has addressed in establishing its first safety assessment and then it's later ISA.

Then lastly, DCS must show that they've designed with the philosophy of defense in depth. I think Dr. Powers said it better than I could with respect to what that means. It doesn't mean that where for example it says preference for the selection of engineer controls over administrative controls, that doesn't mean that all administrative controls are excluded. This is a general overall philosophy. They've indicated a preference for one over the other.

DR. APOSTOLAKIS: This is the only requirement set because you have the three dots at the beginning. This is the only one that refers to defense in depth.

MR. BROWN: Right.

DR. APOSTOLAKIS: Really?

MR. BROWN: This is the only section in the regulation which addresses defense in depth.

DR. APOSTOLAKIS: It doesn't say anything about multiple barriers anywhere.

MR. BROWN: Well, there is the Item 2 here, features that enhance safety by reducing challenges. It doesn't explicitly say multiple barriers, but it does indicate --

DR. APOSTOLAKIS: Well, multiple barriers, you put multiple barriers to reduce challenges. No. To mitigate.

DR. POWERS: Reducing challenges to safety systems is an element of defense in depth but it didn't matter how many barriers you have.

DR. APOSTOLAKIS: That's right.

DR. POWERS: It's an operational philosophy not a design philosophy.

MR. BROWN: Okay. I understand your point. I will point out in just a minute or two that notwithstanding what this requirement says, that this facility does have substantial defense in depth in terms of barriers and what I have is a floor plan of the plant that shows that.

DR. POWERS: It seems to me, David, that it is better to look upon defense in depth here not as multiple barriers but a balance between prevention and mitigation. Using that definition, you'll get a lot farther with this facility than using the multiple barrier kind of concept.

MR. BROWN: Okay.

DR. POWERS: There are multiple barriers. You can find cases where the multiple barriers I think philosophically it falls more in the category of a balance between prevention and mitigation.

MR. BROWN: Okay.

DR. KRESS: Without specifying what we mean by balance.

MR. BROWN: Quantitatively.

DR. KRESS: It's not an equal balance.

MR. BROWN: Right. I understand.

MR. BROWN: It depends on the hazards which are posed. What I have done up to this point is established what we need for the construction authorization. So just to reiterate, what are we expecting later with the license application? Again, it's the safety program descriptions that will establish the programs that will support safety at that plant, an ISA summary which I'll describe in a little bit more detail in a moment and the other required plans.

As I stated earlier, the safety assessment of the design bases is like a preliminary ISA. It's the first step. So the ISA then will develop items relied on for safety or identify these items at a somewhat greater level of detail at the component level rather than at the system level which is how they are defined in the safety assessment. It will also include a facility description and process description, the team qualifications and ultimately the methods that were used to establish the ISA and a list of IROFS.

One of the things I should point out at this point that's at the top of this slide here, I say "ISA Summary." That is what the applicant is required to submit to NRC. The ISA is in what we've done in Part 70, it says that the ISA is something that resides at the plant or with the applicant and is open for review by NRC staff. So that was an agreement received during this rulemaking. The entire ISA including all of the calculations that support the safety decisions, it's not submitted. A bulk of it is left at the site.

DR. APOSTOLAKIS: And why is that?

MR. BROWN: Why is that?

DR. APOSTOLAKIS: Yes.

MR. BROWN: That was just an outcome of the rulemaking, something that was agreed to with the industry. It doesn't mean that safety isn't documented. All I'm merely pointing is where it is.

DR. APOSTOLAKIS: You have access to it?

MR. BROWN: We have full access to it.

DR. APOSTOLAKIS: It's just that physically they don't want to give it to you.

MR. BROWN: Just physically we don't have it here.

MR. ROSEN: They could put it on a CD and give it to you probably.

MR. BROWN: Well, yes. I mean in some cases the ISA is sufficiently well defined in terms of its bounds. This is the ISA but they could do that.

MR. ROSEN: If you're relying on it, it has to be defined. Right?

MR. BROWN: Yes.

DR. POWERS: Is there any conceptual difference between this and the IPEEEs?

DR. APOSTOLAKIS: Yes. The IPEEEs were not used for any licensing decision. This is part of licensing the facility.

DR. POWERS: Okay. Is there any conceptual difference between this and the licensing basis for fire protection of the plant?

DR. APOSTOLAKIS: I don't know now. Just because there is precedent, it just sounds funny. We are going to have it on the site but we're not going to view it.

DR. POWERS: You might want this thing delivered to you.

DR. APOSTOLAKIS: What?

DR. POWERS: Your house is not big enough to hold this thing. You do not want it delivered to you.

DR. APOSTOLAKIS: A lot of inconvenience that we shouldn't even talk about.

MR. GIITTER: Just to put it in perspective, we have not received the ISA summary yet for the MOX license application but we understand that it's over 4,000 pages and that's just the summary. So you can imagine that the entire ISA is very voluminous.

DR. POWERS: And, George, have some faith when the staff asks us to approve their SER for the ISA and what not. The subcommittee will go and see the ISA. You will get to look at this.

DR. APOSTOLAKIS: I'll come along.

DR. POWERS: All right. Your presence will be mandatory.

DR. APOSTOLAKIS: What is it? Savannah River, is that what it is? One of the great resorts of this country. You know I think we're getting in childish things. I mean what you described earlier about methods for likelihood and all that I don't know why you have to call that ISA.

DR. POWERS: Because it's written in the regulations.

DR. APOSTOLAKIS: If I find a method later that will not be up to the state of the art or the state of the practice regarding the likelihood evaluation methods, I don't care whether it's a PRA method or an RPA or an APR method. You would have to use the state of the practice methods. You can't say I'm doing an ISA so I'm going to use a Mickey Mouse method. So I don't care about the PRA and ISA. The words you used are fine. They set the stage on Slide 14.

MR. BROWN: Okay.

DR. APOSTOLAKIS: It's fine.

MR. BROWN: Okay.

DR. APOSTOLAKIS: Okay. Now for regulatory purposes, we may want to use ISA. That's fine too. I don't object to that.

MR. BROWN: Right.

DR. APOSTOLAKIS: But everything in the parenthesis there, that's what we do.

MR. BROWN: Okay.

DR. APOSTOLAKIS: Now the other thing that struck me when I started reading this is the incredible number of acronyms.

MR. BROWN: Yes.

DR. APOSTOLAKIS: IROFS and this and that. I mean within one paragraph you could define 23 of those. Is that also part of the chemical tradition here that we don't want to shake? That's a Mickey Mouse. Keep going.

MR. BROWN: Okay. What I want to talk a little bit now about is the actual facility so we can have some context in which to discuss some of the hazards. This is merely a map showing the approximate location of the facility, where it would be, on the Savannah River site. The Savannah River site is 310 square miles in South Carolina. The point of that arrow is more than five miles from the boundary in any direction and it's just about the north side of F area there.

Having established what the site is, one of the things --

DR. POWERS: David, that's a bit misleading, isn't it?

DR. KRESS: There are thousands of people in the city.

DR. POWERS: Yes, that's absolutely true, but the way they've explained their site boundary is coincident with facility boundary.

MR. BROWN: Right.

DR. POWERS: So it's just as Tom says. Well at that time, there was 22,000. I would think it's only 17,000 now. There's a small city there.

DR. KRESS: And even George might be there once and a while.

DR. POWERS: It's mandatory. In fact, I think they ought to build into the probabilistic risk structure.

DR. KRESS: That's what I think. That name is sequester from MIT.

MR. MAGRUDER: Dave, this is Stuart. You might clarify that the actual MOX facility is only 41 acres.

MR. BROWN: Right, and that's where the

boundary is around that 41 acres not the whole thing.

MR. ROSEN: The distance to the site boundary is typically in hundreds of meters. Right?

MR. BROWN: Right, for the purposes of actually performing a dose analysis for the safety assessment.

MR. ROSEN: Right.

MR. BROWN: The site boundary is, and I should be --

MR. ROSEN: The site boundary of the MOX facility.

DR. APOSTOLAKIS: The MOX facility.

MR. ROSEN: There's a couple of hundred meters from the center line of the plant.

MR. BROWN: What we call that for this facility is the controlled area boundary.

DR. APOSTOLAKIS: And what's the distance from there? The Savannah Site model.

MR. ROSEN: It's about five miles.

MR. BROWN: More than five miles in any direction.

DR. POWERS: When you initially think about this facility and you say it's five miles away, you say "Now what kind of an event could possibly disperse things that far" and you scratch your head and say, "It's hard to think of something that would get to five miles and have a lethal dose at this facility." When you ask the same question at 100 yards, you say, "Gee, there are quite a few things that can give you a lethal dose."

MR. BROWN: Right. I certainly didn't mean to mislead you that this was the important boundary with respect to the safety assessment. I just wanted to provide some context for where the plant is in South Carolina.

MR. ROSEN: In other words, the important boundary for the safety assessment is a couple of hundred meters from the plant.

MR. BROWN: Is 160 meters.

DR. POWERS: Is that that little figure that's right under the arrow there, that little box?

MR. BROWN: That little box is at the area. If I were to draw the site on there, I should probably just pick up a dull pencil and dropped it and that would probably describe 41 acres.

DR. APOSTOLAKIS: How big is the Savannah River area?

MR. BROWN: Really what I wanted to get to is this point these are the kinds of things related to that site that were screened out as being important events that needed to be considered in the safety assessment, wind, fire -

MR. ROSEN: Screened out. You mean screened in.

MR. BROWN: Screened in. Sorry. That's a good point.

DR. POWERS: This site has been characterized up one side and down the other for every facility that we ever built there. It's been scrutinized by the National Academy of Science. It's been folded, spindled and mutilated in every conceivable fashion. Did DCS do anything different than what's been done in the last five years for the safety analysis of DOE facilities there with respect to these natural hazards?

MR. BROWN: To my knowledge except for some characterization of the soils --

DR. POWERS: Which has always been an issue there.

MR. BROWN: Yes.

DR. POWERS: Because there are places there on the site that liquify quite easily and there are places on the site that don't liquify at all.

MR. BROWN: Right, but I think even that information was already available and DCS can correct me on that if you're aware of data that you collected as part of assessing the natural phenomena hazards.

MR. ASHE: This is Ken Ashe with DCS. That's pretty much correct. We relied very heavily on the Savannah River site data. We did do some bore holes specific for our site just to make sure that we understood for our particular site. But basically we used the Savannah River site data.

DR. POWERS: Yes. Savannah River has been characterized like crazy. F area has been characterized a lot even within Savannah River context but you still have to look at the place you're actually physically going to build it.

MR. ASHE: That's correct.

MR. BROWN: I started with a 300 square mile plot and just coming in closer here inside the plant the process does include essentially two major parts of the plant which are really represented by these two rows of boxes in the flow chart. They first need to purify the plutonium using a PUREX-like purification process and reprecipitate plutonium oxylate and then calcined it in a calcining furnace to produce purified plutonium dioxide which would then be ready for MOX fuel production which is blending with depleted uranium oxide to the specified blend, pressing of pellets, centering the pellets in fuel fabrication.

DR. WALLIS: Is the stuff comes in as plutonium oxide, why does it have to be purified?

MR. BROWN: This plutonium dioxide being surplus from the weapon program contains among other impurities things like gallium which was part of the weapon component.

DR. WALLIS: So there would be raw material in plutonium oxide.

MR. BROWN: The raw material is plutonium dioxide and other elements to different levels of impurity.

DR. POWERS: There are four different feeds but the mainline feed if you looked at it you would it's plutonium dioxide. But it has a small fraction of gallium in it which we're concerned about and it will always have a certain amount of americium in it.

Now let me ask you just one question because maybe I misunderstood, Dave. Your scope of this may be more macroscopic than what I've seen. My understanding is in this pellet fabrication they're putting 20 percent plutonium dioxide and uranium dioxide solid solution which is actually micronized with uranium oxide to form the pellets.

MR. BROWN: Correct.

DR. POWERS: Okay. Is that 20 percent solid solution formed at the convert stage or is it formed in a micronizing process?

MR. BROWN: It's formed in the micronizing process. I'm aware for example that history there was a process of co-precipitating these materials of uranium and plutonium together. That is not the process here. Plutonium dioxide is when it's purified it's remade as pure plutonium dioxide and then --

DR. POWERS: They burn the oxylate, throw in the plutonium dioxide and then they fabricate a solid solution.

MR. BROWN: Yes.

DR. POWERS: I'm glad I don't have to run that process.

MR. BROWN: Why is that?

DR. POWERS: It's hard to do, to get a homogenous solid solution.

MR. BROWN: I understand that there is art and the science that has gone into this process.

DR. POWERS: Yes, micronizing is not so difficult because you don't have to form a homogenous solution.

MR. BROWN: I see what you mean.

DR. POWERS: But the form of a 20 percent plutonium dioxide/uranium dioxide solid solution that's reasonably homogenous, I'm glad I don't have to do that.

MR. ASHE: This is Ken Ashe again. I would like to point out in response to a statement earlier and also in response to this is that we do have the reference facilities in France up at LaHague and at Melox where they have done similar type items and so we do have that expertise and Cogema is one of our key partners with respect to this. So we have their understanding and backing and etc. and their facility has been operating. I think that Melox facility is about eight, ten years.

MR. BROWN: Ten years now.

MR. ASHE: Right. And actually longer for parts of it.

MR. BROWN: What I would like to do is just put that in a physical context so you have an idea of how this material flows. The plutonium dioxide will come from different sources. One of them for example will be the next door PIT disassembly and conversion facility. It would come in by truck and be received at the shipping and new receiving area and then stored prior to being further processed. The depleted uranium dioxide of course a very important part of this process comes in and is stored in the secured warehouse prior to being brought over and also loaded in at the shipping and receiving area.

The plutonium dioxide is then routed to the aqueous polishing building where it undergoes this partially PUREX type process in a building that really looks like a number of process cells, closed up concrete cells, where the intent is to put the process, build the process, test it and then button up these cells and only go back in there for any necessary maintenance or surveillance. There are some gloveboxes in there.

For example, when the purified plutonium nitrate is ready for precipitation as the oxylate that plutonium oxylate then comes into a glovebox where there's a calcinate furnace. The calcined plutonium oxylate, now plutonium dioxide again, comes back into the MOX fuel fabrication area and is stored again which is all I mean by that convention there. It's just momentarily stored in storage and then the plutonium dioxide is taken --

DR. WALLIS: So all this chemical processing, you're concerned about various runaway reactions or implosions or whatever.

MR. BROWN: Yes.

DR. WALLIS: It's in that aqueous polishing room there.

MR. BROWN: Right. Almost all of the chemical hazards we've discussed before.

DR. WALLIS: So there is multiple barrier or something associated with that region, area that contain things if they get out of hand.

MR. ROSEN: You shouldn't see that as a room. It's a series of rooms.

DR. WALLIS: Series of rooms.

MR. ROSEN: Four or five stories.

DR. WALLIS: So all sorts of ventilation control and stuff.

MR. BROWN: Yes. There are five stories. It is a series of cells, many rooms.

DR. WALLIS: It's designed so if something gets out in one space it doesn't spread to other spaces and all that.

MR. BROWN: Correct.

DR. WALLIS: You're not going to tell us anything about that or we just assume it happens.

MR. BROWN: Did DCS tell us anything about that? Yes. I had to give you a fairly, I realize, high level overview of the design of this.

DR. WALLIS: It's so high level that it doesn't tell us very much.

MR. ROSEN: Not yet.

MR. MAGRUDER: Dave, I think you have more detail in your next slide that would be helpful.

MR. GIITTER: You might point out the safe haven and the purpose of that.

MR. BROWN: Okay.

MR. GIITTER: That is it's easy to see here.

DR. WALLIS: It's for women and children.

MR. BROWN: Right. You guys got the rest of it. The fuel is then pressed, centered. The future fuel storage is over here and then fuel assemblies are loaded into their cask and backed out. So essentially material does flow in that direction. I did point on this simplified cartoon if you will the safe havens which are DCS's provisions for emergency preparedness in case employees do need to escape an area.

MR. ROSEN: You said five of them? Is that what I'm supposed to believe?

MR. BROWN: Five, yes.

MR. ROSEN: Those are all those records.

DR. WALLIS: Five safe havens.

MR. BROWN: (Indicating.) This one.

MR. ROSEN: (Indicating.) That one.

MR. BROWN: (Indicating.) That one.

MR. ROSEN: Yes.

MR. BROWN: (Indicating.) That one, that one and that one.

MR. ROSEN: And you just want to make sure you're on the right floor when you have the accident. Right? Because otherwise, you might be on the fifth floor and have to go down to the first floor to get to safety.

MR. BROWN: I don't know.

DR. APOSTOLAKIS: What is it that makes them safe havens?

MR. BROWN: I'm sorry.

DR. APOSTOLAKIS: Why do you call them safe havens?

MR. BROWN: Because that's what they are. They are places where employees can escape to escape an event if they need to and what they provide for is a physical, well, material security. They don't have, for example, crash bars on a facility like this where employees can escape. But you need to balance then the need for material security with the need for personnel safety. These safe havens do that. It's an area where the employees can get out. They're in a separate ventilated area under positive pressure. The function of these is such that the guards come and then let people out.

DR. WALLIS: There's access to the outside world presumably.

MR. BROWN: There are doors to the outdoors from these areas but they're controlled.

DR. WALLIS: It's just a holding place.

MR. BROWN: They're a temporary holding for folks who've had to escape an area. Another, I guess, important area is the reagents processing building which is a separate area where chemicals which are necessary for the aqueous polishing process are prepared and then transferred underground to the aqueous polishing step.

DR. WALLIS: Now is there waste stream from all this somewhere?

MR. BROWN: There are both solid and liquid waste streams to deal with. Yes. As you can well imagine, a lot of liquid waste streams are coming from aqueous polishing.

Yes, as Joe pointed out, I did provide this additional cartoon to try to describe the multiple barriers or what they've called the tertiary confinement system at this plant. This demonstrates defense in depth. The first confinement, primary confinement, in this example for powder processing areas is the glovebox. Secondary confinement provided by the room where you find the glovebox and ultimately tertiary confinement provided by the exterior boundary of the building. Each of those served by their own ventilation system with HEPA filters.

DR. APOSTOLAKIS: What is it that makes one a barrier dynamic?

MR. BROWN: I'm sorry. How do I tell the difference between the barriers?

DR. APOSTOLAKIS: You said static and dynamic. What does that mean, dynamic? The secondary confinements.

MR. BROWN: The static barrier is simply the fixed object that defines the --

DR. APOSTOLAKIS: The structure.

MR. BROWN: -- the area. It could be a wall or it could be a HEPA filter also.

DR. APOSTOLAKIS: Okay.

MR. BROWN: The active components are the blowers if you will that provide the negative pressure.

DR. APOSTOLAKIS: I see.

MR. BROWN: So that there is a pressure differential also that's here so that air tends to flow towards the C-4 areas. Having provided that somewhat of a context for what the facility looks like, how it's laid out, I now want to talk to you about the safety assessment methodology that DCS implemented which starts with hazard identification identifying where all the radioactive hazardous chemical inventory is in the facility and what sorts of events can be made to release that.

The safety assessment includes a hazard evaluation and what DCS has done is set up event groups. All the important events that are considered in the safety assessment are one of these, ones that I've listed here, loss of confinement, fire and so forth. Having established that an event could occur in a given area, for example, fire in a certain glovebox in a certain room, that is then grouped with other fires and other gloveboxes in other similar rooms. An unmitigated event description is provided which is merely to say that there could be a fire in the glovebox that involves plutonium dioxide powder for example.

They do go so far as to say that they do screen some things out on the basis of whether it's feasible. For example, in areas where I have powders that haven't been processed yet I won't have a red oil explosion for example. So there is some assessment of what are the feasible events.

Internal events are then screened by consequence. So looking at a specific kind of event, DCS did a consequence assessment. How bad would the dose be? They're looking at the facility worker right next to this area, the site worker immediately outdoors, someone standing at the control boundary that are 160 meters away and they are also looking at the environment. We have performance requirements for all four of those.

DR. WALLIS: How do you evaluate the likelihood of a red oil runaway reaction?

MR. BROWN: In this case in that second bullet, they are described as an internal event. There's no assessment of likelihood except to say it could happen. If I have solvent in a mix with nitric acid then I have a possibility of red oil.

DR. WALLIS: So you're saying it could happen.

MR. BROWN: At this stage in the hazard evaluation stage, they're saying --

DR. WALLIS: Later on you say something more about how likely it is.

MR. BROWN: At this point, the likelihood is one. It is not unlikely if you will.

DR. WALLIS: Well, I hope it's one.

MR. BROWN: At this stage, there is no attempt to screen it out based on likelihood by saying, "Oh, well, it's not" --

DR. WALLIS: Just say it could happen. That's all. It doesn't tell us much at all. But this is a screen. Right?

MR. BROWN: At this stage of our screening that's all you need to know.

DR. WALLIS: If this is a screening, that's all you want. Okay. So are you going to get to the meat of this somewhere?

MR. BROWN: Yes sir.

DR. WALLIS: Okay.

MR. BROWN: I'll move on.

MR. ROSEN: Maybe we should -

DR. POWERS: Maybe we should be very clear. I'm not sure what Professor Wallis is looking for. If he is looking for the kind of detail that we we would do in a subcommittee meeting, he is going to be disappointed.

DR. WALLIS: But there must be something important you're going to get to.

DR. POWERS: Well, I think he's done a great deal of important topics.

DR. WALLIS: It seems to be so descriptive. I haven't gotten a hold of anything yet.

DR. POWERS: Well again I'm not sure. You need to clarify for us what you're looking for. I have a feeling you're going to be disappointed.

DR. WALLIS: Maybe I will be. Yes.

DR. FORD: I think it comes down to the basic question of what we're being asked to do. As I understand it, Graham, like you, I'm a bit frustrated that we haven't seen any of the discussion of what we heard in the subcommittee meeting.

DR. POWERS: Well you won't.

DR. FORD: And now I'm hearing that from you and therefore I'm divining from that what we're asked to do is write a letter to say, "Yes, you're on the right track about it, but don't expect us to write a letter endorsing the specific value of the design basis from it." That is correct.

MR. SIEBER: They didn't provide any of this.

DR. FORD: But in the subcommittee meeting they did. A detailed list of process control and clinical control processes.

DR. POWERS: You are free to ask any question you want.

DR. FORD: Yes, but I think --

DR. POWERS: Now we have given the staff guidance of what they should present and we have given them the guidance to present a more general overview of all the material that was presented to us at now what is something like seven meetings. Now if you are asking them, if you care to ask them what is the particular value for the valve size on line number six, I'm sure Dave would be happy to answer you.

But I did not ask him to go through that kind of detail. It would be inappropriate and he couldn't possibly do that. I asked him to anticipate every detailed question that this August committee would care to ask and said do that in two hours. He would speak very quickly. Now back to Dr. Wallis.

DR. WALLIS: This is the final presentation before we write a letter.

MR. BROWN: Yes.

DR. WALLIS: So there has to be something in the story you're telling us now which gives us assurance that things are being done right.

MR. BROWN: Okay.

DR. WALLIS: It's a long litany and you haven't yet gotten to the point where you've given me that assurance. Maybe you're going to get there.

MR. BROWN: Okay.

DR. FORD: I have a specific question because flipping through the charts, I don't see it being addressed. One thing I am uncertain about is for instances in the control of the preparation where we're introducing nitrous oxide in the control column as oxidation somewhere or another it is stated that there could be process control from the fuel rate of nitrous oxide. That has been withdrawn. Am I correct on that? That control is actually no longer being applied. Is that correct?

MR. BROWN: No, I don't think that's correct. For the purposes of protecting someone outdoors from an overexposure to nitrous oxide, the flow rate of nitrous oxide in the oxidation column is controlled as a PSSC. Do we have a design basis value for the flow rate anybody in the audience and I do want to attempt to be responsive on specific questions of that nature.

MR. MURRAY: Yes, let me try and help you out, Dave. Good afternoon. I'm Alex Murray, the Lead

Chemical Safety Review for MOX. I know you all know that, but I just wanted to make it clear for the transcripts. I see your questions have to do with just a little more extra level of detail.

Let me first answer the immediate question which has to do with the flow rate of nitrogen tetraonidae, how it is controlled to prevent its release of the oxidation column. The applicant has proposed an active flow control strategy. This is essentially a common type of approach which has been used in industry.

It can be very well defined subsequently in the license application stage. There could be multiple type of flow elements, different types of flow valves, different types of transducers, different types of controls and logic applied and we would expect to see these in the subsequent license application, all the details on the items relied on for safety. However at this time, we, the staff, know by analogy to industry plus a number of very simplified faultry analyses we have done, conceptual type levels, that that type of strategy has the potential to achieve essentially any type of likelihood level that is desired.

Now in addition to there being an active control, you have to have a design basis for it to meet. In the case of nitrogen tetraonidae release, the applicant has stated that the design basis will be not exceed the low chemical consequence criteria. They have identified what that criteria is in terms of concentration, so many milligrams per cubic meter. The staff has reviewed that and the staff has included that as an acceptable design basis at this time, i.e. the potential consequence of the event would be indeed low by what we call RAGAGEP, Reasonable and Generally Accepted Good Engineering Practices.

We have compared some of the values to values in the literature used by NIOSH, OSHA and Environmental Protection Agency and we have concluded yes, an exposure up to one hour, the potential health impacts would correspond to low. Low is defined as being mildly irritating, perhaps an odor, but not interfering with any type of operator functions.

MR. GIITTER: Thanks, Al. This was interesting. Dr. Wallis, I wanted to respond to your question to Dave. I think to get a picture of why it's okay to write a letter for construction authorization is it's important to read the safety evaluation report. What Dave's going to do is we're going to walk you through an example for fire protection that will give you some idea of how we went about doing our evaluation and why it's okay using that one specific example. But to get a detailed understanding of why it's okay, I really think you have to read the safety evaluation report. It's difficult to really cover that in two hours.

DR. FORD: I think our problem is that when you read this safety evaluation report there are no analyses in that report. There are no detailed engineering data-driven analyses in that report. I think that's the frustration of some of us.

CHAIRMAN BONACA: But there is a discussion of the professional initiators if you want to call them so of how the conceptual design presented here with different enclosures and individual vacuum systems would in fact deal with maintaining and providing protection and assurance of a level of safety. It's not quite defined the way of having still setpoints or specifics of the components they are going to use. But I think as far as the SER it made a credible case for the accessibility of the design at the conceptual level.

MR. ROSEN: Those of us who were around and I know you were, Mario, in the early days of reactors when we had something called preliminary design analysis reports.

CHAIRMAN BONACA: Absolutely.

MR. ROSEN: These were documents not unlike what we're looking at here.

CHAIRMAN BONACA: Very similar.

MR. ROSEN: Basically, it says, "Here is the envelope. We think you could build a nuclear plant and meet the criteria in this document." That's really all you have. If that's not enough, that's a little bit like smoke. It's hard to grab a hold of because you're trying to think, "Now what's it going to be like to meet this requirement. What's the actual physical hardware of configuration going to be like to meet this criteria." And it's not very satisfying because you might think of something and say, "Well, that might meet it and that might not."

DR. WALLIS: What I found missing was all this description now this thing is going to be controlled by using flow or temperature or something. Now if you could simply show that this has been done before in some plant, that it works, or something. But simply to say, it's going to be controlled by using temperature gives no assurance that that can be done.

MR. ROSEN: Well, I think what we're being told with regard to that is that this plant is very like the ones in Europe.

DR. WALLIS: Well, I think you should emphasize. It's all been done before. There's lots of precedent and not stepping outside the box of experience. Therefore, you have a lot of assurance it will work.

MR. ROSEN: And what I think you and I should do is coil up to strike when we get the ISA. I know George is doing that. No, you are. So that when we get the ISA which will have the kind of details you're looking for now.

DR. APOSTOLAKIS: When will this be by the way? In the future. Right?

MR. ROSEN: We have the ISA summary and then we'll have to go Savannah River to get the ISA details. But that will be at some point in the future.

DR. APOSTOLAKIS: Sometime in the future.

DR. DENNING: I'd like to make some comment about history though and that is that I think that certainly as far as the feasibility of building and operating this facility, there's no question that that history is very valuable. It's also valuable to have seen what they used for safety systems, but the fact that they've operated those for X number of years does not fully provide the level of consideration that has to be done by the NRC because that's a very limited lifetime.

But on the other hand, I know that we've gone through these detailed looking at the various types of accidents that have been done and I don't know whether you've had the chance to do that. And then you have problems that a lot of that's fairly qualitative or there are some kind of holes there. But I think we need to be careful to say just because this facility is operated and safely for a period of time, that's not adequate for what the NRC has to do.

CHAIRMAN BONACA: Yes, but again going back to the example of the PSRs, it wasn't unusual at the FSER stage that you would have to modify your conception design or protection system. In fact, you had new functions you had to add. Some of them you subtracted because at the moment to implementation either you couldn't make certain criteria or the NRC didn't accept what you presented.

I could see that there are really adjustments to do it now. There could be some further flaw than they have required some measure will work. I think the experience we had, and I didn't see the one in France, gives us some comfort maybe that probably a measuring work is not necessary. I mean that's the way I've been thinking about it. But I think as far as what has been addressed here and the issues and possible initiating issues I think is convincing enough to me that at least there is a conceptual design here that qualitatively should be functioning.

MR. BROWN: Let me continue talking a little bit about the likelihood definitions but before I go any further, I should have pointed out, I do want to point out now. I did ask the technical review staff to be here. DCS is here as you will know by now. The Department of Energy is represented. So if there are any specific questions.

DR. APOSTOLAKIS: What's a lifetime of a facility?

MR. BROWN: It's assumed for the purpose of this assessment to be 50 years which is larger than the expected mission time which would be about something like 15 years.

MR. ROSEN: I have a specific technical concern that I've been voicing ever since the beginning of this thing started. Dana, do you think this is appropriate time for me to raise it?

DR. POWERS: Well, we need to get it on

the table right away. He's going to go through an example that deals with fire protection. So why don't we wait for there because I want to get that one out right now. I mean that one needs to come out.

MR. ROSEN: I think that was what this effort was designed for. To bring a concern like that was its conceptual concern.

DR. POWERS: Yes, bring that one forward because that hits at really design philosophy here. With this sort of situation, you have to come up with a philosophy on the approach here. So I think he'll get to it.

MR. ROSEN: Okay. I'll hold off.

DR. POWERS: Okay.

MR. ROSEN: I won't forget it.

DR. POWERS: Well, I definitely want to get a resolution. I mean I want the facts on that one for all parties because that clearly is one that in our draft letter right now, just like I'm interested in getting a resolution on Peter's question which I think we got.

DR. FORD: Yes, I did.

DR. POWERS: So please charge ahead.

MR. BROWN: I will charge ahead.

DR. POWERS: And get to your examples as

quick as you can.

MR. BROWN: Okay. I did mention earlier that a qualitative definition of likelihood is allowed. It is in fact what is used here. Those definitions are there. The goal for many events is to reach a highly unlikely likelihood.

DR. WALLIS: What do you do with something like the red oil runaway reaction? You make an assessment of how likely it is. I never saw anything like that.

MR. BROWN: No, at this stage the likelihood determinations for red oil event will be as part of the ISA summary in the ISA. What we need now is what are the safe operating ranges to prevent a red oil event.

DR. POWERS: I think you answered his question. I think we need to resolve this issue. At this stage you came in and said, "Is a red oil runaway reaction possible?"

MR. BROWN: Right.

DR. POWERS: Your answer was yes.

MR. BROWN: The answer is yes wherever the two things are together, nitric acid and solvent.

DR. POWERS: Correct me if I make a mistake.

MR. BROWN: I'm sorry.

DR. POWERS: Okay because you said, "Yes, it is possible" ergo there must be something done to prevent that from happening because for reasons that are deserving of discussion at some point, maybe not today, we don't like red oil runaway reactions. The fact is whether runaway reactions take place typically in material, it's not particularly radioactive. They typically take replacing the solvent recovery or the acid recovery station.

MR. BROWN: Right.

DR. POWERS: Which we would hope is relatively deplete of plutonium but we don't like them. So we prevent them. Now you ask at that point is possible to prevent these. The answer is yes. We run solvent recovery operations. They are running today as we speak. There are solvent recovery operations going on and not having red oil reactions. How do they do that? We looked and indeed there are standards set up by the DOE that says they can with these facilities with this, just do this and at least we'd never had one when we did those things.

Then you look and say, "Gee, there are some facilities on the site where they don't fit this. Gee DCS, what do you do about that?" And they came back and said, "Okay, we have this clever idea. We're going to have a vent and then a quench operation and you looked at that and said, "That looks like it could do it." Am I correct?

MR. BROWN: Correct. There is a somewhat -- Yes. You say as when the PSSC has been identified you do have to make some judgement as to whether you think they can get there. But it's not a detailed analysis of reliability or availability.

DR. POWERS: What I think Professor Wallis would like to understand better is how far did you go into can they do that. If the vent has to be the size of the Houston Astrodome in order to satisfy that, he's not going to believe you can do that. If on the other hand, a two inch plastic safety relief valve will do, then he might believe that it could be done. Can you answer his question? How far did you go into looking at this to see if this vent and quench process will in fact work?

MR. BROWN: We did verify that the use of a vent is supported by experimental data. There is published literature out there that assesses what an appropriate vent size is given a certain amount of material. We further independently checked to see what the margin of safety is.

DR. WALLIS: This is in a closed system now.

MR. BROWN: I'm speaking of right now an open system.

DR. WALLIS: I think the concern we have is with a closed system.

MR. BROWN: I'm sorry.

DR. WALLIS: We had much more concern with a closed system.

MR. BROWN: Right. So in that case for example there is --

DR. WALLIS: The vent needs to be bigger, right, for a closed system?

MR. BROWN: Well, what we did is we looked at what is really causing the event and it's the build-up of volatile organic compounds, degradation products in the solvent. If there's a means to remove those, then we could prevent the event from occurring at lower temperatures. So that is something we looked at and established that if we added an off-cask treatment system that could remove gases like the volatile reaction products then we could essentially prevent that event.

Now how reliable is the off-cask treatment system? What sorts of things could cause a blockage?

These are the kinds of details that we would have to establish in the ISA. But the fact that it's there is what we're trying to determine before allowing them to build the plant, keeping in mind that the whole focus here back from 1971 is don't allow them to build something that they can't later operate. If we have the equipment in there then we can work on how reliable it has to be, how much surveillance we're going to need to do, how much maintenance does that equipment need to maintain a high level of reliability.

MR. ROSEN: Like the through-puts should be.

MR. BROWN: Right.

MR. MURRAY: Could I just interject just for a second please? Good afternoon. Hopefully my voice will hold up here. I'm Alex Murray again, the Lead Chemical Safety Reviewer and I just would like to point out a couple items which are explained in the final safety evaluation report draft which I think you have. We do have a rather extensive section on the red oil phenomena. All right. We do go into quite a bit of detail about what has been proposed as controls in the literature and also how the applicant has proposed to control it.

I would also like to explain that in the analyses which the staff has done we looked at this from the perspective of does the system have the ability or could have the ability if it constructed appropriately to the PSSCs and design basis information that we have now. It could result in a plant, or I should say, a system with the potential for a red oil explosion where that potential would be rendered to be highly unlikely.

To help support that analyses, we used an approach very similar to what is used by the American Institute of Chemical Engineers. It is top level. It is semi-quantitative, semi-qualitative. At one point, we did do some very top level faultry analysis to look at how the different controls would assist safety and prevent the phenomena from occurring. So we did go into quite a bit of detail. I believe some of the top level faultries were provided at an ACRS meeting back in 2003.

DR. WALLIS: I'm just trying to figure out where all this fits into the picture you're painting for us. On page 24, you have this preliminary accident analysis. That doesn't tell me where in this stage you do this kind of in-depth look at the literature and convince yourselves that it is physically possible, chemically possible to do things. That doesn't come across in your listing of your activities here.

MR. BROWN: What I should make clear here is for example on page 24 this is what the applicant did. This is what DCS did to establish their safety assessment. What isn't clear from this slide is what did we do. What did the NRC staff do to validate?

DR. WALLIS: The design basis PSSCs, is that what we were just talking about or would that fall in that box then? The red oil.

MR. BROWN: Establishing what they are. Right. For example, the 125 degrees.

DR. WALLIS: So what you did was then you looked at the design basis of all these PSSCs and asked a lot of questions.

MR. BROWN: Yes.

DR. WALLIS: And convinced yourselves that the logical know-how was such that this design basis --

MR. BROWN: In a nut's shell, that's the approach.

DR. WALLIS: You think you did that.

MR. BROWN: Yes. For example, if I may go back to an example, the initial design bases for limiting temperature for red oil prevention was 135 degrees Celsius. We looked at it. We, the staff, looked at the available literature and decided that was a bit too close to the initiation temperature for that event.

PARTICIPANT: But it's two degrees below.

DR. WALLIS: But you convinced yourselves that you said 125 degrees everything would be okay. You did that sort of analysis.

MR. BROWN: Yes. We made that sort of assessment. Yes.

DR. WALLIS: I think it's important that we would get that impression. Otherwise it's such a high level to understand the depth to which you went to satisfy yourselves that the design bases were okay.

MR. BROWN: Okay.

MR. GIITTER: Excuse me. As Dave goes through the example on fire protection if he can elaborate on what the staff did or Sharon Steele, our Protection Engineer, do that, then I think it may make more sense to you.

DR. POWERS: But I want to pursue this one just a little further here with Alex and you as well, Dave. You've gone through and you've looked at these. You've looked at the literature. You have a candidate design or a design concept. I think we'd call it a preconceptual design on how to handle this, red oil and the closed system. It looks perfectly plausible. At what point do you say "Yes now prove it to me and what constitutes proof"?

MR. MURRAY: Can I answer that?

DR. POWERS: Sure.

MR. MURRAY: The actual proof or demonstration of the controls for preventing in this case a red oil event would have to be done by the applicant in the license application and you would think that the ISA summary would have quite a bit of information on the red oil or potential red oil event because of the potential severity and known ability to occur in these types of facilities.

DR. POWERS: But what constitutes the proof?

MR. MURRAY: The proof, what we would anticipate, and I want to emphasize this is forward looking, would be the identification of safety controls at the component level. We would expect a clear logical and/or semi-quantitative or if the applicant feels it is important enough, a quantitative demonstration to show that the event can be rendered highly unlikely. It is the applicant's choice to select exactly which approach or which way they want to show that demonstration. As part of the staff's review of that demonstration, we would anticipate that we would get more into semi-quantitative analysis somewhat like a layer of protection analyses which is performed by the chemical industry.

MR. ROSEN: Let's get to specifics now. If the applicant says something is highly unlikely that means it's 10^{-5}, right, or less?

MR. MURRAY: By our guidance.

MR. ROSEN: Yes? So that's what you're trying to agree at. It is 10^{-5}. He's already asserted that. He's giving you a detailed design and now you're trying to see if you think that this red oil explosion or whatever was going to be at less than 10^{-5}.

MR. MURRAY: Yes.

MR. ROSEN: Now to do that you're going to have to sequences.

MR. MURRAY: That's correct.

MR. ROSEN: And those sequences are going to have to have numbers on them and you're going to have branch points where you're going to have conditional split fractions where something works and something doesn't work. And it's all going to start looking like, Dr. Apostolakis, a PRA.

MR. GIITTER: That's if they decide to take a quantitative approach which they're not required to do in a Part 70.

MR. ROSEN: Right. So they can come in and wave their arms or other appurtenances and say, "Therefore it's 10^{-5}" and you're, poor Alex, is probably the only person on earth who could do it, can conclude from a semi-quantitative or non-quantitative analysis a quantitative result. Remarkable.

MR. MURRAY: I as Alex Murray, the Lead Chemical Safety Reviewer, would almost certainly back that up with some of my own calculations.

MR. ROSEN: Well, I don't see how you can do it.

MR. MURRAY: As long as I have a detailed design and identification of the safety --

MR. ROSEN: But why would be a hero other than the factor that we already know you are? Why would you? Why wouldn't you just say "Gee, you're asking me to draw a quantitative conclusion, Mr. Applicant and I don't have any way of doing so and I think the answer is you didn't make it. Do you want a semi-quantitative answer or you want a qualitative answer. My answer is no. What part of no don't you understand? Now if you want to change my mind, come back with a quantitative argument."

MR. BROWN: Well, you just hit on it if I might add. While we don't require that everything be considered in quantitative fashion, if for example in this instance the sequences are complex that really deserve some kind of quantitative analysis, that certainly is not precluded.

MR. ROSEN: Something has to open. Something has to close. Some fan has to start. Some this or that. You know.

MR. BROWN: Yes.

MR. MURRAY: That's right.

MR. BROWN: Those kinds of things are allowed and if that's what DCS needs to do to make its case, that's what they will do.

DR. WALLIS: What about the future here?

MR. BROWN: Right. We're speculating on what the future holds.

DR. APOSTOLAKIS: This is not the future, is it?

DR. WALLIS: What kind of proof are you going to get? Now the person stage, you're nowhere near that. All you're saying is that we've looked at the way in which these reactions have been controlled in the past. We have reasonable assurance that when they've done all the detailed design they're going to be able to come up with a number something like 10^{-5}.

DR. APOSTOLAKIS: That's what they're saying.

DR. WALLIS: But you're not saying that they can do that.

DR. APOSTOLAKIS: Unless they don't want to.

DR. WALLIS: You're saying you have a feel based on experience and some bounding parameters that it's feasible.

MR. MURRAY: That's right. That we have come to a conclusion that they have reasonable assurance and to have some reasonable assurance is more than just a feel. Usually we have a linkage to clear statements and an analogy in the literature. In the case of red oil, some parts of the applicant's proposal lined up very well with practices at existing facilities such as the evaporators in the DOE complex. In some other parts of that proposed safety strategy, there was not that clear an alignment. So it went into a more detailed analyses and actually I did some quantitative work in that area and that allowed us to come to a conclusion we do not have the system described at the component level. We have the controls described at more of a system level. However, if you use typical values for some of those components like controllers, like valves, like pumps which can put in quench water, you can get to some assurance that, yes, if they design it right with specific components, yes this should have the ability to get to the highly unlikely likelihood and then have to demonstrate that at the ISA stage.

MR. GIITTER: I would just add there were some areas in using verterall (PH) as an example where we felt we needed some more information that the DCS committed to provide at the license application stage in terms of testing to confirm, confirmatory testing to confirm what was stated in their construction authorization request.

DR. POWERS: Yes, I think you have given the answer that I was looking for, Alex, here. Let me just summarize. I'm going to take a break here by the way and come back. I think we're at the precipice of doing the examples.

MR. BROWN: We are.

DR. POWERS: But what you did not say is you did not say they are going to have to come in and do an experimental proof that should they get a red oil excursion in this facility, it will indeed handle that. You did not say that.

MR. MURRAY: Could you repeat that again, Dana? I just want to make sure I have the sequence right.

DR. POWERS: You did not say that you were going to have to do an experimental demonstration.

MR. ROSEN: Like futile phosphate.

DR. POWERS: That in a red oil decomposition excursion the facility will indeed be able to coop with it.

MR. MURRAY: The proposed approach is a convention strategy. So the red oil excursion event would not occur if they do it the usual way.

DR. POWERS: You did not say, "Okay, put a bunch of red oil in there, run this thing and show me that that works." You did not say that.

MR. MURRAY: We did not say that because -

DR. POWERS: That would be an impossible thing to do.

MR. BROWN: Well, let me just say. There is for open systems we're saying the red oil event could in fact begin.

DR. POWERS: We're talking quotes here.

MR. BROWN: Right. An event of such and such size, a design basis value that we have will relieve the pressure even as the event occurs. Now does that mean I'm going to go off to do an experimental apparatus and cook this thing up and show that that vent is sufficient size? No, we don't have that commitment and at this point, we don't have. We didn't say that that was something they were going to do.

DR. POWERS: It would be an impossible task because nobody has found a way to reduce the manufacture of red oil.

MR. BROWN: No, the basis for the defense size that we have is experimental data.

MR. MURRAY: Right.

DR. POWERS: It's experiential data.

MR. BROWN: I want to say it's experimental.

DR. WALLIS: You have to be committed to a research program to understand the red oil reaction better. What is the output of that program? What is it supposed to do if it's not going to satisfy what Dana is asking for which is an experimental demonstration that your theories are okay?

MR. BROWN: As I understand that

experimental program, that is focused on establishing a temperature margin.

MR. MURRAY: Right.

DR. WALLIS: Well, that's very important.

MR. BROWN: I'm sorry.

DR. WALLIS: It's very important what the temperature is.

MR. BROWN: It is very important.

DR. WALLIS: They do experiments and show that if you get to 126 degrees it's very bad. You might say, "Oh, wait a minute. You can't operate at 125."

MR. MURRAY: That's correct.

DR. WALLIS: They might learn something from the experiment.

MR. MURRAY: That is correct. Yes.

DR. POWERS: Let me make it very clear. I'm much more comfortable with the approach that Alex laid out than I am with somebody did some experiments and found out that the number was 130 because with this particular red oil you never know if the experiment the fellow is doing is reducing the material that appears by accident. I'm much more comfortable with this, "I've bounded things. I've looked at the design. I know these kinds. I have fundamental physical understanding of quenching phenomena and stuff like that. We'll get rid of it" than I am somebody producing an experimental datapoint because I think I'm privy to every experiment that's ever been done and I have never seen any of those experiments come back and "Yes, what we produced here in the laboratory is exactly what was produced in the accident at this facility."

MR. MURRAY: That's correct.

DR. WALLIS: But you know enough to know how much quenching you need to provide to be sure enough. You know enough to be able to evaluate that?

MR. MURRAY: The, if you will, amount of quenching that is needed will have to be demonstrated by the applicant at the ISA stage.

DR. WALLIS: How will they demonstrate it?

MR. MURRAY: We know what the heat of reactions are if you completely oxidize.

DR. WALLIS: So it would be bounding calculation.

MR. MURRAY: It might be a bounding type calculation. That is correct. But these sort of things can be calculated. Obviously we also will put the applicant in the ISA and the license application plus also to start as part of our review we'll look to see if this is reasonable to accomplish.

If for example quenching requires one or two gallons per minute, that is a very reasonable thing. If it turns out quenching requires say 100,000 per minute, okay, that is no a reasonable control strategy. But some of this reasonableness and comparison with accepted practice, again the term which we like to use is RAGAGEP or sometimes usual and customary is another term, we can look into this and see where the applicant's proposed strategy stands now and also where it would be when we get to the license application stage.

MR. SIEBER: It seems to me though that as far as red oil is concerned no two cans of red oil are the same and therefore you have to have some kind of process controls so that you know that the red oil you're dealing with is in the bounds of the analysis that says "This is the right temperature and this is how much quenching I need." Is that correct?

DR. POWERS: Yes. I think that's the strategy they've taken. For the open systems, they've said, "Look this is not different from the kinds of systems where these standards apply." For the closed system, there's more to do here because we have less experience here.

MR. MURRAY: And I will just add a couple of the safety controls which the applicant has proposed actually focus on eliminating some of the potential reaction pathways such as the presence of impurities to start out with, such as the presence of certain types of compounds primarily alicyclic compounds in the diluent which can if you will accelerate or contribute to red oil events at lower temperature.

They also have identified controls on the impurities primarily C4 type of compounds such as butanol as well as some of the lower esters like a tributyl phosphate. They have also proposed a control on resonance time which of course interacts with the amount of nitration which would occur of the diluent and tributyl phosphate mixture. So they have screened some of the pathways out which historically have contributed to all of the unpredictability of the red oil phenomena plus the ability of controls to be effective.

DR. WALLIS: It seems to me you're doing something satisfying yourself that an ECCS system will work without the benefit of relap or track or any of those codes. You're doing it at some global level making use of the kinds of analyses you know how to do and that's what you have to base it on because you don't have a good model for what happens. Is that where you are?

MR. MURRAY: I think that's correct. At this stage, we have done what I will call a process analogous to the LOCA process, the American Institute of Chemical Engineers process.

DR. WALLIS: It doesn't have the benefit of a code that pretends to describe what's happening.

MR. MURRAY: Right.

DR. POWERS: What I'd like to do now is just go ahead and take about a 15 minute break and I think at that point we'll come back.

MR. ROSEN: Dana, are we going to discuss this slide 27 before we've --

DR. APOSTOLAKIS: Well, there is one -- in 26 of questions.

DR. POWERS: Okay. I'm going to take a break. Off the record.

(Whereupon, the foregoing matter went off the record at 3:05 p.m. and went back on the record at 3:22 p.m.)

DR. WALLIS: Back in session.

DR. POWERS;: If you don't do your example soon, we'll be stuck on the 26 and 27 for eternity.

MR. ROSEN: But I want to have one question answered. If you can't answer it, then that's fine. You can answer it later. It's on the next slide, not 26.

DR. POWERS: Get on that one as quick as you.

MR. ROSEN: Second yellow bullet, application in Part 50 Appendix B. You know it's the devil and the devil's in the details. Part 50 Appendix is eighteen criteria.

MR. BROWN: Eighteen criteria.

MR. ROSEN: That are just very high level that when you try to comply with that you really have to comply with the daughters standards and reg guides all of them which are many and multi-faceted including such things as design control and how one goes about doing design in accordance with Appendix B. Let me tell you. Those standards are very onerous. Is that what you really mean? I mean it's the same site as for reactors. I tell you what I think the staff will do. They'll come in and their QA guys will come down to your contractors and apply the same Appendix and daughter standards that they do on reactors and you're going to be unless they know it's coming, it will be a train wreck.

MR. BROWN: At this point what we have because what the regulation requires at this stage is I mentioned the safety assessment of the design basis, the site description and the quality assurance plan. So DCS submitted a quality assurance program plan that is tailored after the 10 CFR 50 Appendix B criteria.

MR. ROSEN: The normal Appendix B, people reviewed it.

MR. BROWN: Yes.

MR. ROSEN: The same guys reviewed it and said that's an Appendix B program. That seems appropriate to us.

MR. BROWN: We had a quality assurance. Yes, and that's what required for a MOX facility.

MR. ROSEN: All right.

MR. MAGRUDER: And they are anticipating. We've already talked about doing joint QA audits and visits and we're going to vendors to them and things like that.

MR. ROSEN: Oh boy. We have them now.

DR. POWERS: He's not joking. This is something I wouldn't wish upon my worst enemy.

MR. ASHE: Excuse me. This is Ken Ashe again. For 10 CFR Part 70, we didn't have a choice. I mean that's what it says we have to do.

MR. ROSEN: Oh, having fun. You might want to hire a few people who've been through it.

DR. POWERS: Or maybe not.

MR. BROWN: Something I just want to get back to and I apologize if I'm backtracking too far, but there was some question earlier about what is meant by defense in depth. That term is clarified in the regulation and it does mean a design philosophy applied from the outset to completion of the design. It is based on providing successive levels of protection such as health and safety will not be wholly dependent upon any single element of the design, construction, maintenance or operation of the facility.

DR. KRESS: It came out of the commissioner's white paper.

MR. BROWN: Yes, that's right.

DR. KRESS: I think that's the words they used.

MR. BROWN: Okay. If I may now move right on to the example then. The example I chose here for this is the possibility of fire in a glovebox containing plutonium dioxide powder. It is a credible event. One of the ways that we've determined that is are there any causes. Is there combustible material present? Are there ignition sources? And in fact, there are.

So the next step then is to establish, okay if I had such a fire, what are the consequences to each of the receptors. DCS did this in its safety assessment and the staff independently did this part of its safety evaluation to assess whether or not DCS was correctly categorizing events as low, intermediate or high consequence events.

Having established that this would be a high consequence event and DCS did that, staff independently verified, yes, it looks like a high consequence event. They needed to establish a strategy and for this event what they're doing is trying to make what is high consequence low by mitigation. So the strategy for example for the facility worker as I've described is escape.

MR. ROSEN: Run like hell.

MR. SIEBER: Run.

MR. BROWN: Basically. So we have to ask ourselves "Well is it reasonable that a worker in a plutonium processing facility would in fact run if he saw a fire in a glovebox? Are there reasonable indications of danger that would cause the right response?"

DR. WALLIS: He doesn't put it out or anything. He just runs away.

MR. BROWN: As I go on, I'll describe some of the other things that are there by way of available CO_2 cartridges for fighting the fire but in the event that this person decides, well, the first thing this person should do is what he's trained to do which is to get out of there. This is administrative control. I can't tell you what the design basis is. It's qualitative. He responds to the indication of fire.

For mitigation for protection of folks outside, it's that tertiary confinement system. That is the PSSC. The C4 system is the filters on the glovebox ventilation system. The C3 system represents the process room where the glovebox is contained. You need both.

DR. WALLIS: So the design basis if that the whole thing burns up and none of the products get out of a certain space.

MR. BROWN: The event is that the glovebox burns up, consumes, involves all the material in that glovebox.

MR. ROSEN: Is there a criticality concern in this glovebox in your example?

MR. BROWN: In this example, no, there's

not a criticality. Let me ask what your question is again though.

MR. ROSEN: Well, is there a criticality concern because if there is then you won't be able to use water-base via suppression systems and you'll be using a clean agent suppression systems and I have problems with fires that are suppressed by clean agent systems.

MR. BROWN: Okay.

MR. ROSEN: Because they don't cool anything. They just suppress the fire. The minute you get air you have a fire again.

MR. BROWN: I understand.

MR. ROSEN: That's the essence of my technical concern and the one Dana asked me to postpone until this example.

MR. BROWN: Okay. The answer is yes there is a criticality concern in areas where there's plutonium powder stored. They may be moderator controlled areas, areas where they are specifically including the water.

DR. WALLIS: We are talking about a glovebox here. Are we or are we talking more generally?

MR. BROWN: Talking about a glovebox.

DR. POWERS: For this example.

MR. BROWN: For this example right.

DR. WALLIS: So there's a criticality concern with this example.

MR. SIEBER: There could be.

MR. BROWN: If the decision was to fight that fire with water, there is a potential criticality concern.

DR. WALLIS: You've also gotten molten plastic and stuff. We talked about it at the subcommittee.

MR. BROWN: Yes.

DR. WALLIS: It's not as if there aren't any moderators around.

MR. BROWN: Correct. That would have to be considered in a criticality safety evaluation.

MR. ROSEN: So I'm going to assume that there is a criticality concern here.

MR. BROWN: Right. The event then with these PSSCs in place is as we've described.

MR. ROSEN: Operator bagging.

MR. BROWN: The ventilation system will be able to withstand the fire to completion involving all of the combustible materials and the soot loading on the filters would not damage the filters or in any way impair their function. One of the ways they do that is this second to last bullet is to confine that fire to that fire area using the two and three hour rated fire compartments. That's what's necessary to achieve the performance requirements. So those are the PSSCs they need to have.

But beyond that is this C2 confinement, fire detection and suppression systems that are also there. They are just not credited to achieve the performance requirements in this case. So they represent defense in depth.

MR. SIEBER: The main mitigating strategy is to allow it to burn until the fuel is consumed.

MR. BROWN: Right. The assumption is.

MR. SIEBER: And the secondary, the back up, defense in depth is to put the fire out.

MR. BROWN: I think it's important that when we say that that there's a philosophy here. Yes, there's a philosophy of "I could withstand full burning, all of the combustible material is burned." Does that mean that's going to be my operational strategy? That's how I'm going to respond to a fire. No, certainly not. But from a safety assessment point of view, I'm demonstrating that I could in fact do that and I don't need to go fight the fire.

DCS has other concerns. They want to keep this plant operational. They have a customer they need to satisfy. They're going to do something to put the fire out and those provisions are in place also. We talked about the dry stand pipes and the ability to go in there if they had to to fight the fire with water. But what's in there is a clean agent suppression system for these areas.

DR. POWERS: I guess I'm still looking for the answer to Steve's statement that suppose the combustible inventory is substantial such that you can't really afford to have this fire go on to the point that it consumes all the combustible. And you use the clean agent and sure enough, it crusts over the fire. As soon as you evacuate the clean agent and let air in again, it flares up again and this will go on. We certainly know of examples of it going on literally for hours. Now what do you do?

MR. BROWN: I see Sharon is approaching the microphone. I would like to defer to her on that question. Did you understand the question?

MS. STEELE: I don't know if I heard the entire question, but one of my initial responses is that combustible loading controls is a PSSC for gloveboxes that have radiologicals stored. So what

DCS has done is through the combustible loading controls look at fixed combustibles, things that are going to be there by design and transient combustibles, thing that are necessary to continue the operations. As best as possible, they will minimize the combustible load within the gloveboxes. I think that would probably satisfy this question.

MR. BROWN: Well, I think you're getting to that answer which is that there are another suite of controls if you will, another PSSC which is these combustible loading controls and the management measures which are in place to ensure that there is not a build-up of transient combustibles and such.

MS. STEELE: Further to answer Dana's concern, if there is an excess amount of combustibles in those gloveboxes that could lead to a fire that could potentially overwhelm the systems that are in place, for that what DCS has done through calculations was demonstrate that for the very worst case assuming a fire that had 80 adiabatic temperatures within the room, that the ventilation system would be able to dilute the fire air with sufficient air to reduce the temperatures and so that a fire would not affect the HEPA filters downstream. That's one of the analyses that they have done.

MR. BROWN: As I understand that, they looked for and found the two adjacent fire areas that had the highest combustible loading and used that in the analysis.

MS. STEELE: Right. And as a separate analysis just looking at whether the fire barriers could withstand an intense fire, they selected two fire areas, one adjacent to each other with a maximum amount of field loading and used that as a basis for demonstrating that the barriers would be adequate even though the intent is to limit the fire size or a potential fire to one fire area.

DR. POWERS: So what you're saying is that they are removing the hypothesis.

MS. STEELE: Yes.

DR. POWERS: That is that there is a fire area such that the combustible loading is so high you can't tolerate the combustion of that entire fire loading. They are eliminating that hypothesis is what you're saying.

MS. STEELE: Yes.

DR. DENNING: But within an administrative control.

DR. POWERS: Yes, it's clearly an administrative control.

MR. ROSEN: And that does block that and protects the filters downstream or protects the walls of the enclosure.

MS. STEELE: Right.

MR. ROSEN: It does all those things, but inside the enclosure you have a fire that consumes a limited amount of in-place combustibles plus transient combustibles and some of this tributyl phosphate and other stuff that's in there along with plutonium and so and so. That all burns, but it burns and it's suppressed by a clean agent. Now here's where you are. You have this glovebox which is still intact, still hot, filled up with halon or something like that.

MS. STEELE: I was going to just get back. The gloveboxes themselves do not have clean agent suppression. Clean agent suppression is applied to the fire areas themselves where gloveboxes are present that contain radiological material.

MR. ROSEN: Okay. So the gloveboxes have nitrogen or something like that.

MS. STEELE: Some have the gloveboxes whether it's physio-material (PH) or inerted. That is for process reasons. It is not identified as a PSSC.

MR. ROSEN: So that's helpful.

MS. STEELE: Right.

MR. ROSEN: Now let me go back to the beginning again. You have this glovebox which may be inerted. It has tributyl phosphate perhaps and plutonium in it and maybe some other combustibles at a fix like seals or something like that.

MS. STEELE: Right.

MR. ROSEN: And it catches on fire. Bang, off goes the halon, well, no. It catches on fire.

MS. STEELE: You're still in the glovebox.

MR. ROSEN: You're still in the glovebox. You have nitrogen. So it can't burn much but it's burning somehow.

MR. SIEBER: How?

MS. STEELE: I don't think so. There's not sufficient support combustion.

MR. ROSEN: The things never leak? They never leak?

MR. BROWN: Well, just don't --

MR. ROSEN: Then we don't have a fire program. We don't need it, I guess.

MR. BROWN: They do because when you look at this philosophically you're saying as Sharon pointed out the nitrogen is not credited as a safety control. So you don't assume it's even there.

MR. ROSEN: Okay. So it is burning.

MR. BROWN: It's burning.

MR. ROSEN: Somehow it leaked let's just say. Now it's burning. It's getting hot. It destroys the glovebox enough or it breaches the glovebox.

MR. BROWN: Breaches.

MR. ROSEN: And now it's detected and the halon system, the clean agent suppression, goes off.

MS. STEELE: Right. And it would be detected even before there's a breach because there are at least two fire detectors in each glovebox and those are credited as PSSCs. So somewhere in the facility you would know -

MR. ROSEN: So probably early --

MS. STEELE: -- that there's something going on there.

MR. ROSEN: So now we have a detection and a breach of a glovebox and a halon system discharge and the area operators have left already because they know they're off to get to the safe haven.

MS. STEELE: Right. There is a fire brigade also.

MR. ROSEN: If they show up. I'm sure they will.

MS. STEELE: They show up.

MR. ROSEN: But there is a fire of some kind going on in that glovebox inside that breach and it's hot. Fires are hot. There's butane, tributyl phosphate, who knows all what else in there but it's hot and there's nothing cooling it off except what? There has to be some conduction. There has to be some radiation cooling.

MR. SIEBER: Radiation.

MR. ROSEN: There has to be some of that going on and when all of the combustibles have combusted.

DR. KRESS: It mixes with the air in the room.

MR. ROSEN: Mixes with the air in the room.

DR. KRESS: At the cooling process.

MR. ROSEN: Yes, but the air has been replaced to a large degree by the halon. I'm still trying to figure out how does one eventually get the thing cooled off.

DR. KRESS: There's a cooling out there.

MS. STEELE: Well, see the C3 ventilation system, it's safety function is to remain operable. That would also be diluting the air within the room and throughout the C3 system. However, if it's determined that for some reason the temperatures in the fire area are larger than what they're anticipating, there will be procedures where you can actually close the dampers to that particular fire area and still contain the fire to that fire area whose barriers included in the dampers are designed to withstand a two hour fire.

MR. ROSEN: So now it keeps burning until it's a two hour fire, but still hot although it's maybe lost some of the, I mean quantitatively whether or not that's a good heat loss mechanism but still you haven't described to me how one actually gets the cool-down you need. I'm an old fire protection guy from the plants and the thing that they taught us and that we learned at Brown's Ferry is eventually you need spring water on this thing to cool it off.

MS. STEELE: They can eventually do that. Remember the fire area confines two hour fire limit. There's not enough in most cases combustibles to even have a two hour fire. So assuming there's no oxygen coming in, the C3 systems are shut down, dampers are closed, there will not be enough combustibles to go beyond the limits of the fire area if necessary.

MR. BROWN: I do want to try to understand this better because the fire has occurred and it may be faster than two hours and there is still heat in the room, but other than being a hot room what concerns do I have left? The ventilation system has captured all of the potential release. The fire is contained. The fire is out and I just have to wait until the room cools down.

That's philosophically what we're talking about with respect to what the PSSCs will do. Sharon's acknowledging certainly that there are other things they can do and we'll be asking them to do. But that room will cool down eventually.

MR. ROSEN: It depends on how much loading, doesn't it?

MR. BROWN: How much loading there is?

MR. ROSEN: Yes.

MR. BROWN: Oh, absolutely. Yes, we addressed that with the combustible loading controls.

MR. ROSEN: Well, if it doesn't cool down right away, pretty soon you start having fires external to the glovebox in the cables.

MR. BROWN: Right.

MR. ROSEN: Cable trays, anything else in the room in the enclosure starts to catch fire.

MS. STEELE: Cables that are in the rooms where there are gloveboxes are encased in metal conduit and all cables are designed to be IEEE qualified to begin with, cables that enter those rooms.

MR. ROSEN: The bookcases and whatever else is there that's combustible.

MS. STEELE: Not in those areas where there are gloveboxes.

MR. ROSEN: Okay. So these are all matters for the ISA for me to look at in detail.

MR. BROWN: Yes, they are.

MS. STEELE: Yes.

MR. ROSEN: And see what the combustible loading are and whether I believe that there's conduction and the conduction in radiative terms are large enough to actually result in a cool-down.

MS. STEELE: And you're absolutely right, Steve. There's always a potential for fire to come through the barriers. There's going to be penetration seals, penetration seals programs and the barriers themselves which are PSSCs will be designed such that We would largely eliminate that possibility. They're going to meet typical NFPA standards.

MR. ROSEN: You're not going to leave it to me to do this. This is what you're doing.

DR. POWERS: You're the lead analyst.

MR. ROSEN: This is what you're going to do.

DR. POWERS: Sharon has other jobs to do. She's not around to help anymore.

MR. ROSEN: If I got paid what Sharon got paid, I might be willing to do it.

MR. MAGRUDER: I also want to point out that it doesn't stop there. During construction, we're going to have a lot of inspectors on site. There'll be a resident inspector there at the site. He'll be doing tours.

MR. ROSEN: To make sure there's not transient combustibles being produced.

MR. MAGRUDER: Exactly.

MR. ROSEN: So at the design stage, the ISA stage, the kinds of thought processes we just went through kind of as an experiment is what the staff will be doing to show themselves that the applicant has indeed proposed a set of controls that makes sense.

MR. MAGRUDER: Yes.

MS. STEELE: And that's what we're approving it based on.

DR. POWERS: How much thermal leg can you put?

(Laughter.)

MR. ROSEN: All these Appendix B Standards, all of this work that you'll be reviewing will be to Appendix B Standards.

MR. BROWN: That's right.

DR. POWERS: This could easily be the most expensive fuel that's ever been up in any reactor.

MR. BROWN: What I'd like to do is focus on one of the PSSCs that I just talked about, the C3 ventilation confinement. So why do we believe that they've identified design bases that will make that thing work even though there's a fire. The safety function is to remain operable. There are spark arresters. There are on the two stages of spark arrester on the final HEPA filter assemblies that protect the final HEPA filters. That's somewhat of a rather qualitative argument that have these there on protecting the filters from hot embers and particles that may be coming down the pipe.

The filters themselves are designed to withstand 450 degree Fahrenheit temperatures and this is an analysis that DCS did and we looked at. Because this plant is divided into 350 areas when I have only one fire area involved, I have a considerable amount of dilution flow from areas that are not involved in a fire.

DR. WALLIS: This is air?

MR. BROWN: Of air. Yes.

DR. WALLIS: So you're going to mix air with what could be combustible products coming out of the glovebox?

MR. BROWN: Yes, I believe that was a question that we raised during the review. Was it not, Sharon, the possibility for combustible like paralysis products I believe they are called coming out of a fire?

DR. WALLIS: And they mix them with air and there are glowing particles in there to set them off.

MR. BROWN: Yes.

MS. STEELE: You're saying that the products of combustion would be coming from one particular fire area and mixing with clean or relatively clean air from the remaining 349 areas. Right?

MR. BROWN: Right.

DR. WALLIS: What I'm saying is the combustion could have cells themselves be combustible.

DR. POWERS: Quite often are.

DR. WALLIS: Quite often are. Incomplete combustion decompose to plastic and something else.

MR. BROWN: Right and that's going into the ventilation stream along being mixed with fresh oxygen. That's the scenario that you're laying out.

DR. WALLIS: Right. That's the scenario.

MR. BROWN: Right. Do you recall, Sharon, how that addressed?

MS. STEELE: No, I don't.

MR. BROWN: I believe that is part of the analysis where we're showing that even though that may occur say in some manifold immediately downstream of a given area prior to getting to the final HEPA filters which are all the way downstream, they're not likely to see temperatures anywhere near 450 degree Fahrenheit.

DR. KRESS: I could see how you could do that if you knew what the combustibles were and how much because you can take that and mix it with your incoming air and combust it all the way and see what temperature that takes you to without loss. It can be done.

DR. WALLIS: With enough air to cool it down.

DR. KRESS: You have to know how much

dilution air you have. That's an assumption.

MS. STEELE: Right.

MR. BROWN: Keep in mind. That essentially has 349 times the amount of dilution air.

DR. KRESS: Yes. You have to define what combustibles are and what their heat of combustion is.

MS. STEELE: One of the conservative analyses which looked at the dilution of the hot air assumed that the hot air was at a temperature of 2,000 degrees Fahrenheit. I mean that would be the adiabatic temperature that you could expect from a fire involving ordinary combustibles and I don't think there are too many things at the facility where you get a temperature beyond that.

That's really extreme. With that analysis, they were able to demonstrate that the temperatures before you got to the final HEPA filters were within the limits that the HEPA filter could withstand.

MR. BROWN: We at one point carried an open item in the staff's review with regard to how good these filters actually survive a fire. One of the things DCS did to resolve that was these certain pressure conditions calculations to show that, yes, we think DCS had said they think these filters would survive these types of events. We also received at that time a commitment that they would go off and do experimental tests, not only do this by calculation but later show by test that these filters could withstand these kinds of conditions.

MS. STEELE: Let me just add also. Dave talked about the two stage pre-filters.

MR. BROWN: Yes.

MS. STEELE: One of them is a spark arrester which is made of metal and it would prevent any embers, any sparks, from going beyond to reach the HEPA final filters themselves.

MR. BROWN: And so just following through on the methodology here, we know this now. What are we expecting later? The C4 confinement ventilation system, it's just that. We're saying it's the glovebox ventilation system at a system level. DCS will need to identify of that what are the important items relied on for safety and break it down to the component level. Then we want them to show that those things which need to be reliable and available on demand will be so and that in order to get to that point they've identified the appropriate management measures.

For HEPA filters not relating necessarily to a fire, but just the on-going performance of the filters is something you'd want to routinely test and that's normally done on some surveillance frequency. The provisions are in the design that these filters can be individually, the two stages of filters, tested online. I'm going to move to some of my last remarks unless there are any other questions on that fire example.

DR. WALLIS: This soot deposits on a filter which is made out of what?

MR. BROWN: The filter itself is --

MR. GIITTER: The question is what the soot would be deposited on which would be before it actually reaches the HEPA filter.

MS. STEELE: Well, you have the metal spark arrester.

MR. BROWN: Two stage spark arrester stainless steel.

MS. STEELE: The two stage.

DR. WALLIS: What's the filter material in the HEPA filter?

MR. BROWN: Porous silicon glass.

DR. WALLIS: So it's not a conductor. So you get charged soot particles that charge up this thing and there's a spark in the HEPA filter.

MR. BROWN: I'm not sure I understand. You're postulating a condition where the filters could burn.

MR. SIEBER: Yes.

DR. WALLIS: I'm just postulating a condition where electrostatic charge could build up in the filter in various regions.

MR. BROWN: Okay.

DR. WALLIS: And then discharge and have a source of ignition. That's all.

MR. BROWN: Okay.

DR. POWERS: Ignition of what?

DR. WALLIS: It burns the soot which is deposited in there.

MR. BROWN: Okay. That's not --

DR. WALLIS: I guess you're going to consider all these things.

MR. BROWN: We didn't consider that as initiating event for damage for the filter.

MS. STEELE: Well, certainly there will be many answers when DCS performs their actual tests.

DR. WALLIS: I just know that they might put a vacuum cleaner on soot by a furnace like in a spa. I think it's something to do with the charges on the soot products.

MR. BROWN: Okay.

DR. WALLIS: I don't know what causes it, but it happens.

MR. BROWN: Yes. WE haven't considered that at this point. That's an interesting question. Last time we spoke with the subcommittee. We were talking about the closure of what open items remained. Those have all been resolved. We had discussed at that time a permit condition that will be applied for maintaining habitable conditions in the control room. We have discussed that again with DCS and that condition will remain in the permit. I mentioned briefly on that second day of the subcommittee meeting in December that we had some follow up items we were looking into in criticality safety.

DR. WALLIS: So all this discussion about the safety is examples. It's assessment that a fire in the glovebox was supposed to convince us that you had everything under control. Is that what the discussion was for?

MR. BROWN: It was intended to be an example, just that illustrative of the approach that we took.

DR. WALLIS: It does seem to be that for all the questions it didn't have very quantitative or convincing answers.

MR. BROWN: You mean in that example you weren't convinced by it.

DR. WALLIS: Yes. Did I miss something? We won't able to ask the questions that didn't have any crisp, reassuring answers.

MR. ROSEN: Certainly no quantitative answers.

MR. BROWN: I think Sharon described for example that the temperatures that were assumed as part of the fire assessment to show that the filters would meet or the temperatures at the filters would be well below the temperatures at which they're rated. We were specific in the numbers that we described starting with the temperature of 2,000 degrees Fahrenheit in a fire area, not likely to exceed 450 degree Fahrenheit at the final filter.

DR. WALLIS: And then no secondary combustion on the way there? No combustion that collects in the pipe to the filter?

MR. BROWN: I understand your question. I think we explained it that the very conservative assumption that we've had, Sharon, I think described an adiabatic type fire of very high temperatures bounds, those sorts of phenomenon. That mixing of combustion products would occur immediately downstream of the fire area. So I assume it would be at temperatures not very much different from the temperature we assume to be in the fire area of 2,000 degree Fahrenheit.

MR. ROSEN: Which would immediately destroy the ducts.

MR. BROWN: I'm sorry. Immediately be --

MR. ROSEN: Two thousand degrees Fahrenheit, what kind of ventilation ducts are we making these days?

DR. POWERS: Think of the heat capacity, Steve. You're total enthalpy in the gas is microscopic compared to the total enthalpy in the duct. It won't heat the duct up at all.

MR. ROSEN: I see what Graham's point is. We haven't seen any of those calculations. We can do them and talk about them.

DR. POWERS: There are calculations that I need to write on paper and the calculations I can do in my head and the heat capacity of a sheet metal duct and the heat capacity of gas are numbers that I know somewhat intuitively.

MR. ROSEN: I understand all that, but the point here is that we're not doing the calculations here. We're just trying to think about whether or not they could be done, I guess, not with assurances that they will be done either by the applicant or the staff at some point. All we're doing here is making sure that we believe that there's a reasonable assurance you'll be successful when you do those things.

DR. WALLIS: You're telling us that you go to 2,000 degrees in the glovebox and then everything gets cooled off in the pipe. It could well be that you have an oxygen short fire in the glovebox and you boil off all kinds of products from the polymethyl methacrylate which deposit in the exhaust pipe to the filter and at some time later on catch fire up there. I just don't know.

DR. KRESS: I think what they're saying is if you take all the combustibles that are inside the box adiabatically combusted to get a temperature and then you mix that temperature with the air and if that's the low --

DR. WALLIS: But that's not necessarily the worst case.

DR. KRESS: Yes, I think it is.

DR. WALLIS: You can the adiabatic case up in the pipe.

DR. KRESS: I don't see how it can be

worst than that even if some of it comes off as soot and ends up in the pipe.

DR. WALLIS: Yes, but then you have a big fire in the pipe. All the glovebox is is a pyrolitic converter that sends off combustible materials into the pipe. Then you reach your enthalpy somewhere in the pipe and it depends a lot on how much air you put in there.

DR. KRESS: Of course, it depends on how much air, but the process they're talking about I think bounds it.

DR. WALLIS: This is typical though of what we've seen all along. There's a lot of discussion, but there's nothing much to go on in terms of an analysis that we look at. So we have to ask a few questions and say, "You know generally it looks as if you guys know what you're doing."

MS. STEELE: This is Sharon again. One of your concerns is the combustion of particulates that are in the ducts if there were a fire. As we understand it, the velocities in the duct through the C3 system for example would be high enough that there's always a flow of those particulates and they would be caught on the HEPA filters. HEPA filters are changed out every so often and so that would help to eliminate that concern.

Another issue is that the HEPA filters themselves are a great distance away from those fire areas that contain those gloveboxes. I don't know exactly what the distance is but that certainly helps with dilution and the reduction in temperatures of any product of combustion before you get to the spark arrester which would eliminate the embers and before you get to the other pre-filter which prevents the passage of items that are greater than one micron which are certainly before the final HEPA filters themselves.

There is also temperature detectors in the duct work which would let you know that there is something going in the duct if there is a fire in the room itself. It would let you know there is something going on there that's unacceptable.

DR. WALLIS: I think we were discussing gaseous combustible products in the pipe, not necessarily just particles.

DR. POWERS: I guess I am at total loss to understand how I can put more enthalpy in the adiabatic enthalpy.

DR. KRESS: That's exactly right.

DR. WALLIS: That depends on what it's

diluted with. If you have the fire --

DR. POWERS: How can I possibly put more enthalpy into a system than the adiabatic enthalpy?

DR. WALLIS: You're saying you can get say 2,000 degrees coming out of the glovebox and you dilute it with air and you get down to 500. I'm saying you could have 1,000 degrees in the glovebox. You could have a fire in the pipe which gets you up to this maximum enthalpy and so you have 2,000 degrees in the pipe and now you're not diluting with anything. Your area around the pipe --

DR. POWERS: I guess I'm at a total loss how I'm going to not dilute with air.

DR. WALLIS: The air is now supporting the combustion in the pipe. Now if you add a lot more --

DR. POWERS: You will knock the temperature down like crazy. So now I do an analysis in which I put the adiabatic enthalpy and I dilute it.

DR. WALLIS: Sure. If you dilute enough, you can always do it.

DR. POWERS: And by the design, how many flows do I have? Thirty-nine volumetric flows in.

DR. WALLIS: So the argument --

DR. POWERS: I'm sorry. Three hundred fifty-fire areas.

DR. WALLIS: -- is that you completely overwhelm your energy source. We could have said that at the beginning and avoided this whole thing.

DR. POWERS: I think we tried to.

MR. ROSEN: Let's talk about one other thing which is assuming you don't have this dilution. You don't want to overwhelm anything. Are all these spaces available in the plant where you might have moderation control? Do you have pre-action systems available to respond to this?

MS. STEELE: Right. Outside of areas where there is physio-material like in the corridors and so on, there are pre-action suppression systems, water based.

MR. ROSEN: So I could say something like you should demonstrate that if you had a fire and recognizing that you don't need this -- the responders could ultimately use under the management control, administrative control or post fire plans a preaction type, they would have access to water through a preaction type system.

MS. STEELE: Right. They would access to water through the dry stand and they are water-based suppression systems outside of those areas where there are gloveboxes.

MR. ROSEN: So that the option is available to them if they analyze the situation and believe for example that though it's a moderation controlled space they are having a fire but there is material in there that could induce criticality at this time. So they could make a decision conscious decision to use these things.

MS. STEELE: They could. Yes. Even with the clean agent system, it's not a done deal. They have to ensure that they can maintain pressures and so on throughout the facility and that would be demonstrated during the ISA stage. So I would imagine that if for some reason it's been demonstrated that the clean agent suppression system would not be effective that they would consider other types of systems. Of course, we'd have to compare our analyses with the other folks.

MR. ROSEN: I needed that answer.

DR. POWERS: Dave, I want you to go through your summary real quick because I have one more question to ask you.

MR. BROWN: Okay. With regard to resolution of open items, we have received recent changes to the construction authorization request. We will certainly incorporate those in our safety evaluation report by citation. This slide is merely to go back over those things which we needed to find now namely that the design basis of PSSCs were acceptable, if they've addressed the baseline criteria.

DR. POWERS: -- is really PSSCs. Right?

MR. BROWN: You got me. Yes. PSSC.

DR. POWERS: Just have to harass you a little bit.

MR. BROWN: I was waiting. Then that they designed this in accordance with the defense in depth philosophy. That's the conclusion of my presentation.

DR. POWERS: One more question that came up at the subcommittee meeting, and I guess we're looking again for a crisp answer on this, is that right now the facility is part of an integrated complex. Unfortunately two elements of that integrated complex are promised but not yet designed. One is to feed and the other one is to receive waste. The question comes up because many examples within the DOE complex have shown us that when you interrupt the output of the systems so that they can't deliver their waste stream to whatever the receiving organization is and they have an interruption, that we have very frequently seen that that produces safety hazards within the facility itself.

So the question comes up right now you're going to deliver this waste stream to a facility that the NRC does not regulate. Some other entity regulates it. What happened if that facility receiving the waste shuts down and it says you can't send me anything anymore? Have you looked at that and what's the conclusion on that?

MR. BROWN: What you have looked at is certainly those things that could affect safety as material is making its way to base storage at the MOX facility. An example is a metal azide build-up inside the waste tanks resulting from incomplete processing in the process. When waste is transferred to the temporary holding tanks at the MOX facility, DCS has assessed and we have evaluated what the different hazards that can come out of that.

So as I understand the question, there is this issue of capacity. If the MOX waste tank is nearly full and DCS is processing material and simultaneously, the offsite waste treatment facility suddenly declares a stop and I have to bring the plant to a safe condition so I needed to have margin in my waste tank in order to fill it up with the waste that would be generated as a result of bringing the plant to a safe condition, have I considered that now as part of the safety assessment of the design basis?

No, I don't think that we've looked at that scenario as part of the safety assessment. That to me is more of an operational concern that it is likely that, in fact, I think that's a very credible scenario, they will have to have some sort of operating limits such that they always have sufficient volume in the tanks to deal with the shutdown condition without the ability to transfer. That's something we'll have to look at.

MR. ASHE: Excuse me. Ken Ashe with DCS and you're absolutely right, Dave. It is what we've looked at and I believe that we have had some discussions about the fact that we have a 90 day capacity if you will and the process is set up now so that every couple weeks we will take and have batch transfers to the waste solidification building. So we believe we would ample capacity. It's not our intent to take and nearly fill up our tank and from operationally standpoint that is true. It's also true that if the Department of Energy says that we're not receiving any additional waste we will shut down. We would have to do that.

MR. BROWN: Let's stop at that point. I

want to be sure we answered the question.

DR. POWERS: Okay. You've certainly answered the first question which is do you have capacity. What's gotten us into trouble in many facilities not only in the United States but in Russia and every place else is that you sit there and that stuff starts aging. It's sitting there and many, many of these chemicals are far from the most stable form of the elements.

So they evolve and I think ellia (PH) protogene (PH) had something to say about all this. They tend to evolve to higher enthalpy states. Life starts to be created I think in these things. Will the evolution as you sit here and wait for DOE to say yes has any of that scenario been examined if there's any credible hazard there?

MR. BROWN: Yes, that's what I meant by for example of looking at that metal azide accumulation. For example one of the controls, now this gets a little bit away from waste. So I apologize. But for long terms for shutdowns, one of the things we need to watch out for and it's an identified control is the evaporation of solution in any tank containing hydroxylimine nitrate which would cause the hydroxylimine nitrate to unintentionally concentrate and essentially start going into a dangerous condition.

That kind of thing has happened at another facility and I think it was Hanford. We've identified that. DCS has identified that. It's a specific control for this facility. I said I got away from waste because I think I really did. That's really the chemical storage in the plant.

The other things we have to look out for is radiolysis reactions. If I have a tank of, and this is somewhat very significant quantities of, Americium 241 in the high alpha activity waste. Up to 84,000 curies per year would be produced at DCS's maximum production capacity. They do transfer as Ken pointed out every two weeks, but still I could have a significant quantity of Americium 241 in a waste tank producing hydrogen by radiolysis. That has been considered in the safety assessment through a scavenging area to make sure that hydrogen doesn't build up.

So I want to be clear that while that stuff isn't on site and it's licensed material that DCS must consider in its safety assessment, those considered those kinds of things. But I thought the question had more to do with making sure not just that it was safe but that you had somewhere for it to go if you had to go into a shutdown condition.

DR. POWERS: Steve, the first part of the question is yes, you have a place for it to put this thing or you have to get yourself traps so you have to keep it. The second question is because we can site numerous cases where DOE has shutdown facilities and for a protracted period of time and so now we need to know about how the material in the waste tank begins to evolve and radiolysis produced hydrogen is coming into it.

MR. BROWN: Right.

DR. POWERS: But one can imagine there to be a lot of other things might happen here and to what extent do we look at that and maybe it borders on a philosophical question but you want to make sure.

MR. BROWN: Yes.

MR. RYAN: And again I apologize for not being an expert on the process but I think about your question then as well on target and let's say three time horizons if I have to stop sending waste today that has a days or weeks sort of implication and then it's months and then on to years and the point you're raising about what would the technical issues be could be bent according to those time horizons.

Certainly some things would be at issue much later in the process or later in time for the process than some short term interruption. You might find that tanks that contain a lot of acid or other things might become more problematic over time if they have to continue to hold it then say for a week or a day and then you back up on a normal kind of mode. So I think the time horizon aspect of it is one.

To me the other part which crosses this, what the NRC regulation, what is DOE's responsibility is this question of the waste acceptance criteria that they may impose. I've yet to see a real detailed WAC for the waste you're going to produce or the waste received. It raises a question that again I think as David has pointed out is often a question of a match or a potential mismatch of are you going to produce something they'll take. It's a very basic question and I guess I'm not sure if that's been answered yet or how that's working and if they'll take it, what's your assurance they're going to take everything you're producing at the rate you're producing it and so forth and so on. How far along is that process?

MR. ASHE: Excuse me. This is Ken Ashe again. Clearly the DOE is the only rebirth facility and it's their program overall where they want to do this. For the waste acceptance criteria, we've been working with the people, the waste solidification building, and so we understand what they can accept. They understand what we're producing. Clearly, we'll have to make sure that it matches up and we have a commitment in the CAR that we will loop their WAC, their waste acceptance criteria. We believe that that has been covered and that there shouldn't be an issue of blocking.

MR. RYAN: It's kind of on the list of, I think, Professor Wallis has been talking about. That's one of those things we'll have to maybe see the detail to really say, "Yes, now we agree with that." But I understand you have a commitment. They are going to produce a WAC and you're going to meet it, but with the details that's where you need to provide an answer.

DR. POWERS: I guess that answer leaves me somewhat distressed. Suppose they come back with the WAC that says you need another component on the system.

MR. RYAN: That's my last point. There's very often a match up of a waste acceptance criteria and a process. It means the process has to change from the ideal to meet some condition. That's a general question and I recognize you're capable of dealing with the variables. But at this stage at this level of detail, it's not there. It's causing members of this committee asking questions and certainly me on this waste question.

MR. ASHE: It should also be recognized that the waste building is tied to the PDCF and to the MOX facility. It's clearly that they have that in mind as to the design for the waste building and etc.

MR. RYAN: And again are the details apparent today so we can figure out it can work?

MR. BROWN: But as I understand it, those details are not apparent today what the waste criteria are as compared to the waste that's going to be produced. There is of course a legal issue here that because that there's an interface here between NRC and DOE with respect to license material and then DOE owned material. There will be transfer of custody from DCS to DOE of that material. At that point there is an obligation that DOE must fulfill to deal with that waste and we will certainly pay attention to facility safety and protect those boundaries including any changes the plant might have to make to meet the WAC. Those have to be reviewed according to our regulations for the facility.

MR. RYAN: Sure. I can imagine the handoff has to be pretty clear from a legal perspective. That's clearly right, but the technical aspects of the handoff, you have to make sure that the rails line up.

MR. BROWN: No, I'll say those details are not crystal clear at this point, exactly when that handle off occurs, where it occurs.

MR. RYAN: Hopefully at the next stage of the safety analysis work because again I think it's possible. It may not be possible in this case to a high probability but it's possible that that waste handoff and requirements for that handoff affect the design of the process and in turn affect your safety analysis of it.

MR. BROWN: I would agree with that.

MR. RYAN: Okay.

DR. POWERS: Any other? You've wrapped up.

MR. BROWN: No, I have no other comments.

DR. POWERS: Any other questions for the speaker? Well, thank you, Dave.

MR. BROWN: Thank you.

DR. POWERS: Joe, do you have any closing comments to make?

MR. GIITTER: No closing comments.

DR. POWERS: Good. We have another speaker here to hear from. Ed Lyman has volunteered to make a few comments to us. Ed, you want me to give an elaborative introduction or do you think everybody knows you here.

DR. LYMAN: No introduction. I'm Ed Lyman from the Union of Concerned Scientists and I just wanted to make a few brief remarks given that this may be the last meeting of the ACRS before a letter is written regarding the construction authorization request.

I think the first remark I'd start with was actually the last one on my list. But since you were just discussing waste issues, I thought I'd bring it up and that's the fact that the Department of Energy in their budget released on Monday indicated for the first time that there may not be a waste solidification building at all and that the program is now on hold. I'll just read from this. "The detailed design is on hold pending evaluation of cost effective alternatives involving the use of existing facilities to provide radioactive waste treatment capabilities. At the Savannah River site, a decision is expected later in FY 2005."

Any hope that the facility you're talking about is going to be designed in any way with a clear understanding of where the waste is going to go once that transfer takes over. There's no hope right now because it looks like the Department of Energy isn't even sure any more what it is going to do with that waste. So I think you're a step even further back than you were last week.

DR. POWERS: Don't tell us we're moving backwards, Ed.

DR. LYMAN: Well, anything involving DOE, backward is the best you can hope for. The other issues I wanted to discuss which weren't raised, I don't believe, they were raised as this meeting, had to do with the issue of material control and accounting and physical protection at this facility and its relationship to the CAR.

In 2001, I assisted the environmental group, Georgians Against Nuclear Energy, in their intervention against the construction authorization request and the first two contentions which I participated in had to do with the issue that the CAR as originally presented had no information regarding the design bases for either material control and accounting or physical protection. There was simply a commitment in the case of the former that the operating license application would contain a fundamental nuclear material control plan. In the case of the latter, the operating license application would contain a physical protection plan and that there was a verbal assurance that whatever they did those plans would be able to meet the regulatory requirements.

We on the other hand recognize that there are potentially significant design issues that have a bearing on the ability of the facility to come up with an effective plan either for material control and accounting or for physical protection and that it's quite possible that integrating those issues into the design of the plant would lead to efficiencies and in fact a superior operating license application when it came to that stage. So the substance of our two contentions were first that the CAR itself did not contain detailed information on design features sufficient to establish that the applicant's design basis for MC&A will lead to FNMCP that will meet regulatory requirements.

The second was essentially the same issue regarding the design basis for physical protection. In other words, does the CAR establish a design basis that would enable a physical protection plan to be put into place that has a chance at being effective in meeting the regulatory requirements?

In that we did refer to the definition of design basis that was presented before in 10 CFR 50.2 which is that information which identifies the specific functions to be performed by a structure system or component of the facility and the specific values or ranges of values for controlling parameters as reference has been for design. So design basis does have a numerical aspect in that it does where possible request some sort of quantitative bounds on on the various parameters of interest in the system you're talking about.

DR. WALLIS: Could I ask you what you mean by "materials control"? I guess you mean keeping a count of where the plutonium goes.

MR. LYMAN: That's right. It's all the activities associated with establishing --

DR. WALLIS: Hundreds of units come in. You want to know with some accuracy where it has all gone when you add up all the different streams and everything. Is that what you mean?

MR. LYMAN: Yes, that's right. In Part 74, there are requirements for a facility that processes special nuclear material that establishes the need to close your material balance on a periodic basis. It establishes the limits of error that your measurements have to conform to to be able to say that you've closed the material balance and ensure that there hasn't been any diversion of special nuclear material along the way.

So those are the two design issues we raised and those contentions were admitted in December of 2001 based on the standards for admitting contentions that those were, I don't have the standard in front of me, issues that could reasonably lead to a dispute with the applicant that would require a hearing to resolve.

The original CAR like I said, just contained commitments and no detail of that MC&A or physical protection. During the course of the proceeding and in discovery, the first stages of discovery, DCS did provide what they called the design bases for physical protection for MC&A. This was an additional chapter or an addition to the CAR which is on the order of 15 or 20 pages describing general issues having to do with MC&A and physical protection. Those are deemed proprietary so I can't discuss them here. But you're certainly privy to them in the proprietary version of the CAR.

One feature that was discussed that was contained in those design bases was the so-called safe havens, the very fact that they had instituted rooms where in the event of an emergency you would be able to send staff so that they wouldn't be allowed to leave the site, yet would remain safe in the event of an accident so that it would deal with the concern that how do you ensure that if there is an accident that you have to have evacuation from the site and that you're also ensuring that no one is walking off with any plutonium. So the very presence of safe haven was an aspect of the design basis for physical protection that was submitted.

But overall we didn't feel that the detail in that information was sufficient to meet the definition of design basis in 10 CFR 50.2. In other words, there was no real bound parameters arranged for parameters for various structures of interest either to MC&A or to physical protection.

However, DCS filed a motion for summary disposition on those two contentions essentially saying that our contention just said we criticized the CAR for not having any information at all about these issues. It didn't say that the information had to be adequate. So now they've done something and it doesn't matter whether or not we think it's adequate. The very fact that there's something now means our contentions are moot and the Atomic Safety and Licensing Board after a long period of deliberation granted those motions basically saying if we didn't like the information we got we should have changed the contention and said, "It's not just that it's nothing as opposed to something, but that something also has to be good." We didn't do that. So we're out of luck.

I'm bringing this up because I just want to emphasize that I believe these issues were dismissed not because they were resolved, but simply on the basis of a technicality which I think sounds pretty absurd to me given the gravity of the issue associated with the fact that this is a facility whose main purpose is to try to provide assurance that the U.S. is taking plutonium out of dismantled weapons and converting them to a form which is less useful for terrorists and encouraging Russia to do the same thing in which case issues of physical protection and MC&A are crucial. I just wanted to emphasize that point that I think these issues are still ripe and I was quite surprised when I heard the new Secretary of

Energy say on Monday that an important new strategy for the Department of Energy would be to rethink the whole concept of facility design with regard to security and he even said that in the past facilities would be built and security would be imposed post hoc and now they want to do things the other way around.

I was quite shocked to here that and I didn't know if he was aware that his own department had encouraged essentially a philosophy contrary to that for one of the major capital projects that they're engaged in. I think there's some confusion now on the part of the Department of Energy as to this issue.

Related to that is the whole issue of the design basis threat. The fact is that the design basis threat for Category One facilities as applied to the design of the MOX plant is a pre-September 11th threat and that's for the simple fact that when the design basis threats for operating facilities were amended after September 11th to take into account greater adversary or more severe adversary characteristics, they were done in the form of orders for facilities that already had licenses as a change to their license. Therefore, this MOX plant since it doesn't have a license yet that couldn't be done.

Again a technicality, but the bottomline is that the design basis threat applicable to this plant was a pre-September 11th threat.

Now to the extent that the design basis threat has some impact on the design of the plant, I think anyone can see that this will lead to another paradoxical situation in that if the design is approved by the NRC then it will be issued a new design basis threat taking into account greater adversary characteristics which may render some of the design features that were just approved as things that have to be upgraded. Again, being caught up in these regulatory traps is not leading to the most efficient way to go about designing this facility and would ensure physical protection.

Now this is all an artifact of the two-step licensing process that was described at the beginning of the presentation today, but I think there was a misrepresentation in the description of this two-step process. The process as DCS has implemented it was never envisioned by the regulations. The regulations simply said if you're a fuel cycle facility you apply for a license. You give us all the information to support the license. If you are a plutonium facility, we're going to impose extra requirements on you. You have to do something extra in order before you start construction. You have to satisfy us about the design bases that your license application supports before you start construction. So this is meant as an extra layer of protection.

There was nothing in the regulations that contemplated the fact that that meant you could give only partial information at the beginning, base the construction decision on that and give everything else later. That was a novel interpretation in the context of this current license application.

The Commission later upheld that again it's not clear whether or not it's consistent with the regulations that are written. In fact, that bifurcation of this two-step process I think has led to a number of the problems that we've experienced today with the confusion about the right level of detail on which the NRC can make a decision to go ahead and build this facility.

In that regard, the Department of Energy has announced that construction is not likely or will not begin before as a minimum May 2006. That means that approval as expected of the CAR which will be in March 2005 will be more than a year before construction actually starts and if DCS submits the operating license application in the spring, I believe March 2005 is also the target date; that means the NRC will have the operating license application for more than a year before construction starts.

Now this provides an opportunity really that whatever perceived advantage there was in having the two-step process in the first place has evaporated now because the NRC is going to have all the licensing information well before construction starts. That does provide another opportunity for rethinking this process and the fact of whether there may be efficiencies gained in waiting until the operating license is submitted before approving construction because simply the construction isn't going to be taking place for a long time anyway and I find it hard to believe that there won't be issues that arise in the operating license application that won't suggest at a minimum changes to the design. So that's the state of things today. That is all I have to say. Thank you.

DR. POWERS: Any questions for Dr. Lyman?

DR. KRESS: One maybe. It seemed to me that the concern here was mostly the efficiency. Other than that, you think these things could be worked out if there were design changes based on physical, security or stuff that all this might just result in delays and more hearings and so forth. But it could be worked out.

DR. LYMAN: Well, it could be worked out. But again depending on the specific issue, it could require a significant upgrading. One of example and I have absolutely no idea, but I know that most DOE facilities today would not withstand a sabotage attack by a small aircraft or even a helicopter. That's an established fact. That was never a part of the design basis for those buildings.

Perhaps post September 11th for a facility that handles plutonium, you might want to have that kind of construction that could withstand a greater impact. That would mean essentially a more robust building, more concrete, more Rebar or even going into the ground. So to that extent if it means significant changes to the basic infrastructure of the plan once you start construction, that will be much harder to do. So there are potentially issues which would mean starting from scratch or really undoing what you're done at great cost. So it does boil down again to a delay in efficiency but as taxpayers we're the ones who are paying for any mistakes that are made.

DR. KRESS: Are you concerned that the new requirements say for a design basis threat may be so onerous in terms of complying with it but they might go ahead anyway trying to get around it some way?

DR. LYMAN: Well, I'd hate to speculate, but there is the facts on the ground issue which is once you've gone far enough wouldn't it make more sense just to give us an exemption rather than to make us do something else?

DR. KRESS: That's basically what I meant.

DR. LYMAN: Yes, and I think we've seen that in another related hearing associated with the MOX lead test assemblies and the security plan that's been proposed for protecting them at the Catawba Nuclear Power Plant. I can't talk about the details there, but there is an element of if we'd like to implement that requirement. But it would be so onerous and it would take so long that it doesn't make sense anymore. It's definitely a possibility.

DR. KRESS: So that may be a part of your concern.

DR. LYMAN: Yes.

MR. ROSEN: Aside from the questions of efficiency, Ed, is your organization in favor of the purposes of this facility?

DR. LYMAN: We're in favor of the overall mission, but on a philosophical basis, the idea of plutonium disposition is to reduce the risk posed by separating plutonium. You don't want to increase the risk of a near term to reduce it in the long term. So if it's going to be done, it has to be done with as much attention to safeguard and physical protection issues as possible.

I don't think that all the options were fully explored to maximize the benefit and minimize the risk and so to that extent we have concerns of the MOX program and believe that there were alternatives that had been considered that might have been able to achieve similar results both with lower risk and lower cost. But that said, if there is certainly a safety and security regime where if it were implemented, I would say I would have confidence the cure isn't worst than the disease.

Unfortunately what's happened is it's so expensive, the delays have become so expensive, that you're starting to cut corners in a way which really acts against the overall purpose of the program. The biggest implication is what the Russians will do and that is a direct bearing on the decisions that were made here. If we show that we think that physical protection and MC&A are not such important issues in certain respects, that sends exactly the wrong signal to Russia. So there's a real danger that this program could undermine its ultimate purpose.

DR. POWERS: Any other questions? Thank you, Dr. Lyman.

DR. LYMAN: Thank you. I appreciate it.

DR. POWERS: Chairman, I think we've concluded our presentation on these subjects. So I'll take it back to you.

DR. WALLIS: Well, thank you, Dr. Powers, for leading us through the intricacies of this application. We have finished the formal part of today. We don't need the transcript anymore. We're going to take a break and when we come back you will consider the draft versions of the two letters we have to write and what I want to achieve is that we understand as a committee what our position is going to be that we take in these letters, that the substance of the letter is agreed to and then we can work on the details tomorrow. Since you have been so good, I would give a little break until 5:00 p.m. Off the record.

(Whereupon, at 4:39 p.m., the above-entitled matter concluded.)

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 519TH 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.

Matthew Thompson

Matthew Thompson
Official Reporter
Neal R. Gross & Co., Inc.

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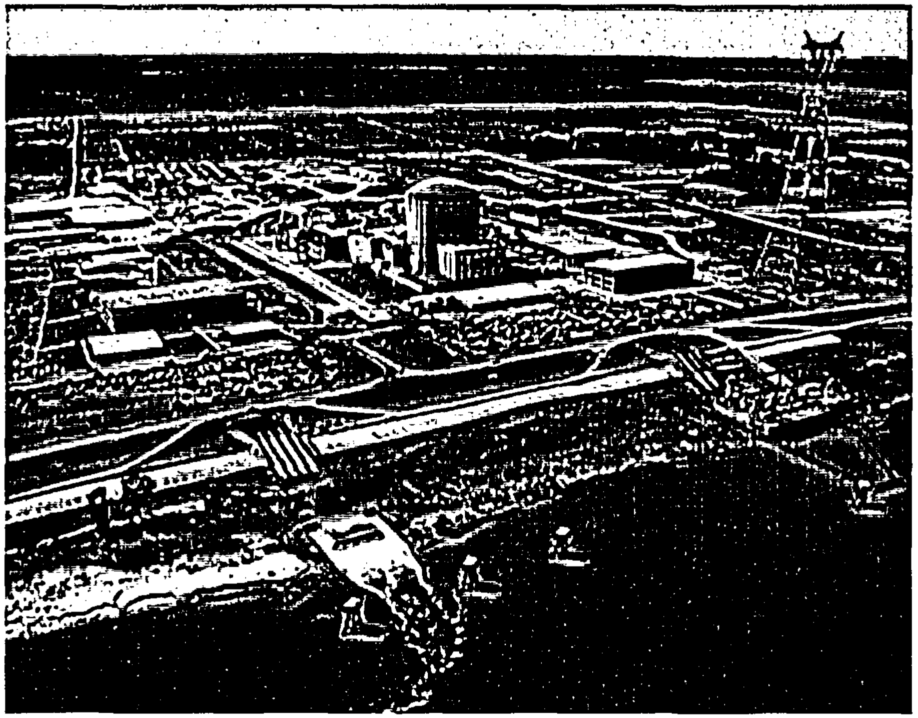
Waterford 3 Extended Power Uprate Project



Advisory Committee on Reactor Safeguards

February 10, 2005

Entergy

Joe Venable

VP Operations

Entergy

Tim Mitchell

Engineering Director

Entergy

Agenda

- Introduction – Joe Venable
- Overview of W3 and EPU Project – Tim Mitchell
- Boron Precipitation
  - Entergy – Jerry Holman
  - NRC Staff
- Large Transient Testing
  - Entergy – David Constance
  - NRC Staff
- Steam Generator Dryers – Don Siska
- Conclusion – Joe Venable

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Overview

- Project Scope
- Design Basis Improvements
- Oversight & Rigor
- Industry Operating Experience

Entergy

Overview

- Combustion Engineering Nuclear Steam Supply System (NSSS) Pressurized Water Reactor (PWR)
- Entered commercial operation 1985
- 3390 MWt original licensed power
- 3441 MWt Appendix K Uprate
- 3716 MWt Extended Power Uprate (EPU)

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Overview

- Project Team
  - Entergy
  - Westinghouse (NSSS)
  - Enercon (Balance of Plant (BOP))
  - Siemens-Westinghouse (Turbine / Generator)

Entergy

Significant Modifications

- Replace HP Turbine Steam Path
- Main Generator Rewind and Alkalizer Skid
- Replace Main Generator Output Breakers
- Main Transformer A Improvements
- FW Heater Drain Valve Capacity Increase
- Condenser Tube Staking
- Control Systems and Instrumentation

Entergy

Engineering Plant Impacts

- Decay Heat
  - Safety Systems Acceptable without Modification
    - Ultimate Heat Sink
    - Emergency Feedwater
    - Shutdown Cooling
    - Fuel Pool Cooling
  - Raised Fuel Oil Minimum Requirement
    - Maintain 7 Day Supply per Current Licensing Basis
    - Commitment to provide additional storage

Entergy

Safety Analysis Impacts

- Demonstrate Acceptable EPU Impact:
  - Emergency Core Cooling System (ECCS)
    - 1999 Large Break Evaluation Model
    - Credit Atmospheric Dump Valve for Small Break secondary pressure control
  - Non-LOCA Transient Events
    - CENTS analysis code
- Meet acceptance criteria for Fuel Design Limits (e.g., DNBR), RCS Pressure, Dose

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Alternative Source Term

- Alternative Source Term used to address Control Room Habitability Issue
  - Tracer Gas Testing April 2004
- Submittal under Staff Review
- Meet 10CFR50.67 & GDC19 acceptance criteria

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PRA Impacts

- Conclusions
  - All PRA model elements reviewed for impact
  - Minor reduction in Operator recovery times
  - Internal Events (per year):
    - CDF increase = 3.5E-7
    - LERF increase < 1.0E-7
  - External Events
    - Slight increase in fire CDF due to operator response time reduction

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Conclusions

Entergy

Boric Acid Precipitation

Jerry Holman

Manager, Nuclear Engineering

Entergy

Boric Acid Precipitation

- Issue Summary
  - W3 analysis uses collapsed volume per previous NRC approval
  - NRC review focus on voiding in core
- Conclusion
  - Supplemental calculations confirm significant margin to solubility limit

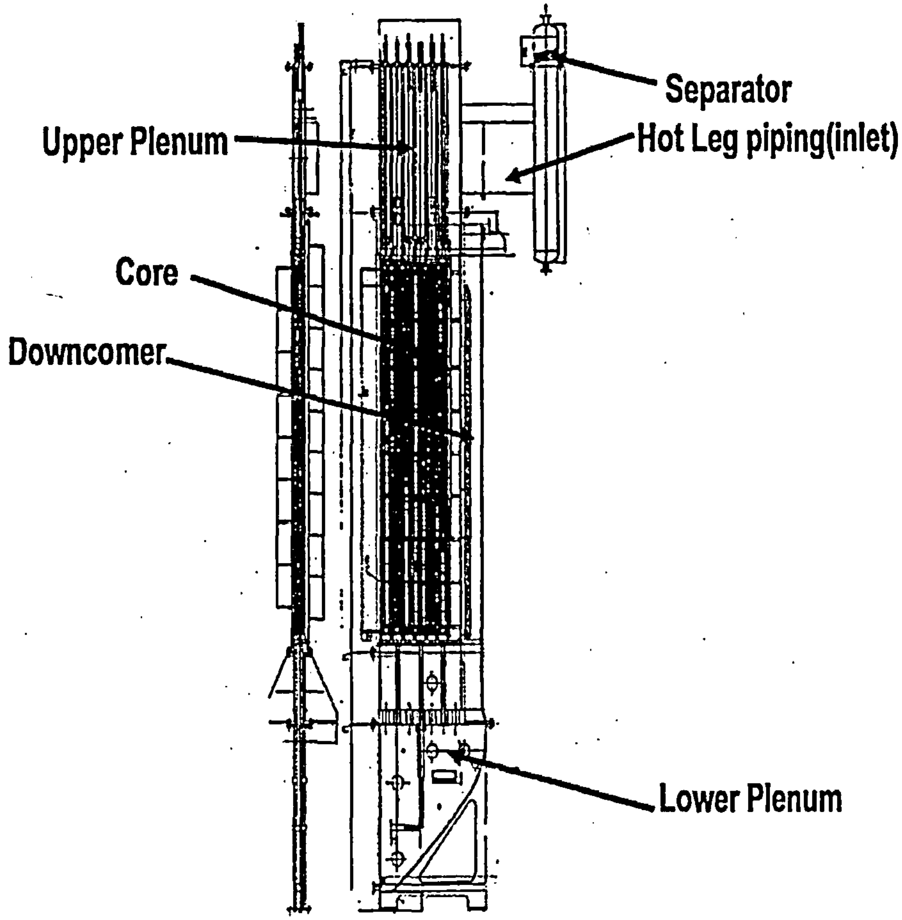
Entergy

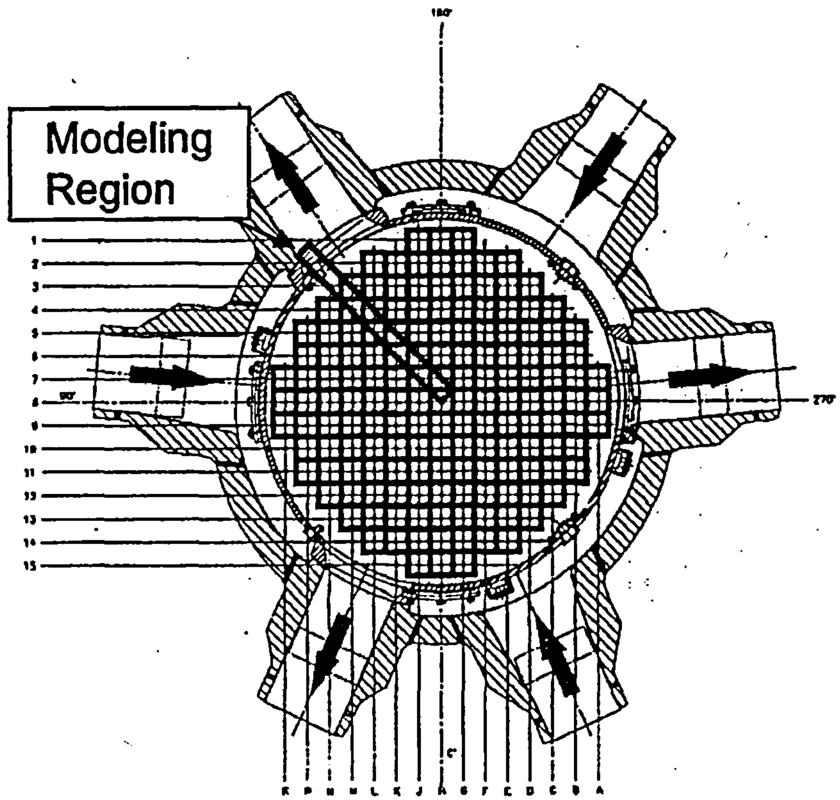
Boric Acid Precipitation Supplemental Results

- Account for:
  - Voiding in core
  - Lower plenum mixing
  - Mixing of BAMT and RWSP
  - 1979 ANS Decay Heat Best Estimate
  - Containment Pressure of 20 psia
  - TSP solubility limit elevation
- Boric Acid Concentration at 3 hours 17.2 wt%
- Solubility Limit = 40 wt%

Entergy

Boric Acid Precipitation BACCHUS Test Facility





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Boric Acid Precipitation BACCHUS Test Results

- Mixing driven by fluid density difference
- Mixing starts at delta C = 8.5 wt% (15,000 ppm)
- Entire lower plenum volume participates

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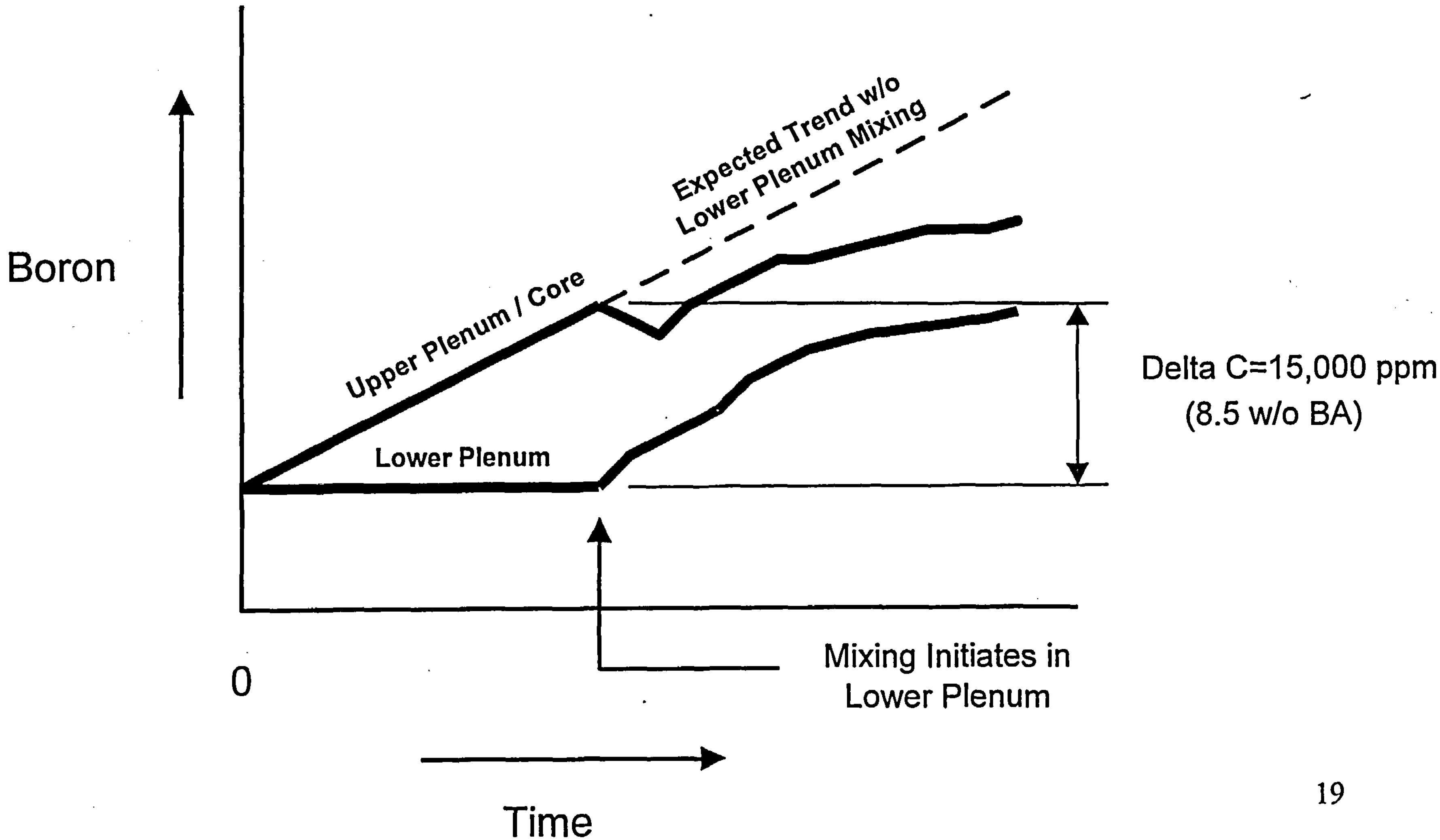
Boric Acid Precipitation
BACCHUS Reactor Vessel Mixing Tests



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Boric Acid Precipitation Solubility Limit

- TSP in sump water
  - Increase limit to 36 wt%
- Minimum containment pressure of 20 psia
  - Increase limit by 4 wt%
- Solubility limit = 40 wt%

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Boric Acid Precipitation
Boiling Solution Near Solubility Limit

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Boric Acid Precipitation Supplemental Calculation Input

- Mixing Volume
  - 50% lower plenum
  - Upper plenum to top of hot leg at 3 hours
- 66% average voiding in core at 3 hours
- 1979 ANS decay heat best estimate

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Boric Acid Precipitation Supplemental Calculation Results

- Boric acid concentration at 3 hours with 50% Lower Plenum = 17.2 wt%

- Large margin to precipitation limit of 40 wt%

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Boric Acid Precipitation Updated Licensing Basis Analysis

- Assumptions
  - Voiding in core
  - 50% Lower Plenum Mixing
  - Mixing of BAMT and RWSP
  - TSP Solubility Limit Elevation
- Demonstrates Significant Margin to Precipitation

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Boric Acid Precipitation

NRC Staff Conclusion

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Large Transient Testing

David Constance

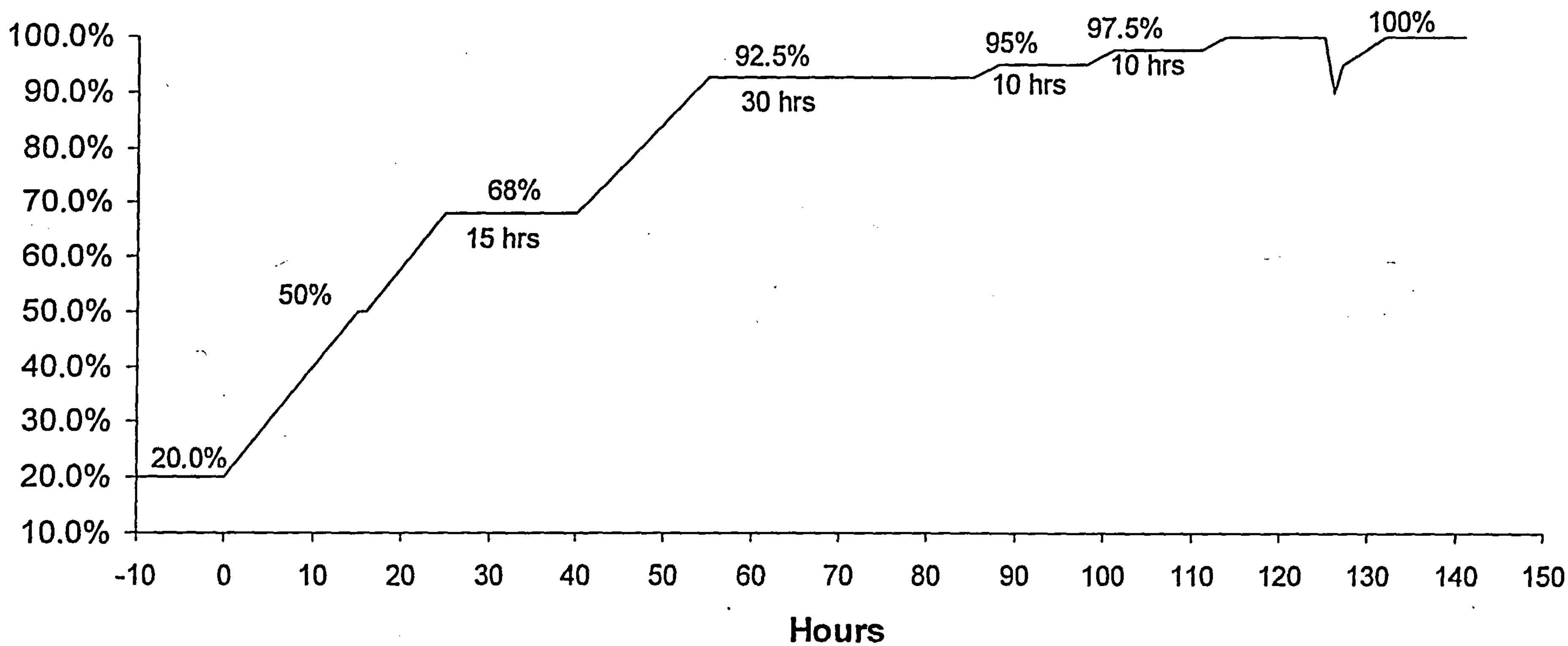
Operations

Entergy

Power Ascension Testing

- Reactor Engineering Tests / Power Verification
- Transient and Steady State Data Record
- Post Modification Testing
- Plant Maneuver Test (100%-90%-95%)
- Post 100% Testing, Data Collection & Surveys
- Vibration Monitoring

Power Ascension Profile



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Power Ascension Testing

- Low Power Physics Testing (LPPT) remains unchanged for EPU
- Data sets
  - Collected every 10% from 20-100%
  - Collected at 7 different power plateaus
  - Approximately 1000 parameters monitored
  - Data will be automatically collected and processed
  - Data evaluated against predetermined criteria
- Plant Safety Subcommittee reviews results report at each power plateau (>68%), and recommends continued power ascension.

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Large Transient Testing

- Reviewed Initial S/U Testing per SRP 14.2.1
- The Initial Turbine Trip Test (84% RTP) potentially applicable to EPU
- Transient Testing should be considered in relation to the full spectrum of testing and monitoring, including:
  - Power Ascension Testing
  - Post Modification Testing
  - Routine Testing, Surveillance, & Trend Programs
  - Continuous Active Monitoring Plant Equipment

Entergy

Large Transient Testing

Modification	Post Modification Test		Further tested by Turbine Trip
ADV Setpoint Change	Channel Calibration		No
Low S/G Press Setpoint	Channel Calibration		No
FWCS, SBCS, RRS Constants	Channel Calibration Transient/Steady State Data Record	Load Change Test	Partially
RT/TT Permissive	Channel Calibration		No
HP Turbine Rotor Replacement	120% rotor speed factory test Transient/Steady State Data Record Validate TFS Power constants	Overspeed Trip Test Vibration monitoring Thermal Performance Test	No
DEH Program Constants	Channel Calibration Transient/Steady State Data Record	Load Change Test	No

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Large Transient Testing

Modification	Post Modification Test		Further tested by Turbine Trip
Main Generator Rewind	Pre-Operation Electrical Tests Transient/Steady State Data Record Isophase Bus Temp Monitoring	Vibration monitoring Generator Capability Test	No
Main Transformers	100% factory load test (MT A) Temperature survey of connectors	Monitor Temperatures Test Oil Samples	No
GOB Replacement	AC and DC acceptance tests Synchronizing Check calibration	Power factor tests Timing tests	No
DCT NLCV trim change	Channel Calibration Transient/Steady State Data Record	AOV Testing Load Change Test	No
Condenser Tube Staking	Circ Water tube leak check Monitor Secondary Chemistry		No
SCW Alkalizer Skid	Vendor Startup and Calibration SCW Chemistry monitoring		No

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Large Transient Testing

- A Turbine Trip Test is not an effective test for the majority of modifications for the W3 EPU
- Integrated Control System performance is more rigorously evaluated using a calculation model
- The calculational model has been sufficiently benchmarked to the plant at near EPU conditions

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Large Transient Testing

- Current Benchmarking Transients
  - Turbine trip from 100% power / RPC – February 14, 2003
  - Feedwater pump trip from 100% power / RPC – June 3, 2001
  - Reactor trip from approximately 82% power – February 13, 2001

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Large Transient Testing Conclusion

The Post EPU Plant Performance

- Will be adequately demonstrated by Post Modification and Start Up Testing
- Has been thoroughly evaluated using a well benchmarked calculation model
- Will not be further demonstrated during a Turbine Trip transient

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Large Transient Testing

NRC Staff Conclusion

Entergy

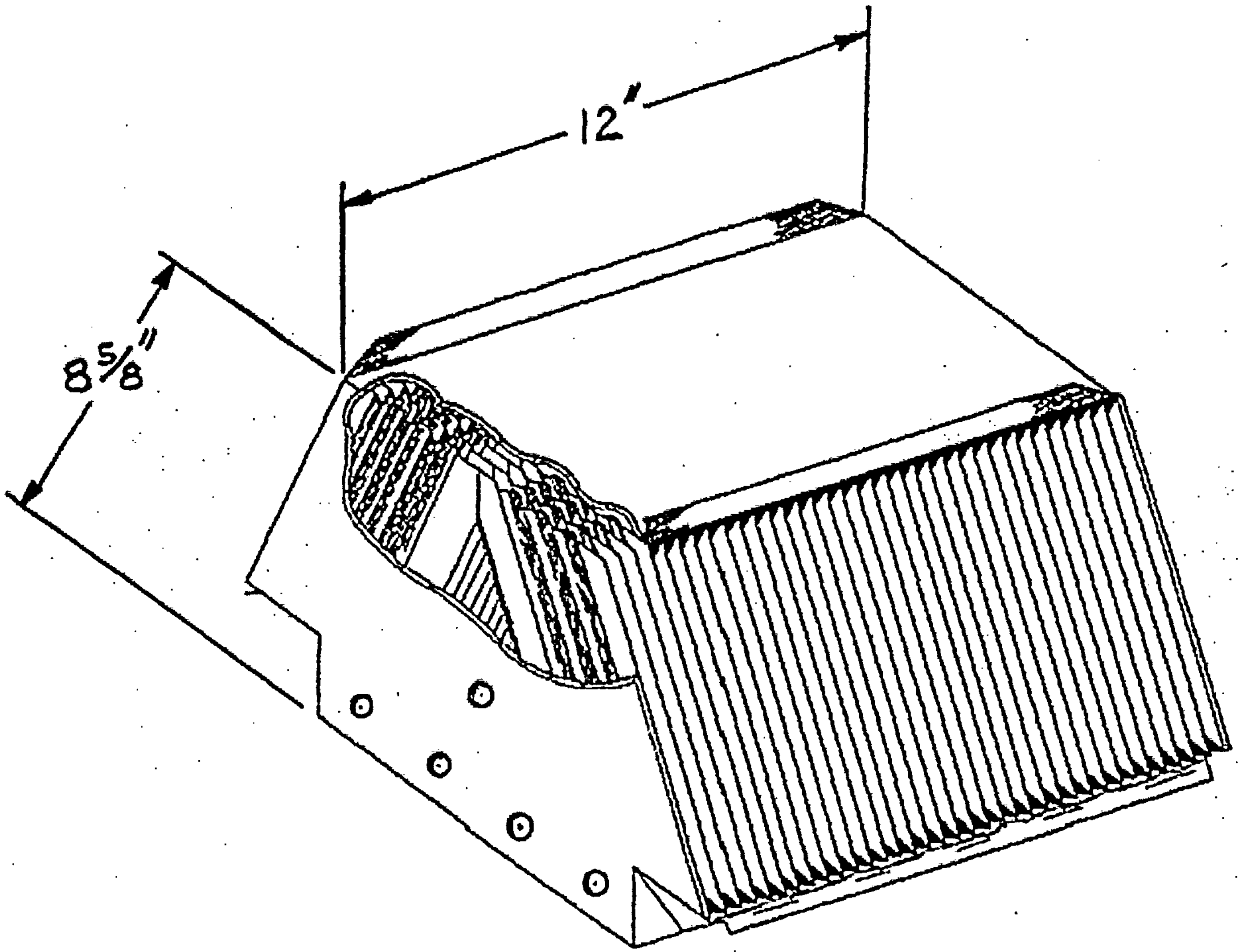
Steam Generator Dryers

Don Siska

Westinghouse

Entergy

Steam Generator Dryers



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Steam Generator Dryers

- Description
  - Same chevron design used in all CE Original SGs.
  - Used in Fossil Power Industry since 1940's.
  - 12" x 12" at base; 8 5/8" tall.
  - Very low pressure drop (~0.25 psi).
- Testing Performed
  - Flow Rates of 30,000 lb/hr to 60,000 lb/hr.
  - Pressures of 600 psia to 1200 psia.
  - Bounds conditions for Waterford EPU (approximately 51,250 lbs/hr at 805 psi).

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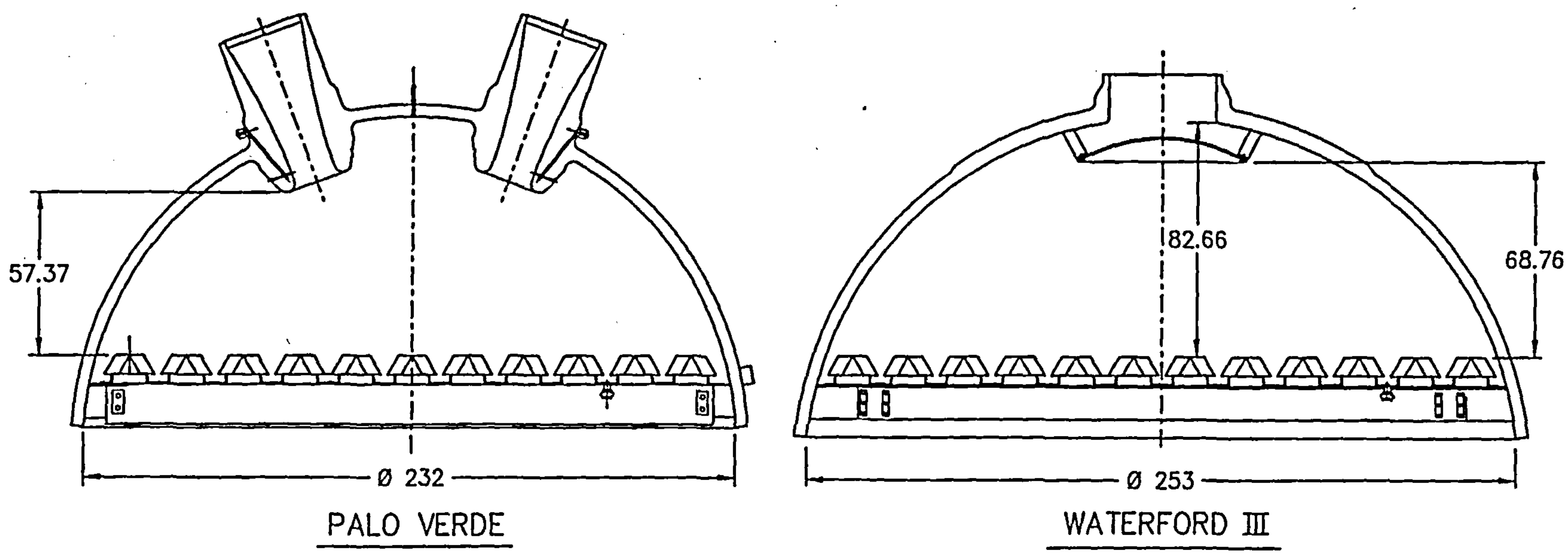
Steam Generator Dryers

- Comparison with Palo Verde



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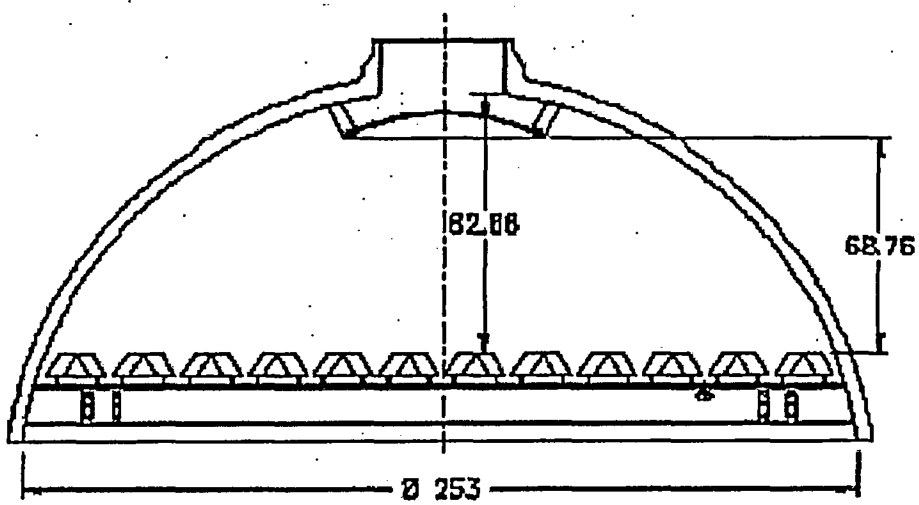
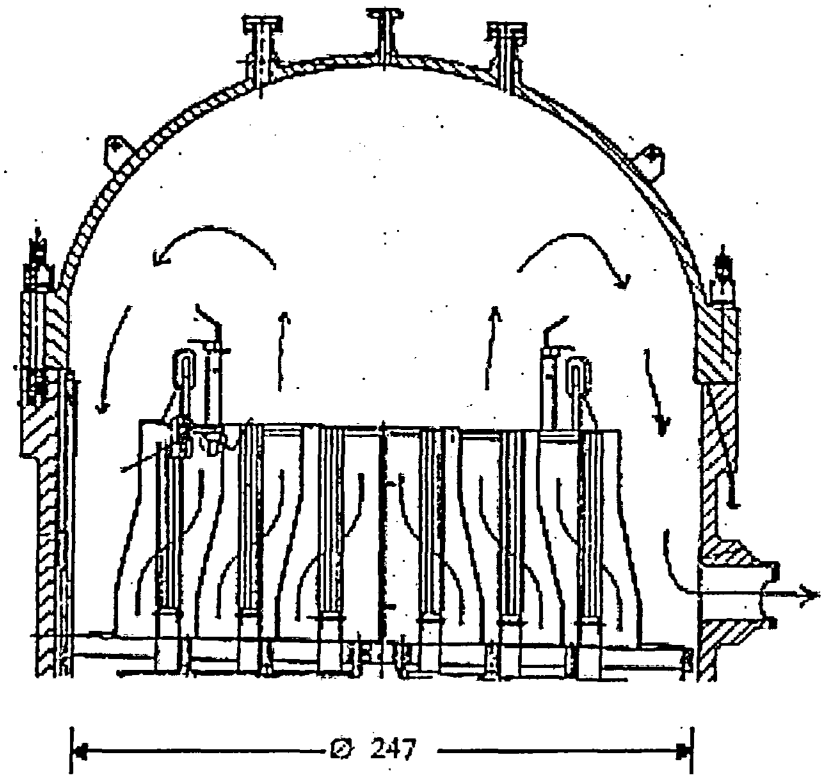
Steam Generator Dryers

- Comparison with Typical BWR





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Steam Generator Dryers

- Potential for Loose Parts
  - No dryer failures in over 200 reactor-years operation.
  - Nuts used to attach dryers to drain channels and dryers at end of row are welded in place.
  - All other nuts, bolts and lock washers below dryers.
  - No pathway or loading condition sufficient for fasteners to enter main steam line.
  - Secondary side inspection during RFO12 showed no damage or missing fasteners

Entergy

Steam Generator Dryers

- Summary
  - EPU conditions bounded by test program.
  - EPU conditions less severe than Palo Verde.
  - Low flow loadings; not enough energy absorbed to cause vibration.
  - Potential loose parts (nuts, bolts and lock washers) can not enter main steam line.
- Conclusion
  - EPU will not adversely affect dryer integrity.

Entergy

Concluding Remarks

Joe Venable

VP Operations

Entergy

End of Presentation

WATERFORD STEAM ELECTRIC STATION, UNIT 3

EXTENDED POWER UPRATE (8.0%)

ACRS THERMAL-HYDRAULIC PHENOMENA
FULL-COMMITTEE BRIEFING
FEBRUARY 10, 2005

N. KALYANAM, PROJECT MANAGER
PROJECT DIRECTORATE IV, SECTION 1
DIVISION OF LICENSING PROJECT MANAGEMENT

Waterford 3 EPU

Intoduction by

TAD MARSH

DIRECTOR

DIVISION OF LICENSING PROJECT MANAGEMENT

Waterford 3 EPU

Background

- Originally licensed in 1985 for operation at a reactor core power (CP) not to exceed 3390 mega-watts thermal (MWt).
- Measurement uncertainty recapture uprate granted in 2002 to operate at a CP level not to exceed 3441 MWt (a 1.5% increase)
- The extended power uprate (EPU) requests an increase of 8%, CP level not to exceed 3716 MWt
- Largest pressurized water reactor (PWR) power uprate to date

Waterford 3 EPU

Background - Major Plant Modifications

- Upgrade the high pressure turbine
- Rewind main generator (MG) / provide associated auxiliaries
- Install higher capacity MG output circuit breakers, disconnect switches, and bus work
- Main transformers modifications
- Replace/upgrade control valves for the heater drain system and reheat system safety valves
- Stake the condenser tubes

Waterford 3 EPU

Background - EPU Implementation Schedule

- Entergy plans to implement the Waterford 3 EPU in one increment.
- Completion of plant modifications necessary to implement the EPU are planned prior to the end of refueling outage 13 in the spring of 2005.
- With the approval of this license amendment request, the plant will be operated at 3716 MWt starting in Cycle 14.

Waterford 3 EPU

Background - Staff Review Approach

- The first PWR EPU to follow RS-001
- Utilized Standard Review Plan (SRP)
- Used Acceptable Codes and Methodologies
- Requests for Additional Information (RAIs)
- Total of 32 supplements received
- Audits/Independent Calculations in Selected Areas

Waterford 3 EPU

Status of the 4 Issues Identified as Open in S/C Briefing

- AST amendment
  - Review proceeding on schedule
  - No surprises anticipated
  - Scheduled for issue by mid-March 2005
  - Pre-requisite for EPU amendment issuance
  - EPU SE reflects this position
  - This issue is closed

Waterford 3 EPU

Status of the 4 Issues Identified as Open in S/C Briefing (Contd.)

- 3-second time delay between steam generator tube rupture (SGTR) and loss-of-offsite power (LOOP)
- Potential for aging effects on Reactor Vessel Internals - EPRI MRP Report
- Accounting for Instrument Uncertainty

  - The above three issues have been resolved and closed with either a commitment or condition in the Amendment from the licensee on the docket. The staff SE will reflect this.

Waterford 3 EPU

Post-LOCA Long Term Cooling

L. W. Ward
Reactor Systems Branch
Division of Systems Safety and Analysis

Waterford 3 EPU

Post-LOCA Long Term Cooling

- Agenda
  - Large Feedwater Line Break
  - Limiting Small Break LOCA
  - Post-LOCA Long Term Cooling

(Boric Acid Precipitation and Timing for Simultaneous Hot/Cold Side Injection)

Waterford 3 EPU

Post-LOCA Long Term Cooling

- Conservative emergency core cooling system (ECCS) licensing analyses are performed to identify earliest time to switch to hot/cold side injection
  - But not too early to cause core uncovery
  - This assures concentration is well below the limit at re-alignment
- Staff calculations revealed non-conservative input in mixing volume (assumed void fraction 0% in mixing volume following large break LOCAs (LBLOCAs))
- Non-conservatism produces precipitation at one hour versus 4 hours

COLD LEG BREAK

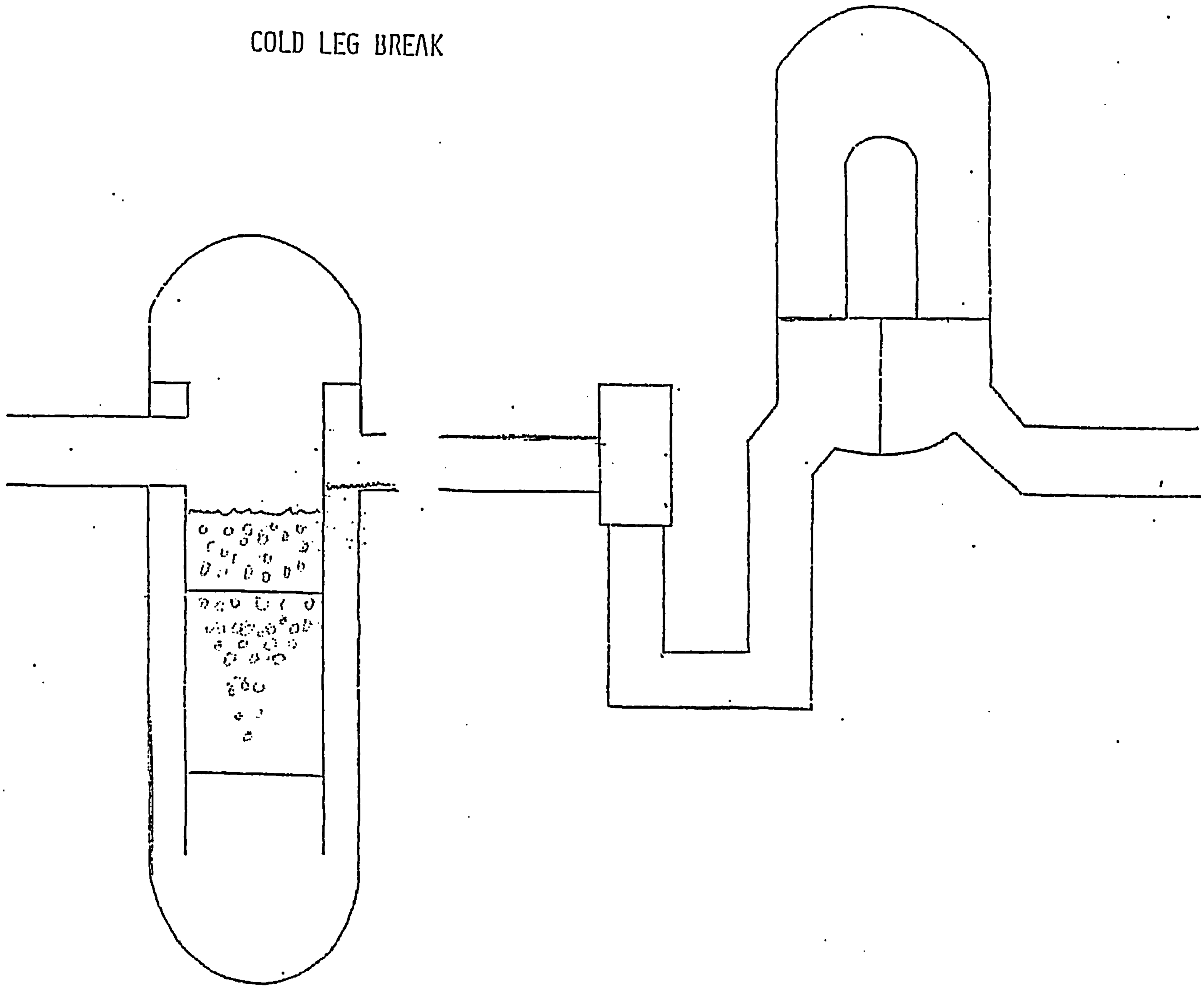
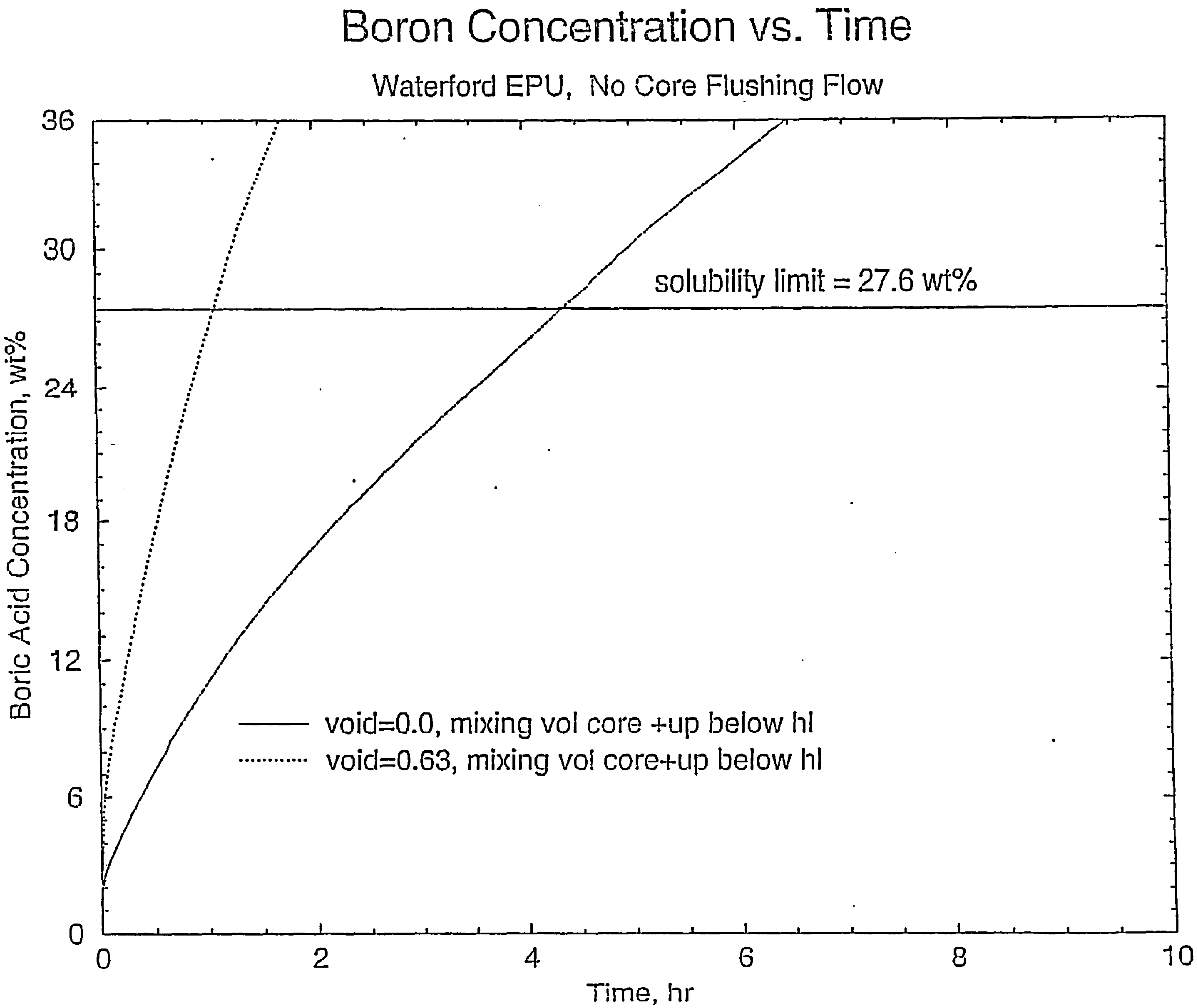


Fig. 1



Boron Concentration vs. Time
Waterford EPU, No Core Flushing Flow
Boric Acid Concentration, wt%
0
6
12
18
24
30
36
Time, hr
0
2
4
6
8
10
solubility limit = 27.6 wt%
void=0.0, mixing vol core +up below hl
void=0.63, mixing vol core+up below hl

Waterford 3 EPU

Prevention of Boric Acid Precipitation

- Westinghouse has shown margin in licensing methodology to compensate non-conservative input
  - Larger mixing volume includes lower plenum, core, and upper plenum to hot leg top elevation plus lower plenum (versus mixing volume of core and upper plenum to hot leg bottom elevation)
  - Minimum containment pressure raised to 20 psia (versus 14.7 psia)
  - Performed minimum containment pressure calculation using NRC approved methodology (GOTHIC)
  - Westinghouse analysis shows concentration of about 12 wt% (extrapolated to include entire lower plenum)

Waterford 3 EPU

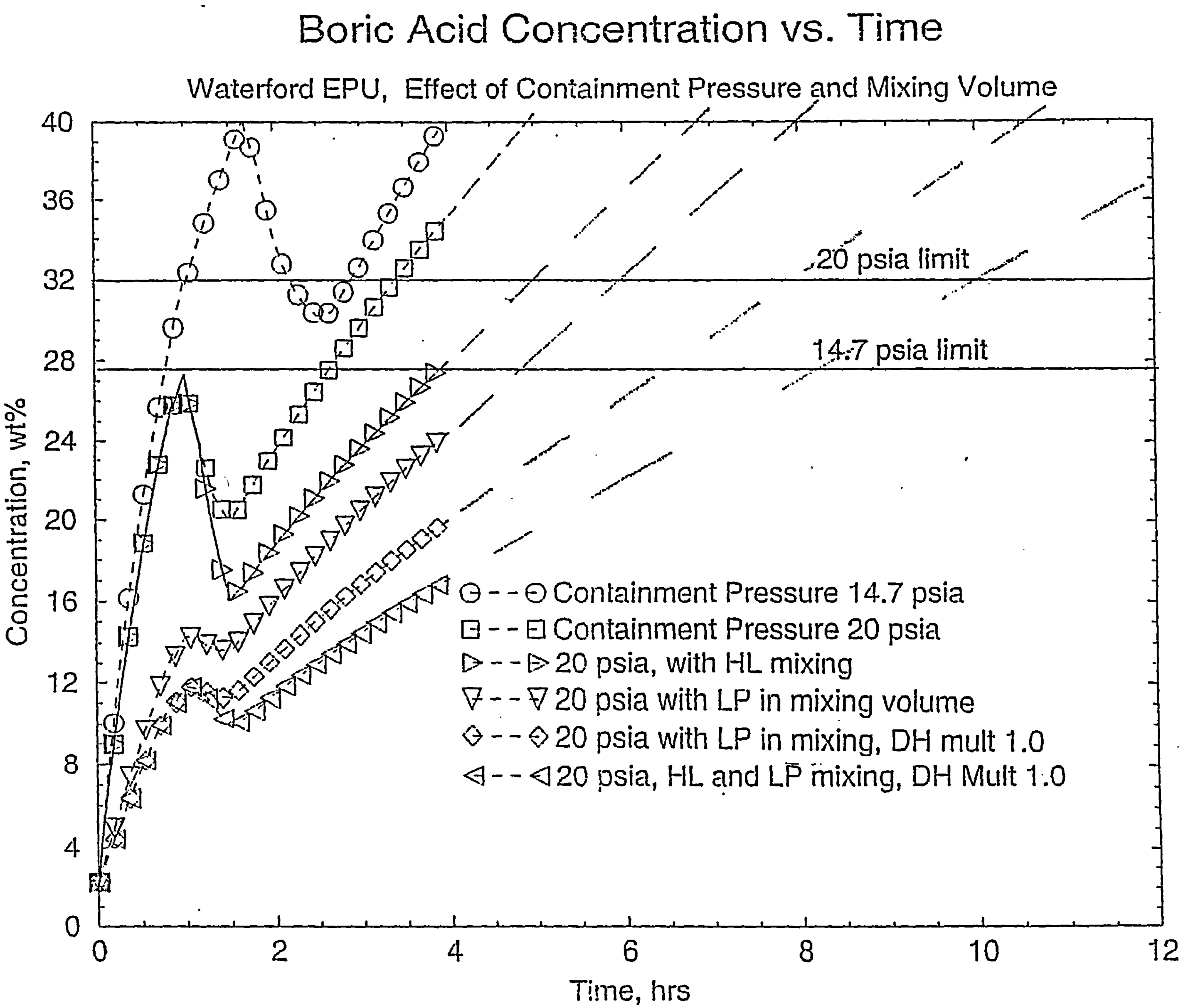
Prevention of Boric Acid Precipitation

- Staff analysis demonstrates adequate margin remains to support power uprate
  - Additional mixing volume available
    - Lower plenum
    - Hot legs
  - Higher containment pressure
  - Impact of decay heat multiplier
  - No credit for liquid entrainment (also no removal of boric acid by vapor)

Waterford 3 EPU

Prevention of Boric Acid Precipitation (contd.)

- Staff analysis demonstrates adequate margin remains to support power uprate (Contd.)
  - No mixing in core bypass
  - Boric acid make-up tanks discharge (6187 ppm, directly in core; no mixing in DC and LP)
  - Upper plenum pressure higher than containment by loop pressure drop (raises saturation temperature)
  - No credit for subcooling during the injection phase



Boric Acid Concentration vs. Time
Waterford EPU, Effect of Containment Pressure and Mixing Volume
Concentration, wt%
Time, hrs
20 psia limit
14.7 psia limit
Containment Pressure 14.7 psia
Containment Pressure 20 psia
20 psia, with HL mixing
20 psia with LP in mixing volume
20 psia with LP in mixing, DH mult 1.0
20 psia, HL and LP mixing, DH Mult 1.0
0
4
8
12
16
20
24
28
32
36
40
0
2
4
6
8
10
12

14a

Waterford 3 EPU

Prevention of Boric Acid Precipitation (Contd.)

- Westinghouse boron precipitation analysis consistent with staff calculations at 3 hours
  - "Best Judgement" staff calculation shows 14 wt%
  - Compared to limits:
    - 28 wt% at 14.7 psia
    - 32 wt% at 20 psia
    - 39 wt% with trisodium phosphate
- Sufficient margin exists to show concentration at 2-3 hours is less than ½ of the limit
  - At 14.7 psia, margin remains large

WATERFORD, UNIT 3

Extended Power Uprate Test Program

Steven Jones
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Plant Systems Branch (SPLB)
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Waterford 3 EPU

Major Plant Modifications

- Upgrade the high pressure turbine
- Rewind MG / provide associated auxiliaries
- Install higher capacity MG output circuit breakers, disconnect switches, and bus work
- Main transformers modifications
- Replace/upgrade control valves for the heater drain system and reheat system safety valves
- Stake the condenser tubes

Waterford 3 EPU

Test Program

- First Application of RS-001, "Extended Power Uprate," including SRP Section 14.2.1.

- SRP Section 14.2.1, "Generic Guidelines for Extended Power Uprate Testing Programs"
  - Testing based on plant-specific intial test program
  - Includes large transient testing (LTT) within scope

Waterford 3 EPU

Test Program

- SRP provides supplemental guidance for staff evaluation of alternative approaches used to justify elimination of LTT based on the following factors:
  - Operating experience
  - Potential for new phenomena or system interactions
  - Validity of analytical methods for EPU conditions
  - Degree of margin reduction in safety analysis
- Initial application did not address SRP review criteria. The staff requested additional information and held discussions on testing during public meetings.

Waterford 3 EPU

Test Program

- Justification for eliminating LTT at Waterford includes:
  - Test program includes monitoring of important parameters during EPU power ascension.
  - TS surveillance and post-modification testing will confirm the performance capability of the modified components.
  - Recent operating experience includes transients initiated from high power at Waterford and from post-uprate transient at ANO-2.
  - Code used for safety analysis benchmarked to operating experience.
  - Scope of modifications likely to affect transient response limited - largely setpoint changes.
  - Analysis code models instrument algorithms.

Waterford 3 EPU

Test Program

- Regulatory Guide 1.68 testing "Objectives"
  - Operator training and familiarization
  - Confirmation of design and installation of equipment
  - Benchmarking of analyses codes and models
  - Confirmation of the adequacy of emergency and operating procedures
- Objectives satisfied by proposed test program and operating experience
- Due to the limited extent of modifications, any benefit from LTT would not be unique to post-EPU conditions

Waterford 3 EPU

Summary

- SRP 14.2.1 allows for justification for not performing EPU Power Ascension Tests.
- In response to staff RAI, Entergy provided adequate justification for eliminating LTT using SRP criteria.
- Conducting LLTs would not provide significant new information regarding transient modeling and component performance.

23


24

Waterford 3 EPU

3-Second LOOP Delay for SGTR

- Waterford crediting 3- second LOOP delay following reactor trip in SGTR analysis

- 3-second LOOP delay utilized and approved for use in RCP seizure events in early 80's
  - Based upon wide scale grid collapse event due to loss of the nuclear plant generation (plant trip)

Waterford 3 EPU

3-Second LOOP Delay for SGTR (Contd.)

- Subsequent operating experience and investigation by NRC staff in support of risk informing 50.46 indicates consequential LOOP as a result of plant trip much more likely to result from localized events rather than wide scale grid collapse
  - Degraded switchyard voltage
  - Automatic bus transfer failure
  - Spurious switchyard breaker-failure-protection-circuit actuation
  - Startup transformer failure

Waterford 3 EPU

3-Second LOOP Delay for SGTR (Contd.)

- Entergy evaluated LOOP delays and operability of electric equipment associated with these scenarios for SGTR
  - Degraded switchyard voltage
    - Safety bus LOOP occurs approximately 19.5 sec. following reactor trip if degraded voltage due only to loss of Waterford 3 generator voltage support to grid. Safety injection actuation signal occurs approximately 20 sec. to 1 minute following reactor/turbine trip. Sequencer resets and additional ECCS loads sequenced onto emergency diesel generators as necessary. Safety motors started within their specified parameters.
    - Offsite power remains available to reactor coolant pump(RCP) non-safety buses

Waterford 3 EPU

3-Second LOOP Delay for SGTR (Contd.)

– Safety bus LOOP occurs approximately 36 to 76 seconds from reactor trip if degraded voltage due to combined loss of Waterford 3 generator and SIAS loading. Some ECCS motors started on degraded offsite voltage while degraded voltage protection timing out. Sequencer resets and ECCS loads re-sequenced/sequenced onto EDGs. Some safety motors started outside their specified starting parameters.

– Offsite power remains available to RCP non-safety buses

Waterford 3 EPU

3-Second LOOP Delay for SGTR (Contd.)

- Automatic bus transfer failure
  - Approximately 7 seconds following reactor trip, one-half LOOP (only one division loses offsite power) occurs on safety and non-safety buses. Opposite safety and non-safety divisions remain energized from offsite power. EDG starts and re-energizes lost safety division.
- Spurious switchyard breaker-failure-protection-circuit actuation
  - Same as automatic bus transfer failure
- Startup transformer failure
  - Same as automatic bus transfer failure

Waterford 3 EPU

3 Second LOOP Delay for SGTR (Contd.)

- Likely consequential LOOPs due to SGTR event will occur in excess of the 3 seconds following a reactor trip assumed by Entergy for Waterford 3.
- Entergy committing to take advantage of Transmission Operator enhanced capability for determining Waterford 3 post-trip switchyard voltages (real time contingency analysis program) when available, or provide additional independent assurance of motor operating capability under degraded voltage/double sequencing SGTR scenario.
- Issue is resolved and closed

Waterford 3 EPU

Potential for aging effects on Reactor Vessel Internals - EPRI MRP Report

- The licensee has made the following commitment in its supplement of February 5, 2005:
  - "Entergy Operations, Inc (Entergy) is currently an active participant in the Electric Power Research Institute (EPRI) Materials Reliability Program (MRP) research initiatives on aging related degradation of reactor vessel internal components. Entergy commits to:
  - continue its active participation in the MRP initiative to determine appropriate reactor vessel internals degradation management programs,
  - evaluate the recommendations resulting from this initiative and implement a reactor vessel internals degradation management program applicable to Waterford 3,

Waterford 3 EPU

Potential for aging effects on Reactor Vessel Internals - EPRI MRP Report (Contd.)

– incorporate the resulting reactor vessel internals inspections into the Waterford 3 augmented inspection plan as appropriate.

– In addition, as requested by the NRC, a description of the program, including the inspection plan, willl be submitted to the NRC for review and approval. The submittal date will be within 24 months after the final EPRI MRP recommendations are issued or within five years from the date of issuance of the uprated license, whichever comes first."

- Issue is resolved and closed

Waterford 3 EPU

Accounting for Instrument Uncertainty

- The licensee has made the following commitment in its supplement of February 5, 2005, which will be included as an amendment condition:

"Prior to exceeding 3441 MWt, Entergy will submit, for NRC review and approval, a description of how Entergy accounts for instrument uncertainty for each Technical Specification parameter impacted by the Waterford 3 Extended Power Uprate."

- Issue is resolved and closed

NRC Review of the Construction Authorization Request for the Mixed Oxide Fuel Fabrication Facility

David Brown, Sr. Project Manager
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Division of Fuel Cycle Safety & Safeguards
Office of Nuclear Material Safety & Safeguards

Presentation Outline

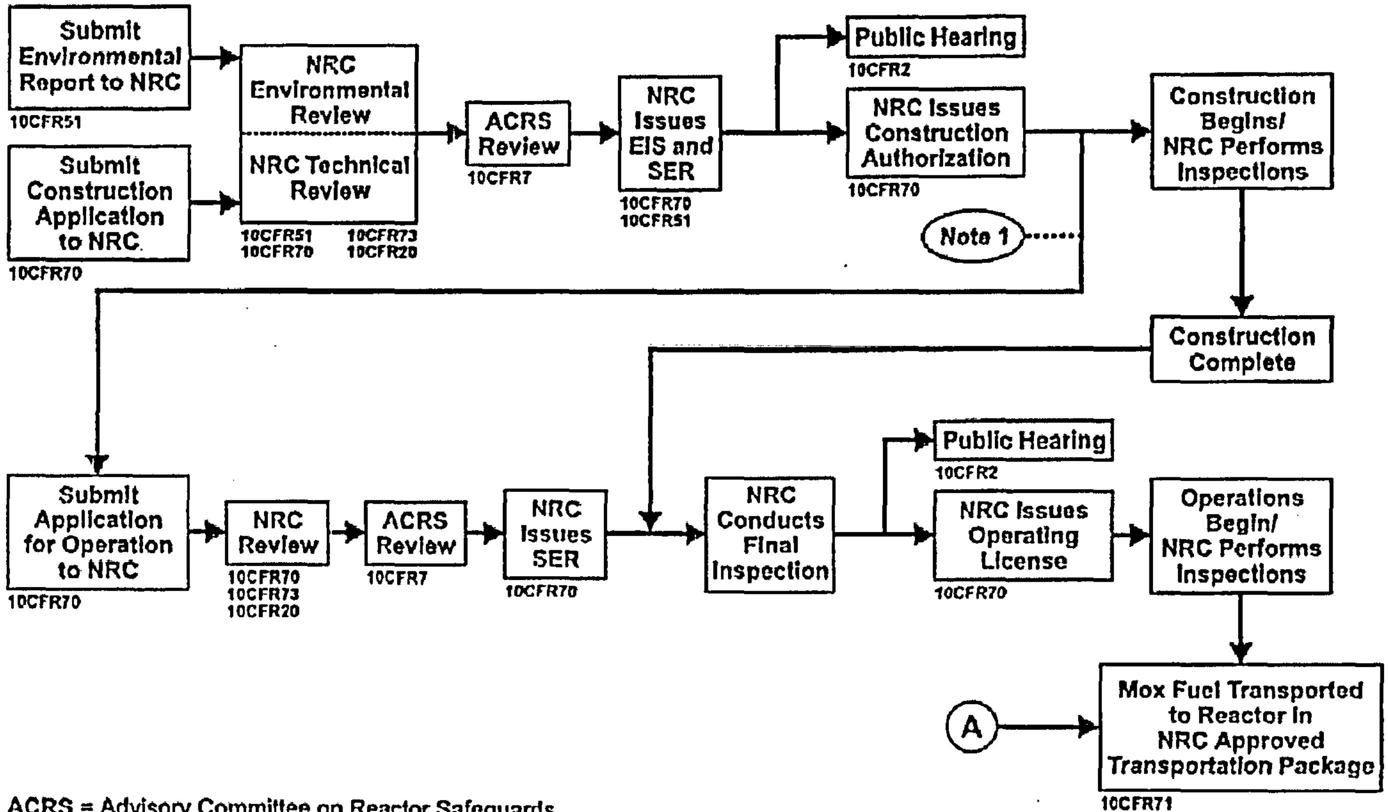
- Regulatory Framework for Construction Authorization
- Future MFFF License Application and ISA Summary
- MFFF Description
- Safety Assessment Methodology & Example
- Summary

Purpose of this Meeting

- Purpose of this meeting is to brief the ACRS on the staff's Final Safety Evaluation Report on the Construction Authorization Request for the Mixed Oxide Fuel Fabrication Facility

MFFF Licensing Overview

LICENSING PROCESS FOR MOX FUEL FABRICATION FACILITY



ACRS = Advisory Committee on Reactor Safeguards
EIS = Environmental Impact Statement
SER = Safety Evaluation Report
10CFR70 = Title 10 of the Code of Federal Regulations, Part 70

NOTE 1:
It is expected that application for operation will be submitted after construction is authorized but it can be submitted at any time.

Regulatory Framework: Construction Authorization

- In September 1971, the AEC revised 10 CFR 70
- Two-step licensing approach for plutonium processing and fuel fabrication (MOX) plants
- 10 CFR 70.23(b) – requires staff finding on DESIGN BASES of the principal structures, systems and components that provide reasonable assurance of protection against natural phenomena and the consequences of potential accidents

Regulatory Framework: Construction Authorization

- 10 CFR 50.2 Definition of Design Bases:
  - "Design Bases means that information which identifies the specific functions to be performed by a structure, system, or component of a facility and the specific values or ranges of values chosen for controlling parameters as reference bounds for design..."

Regulatory Framework: Two – Step Licensing

- Construction Authorization
  - Site Description
  - Safety Assessment of the Design Bases
  - Quality Assurance Plan

- Possession and Use License Application
  - Safety program descriptions
  - ISA Summary
  - Security Plan
  - Emergency Plan
  - Fundamental Nuclear Material Control Plan

Regulatory Framework: Possession and Use License

- September 2000 Revised Rule added requirement for an Integrated Safety Analysis (ISA)

- Under the new rule, an applicant or licensee will:
  - Identify potential accidents and items relied on for safety (IROFS)
  - Implement measures to ensure that the IROFS are available and reliable to perform their intended safety function
  - Maintain the safety basis and report changes to NRC
  - Make certain changes to its safety program and facilities without NRC approval
  - Report certain events

Regulatory Framework: Performance Requirements

Likelihood / Consequence Category (Worker)	Highly Unlikely	Unlikely	Not Unlikely
High TEDE > 1 Sv Chem. > Level 3	No Principal SSCs Applied	Principal SSCs Applied	Principal SSCs Applied
Intermediate 0.25 Sv < TEDE < 1 Sv Lev. 2 < Chem. < Lev. 3	No Principal SSCs Applied	No Principal SSCs Applied	Principal SSCs Applied
Low TEDE < 0.25 Sv Chem. < Level 2	No Principal SSCs Applied	No Principal SSCs Applied	No Principal SSCs Applied

Chemical consequence levels are based on ERPG-1, -2, or -3 where such limits are available, and Temporary Emergency Exposure Limits (TEELs) where ERPGs are not available.

Design Bases and the Performance Requirements: Working together

- To meet 70.22(f), and in anticipation of ISA requirements, DCS completed a Safety Assessment (SA) of the Design Bases as a first step in performing its ISA.
- The MFFF SA is the safety basis for construction authorization.
- The SA includes a hazard assessment and preliminary accident analysis based on the MFFF preliminary design.
- Regulatory bases for selecting PSSCs are the sec. 70.61 performance requirements, 70.64(a) baseline design criteria, and the defense-in-depth requirement of 70.64(b).

Regulatory Framework

- Baseline design criteria are set forth in 70.64(a)(1-10), and include:
  - Quality standards and records
  - Natural phenomena hazards
  - Fire protection
  - Environmental and dynamic effects
  - Chemical protection
  - Emergency capability
  - Utility services
  - Inspection, testing, and maintenance
  - Criticality control
  - Instrumentation and controls

Regulatory Framework

- Defense-in-depth requirement set forth in 70.64(b)
  - ". . . The design must incorporate, to the extent practicable: (1) preference for the selection of engineered controls over administrative controls to increase overall system reliability; and (2) features that enhance safety by reducing challenges to items relied on for safety.

Future License Application & ISA Summary

- Description of Safety Programs
  - Radiation Protection, Criticality Safety, Fire Protection, Chemical Safety, Management Measures, etc.
- ISA Summary
- Other required plans, such as:
  - Security Plan
  - Fundamental Nuclear Material Control Plan

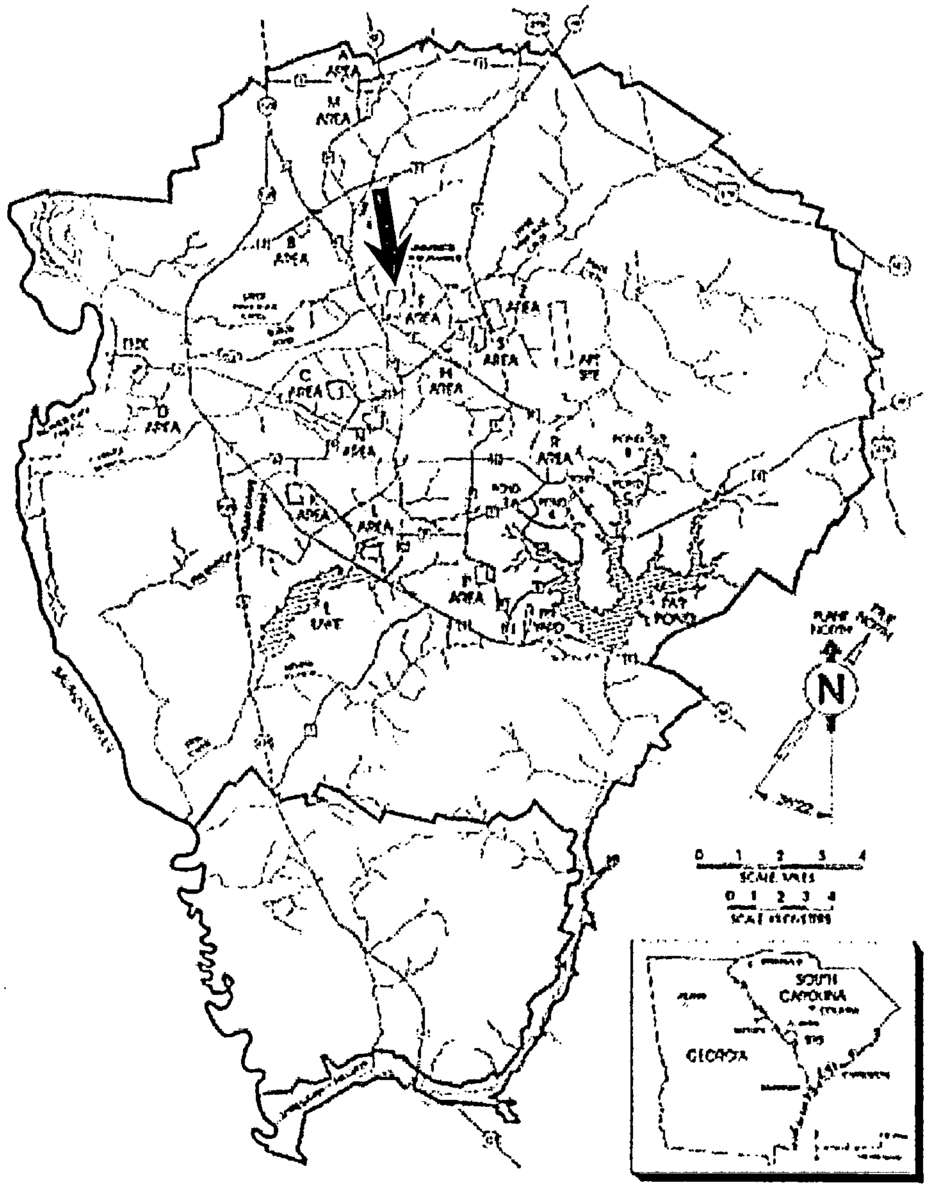
Future ISA Summary

- The ISA Summary will include:
  - IROFS at a component level of detail
  - Facility description
  - Process description
  - ISA Team qualifications
  - ISA Methods (Hazard ID, consequence evaluation methods, likelihood evaluation methods)
  - List of IROFS and sole IROFS

Future ISA Summary

- The ISA will also include:
  - Hazards and Operability Studies (HAZOPs)
  - Fire Hazards Analyses
  - Nuclear Criticality Safety Evaluations
  - Failure Modes and Effects Analyses

MFFF Description

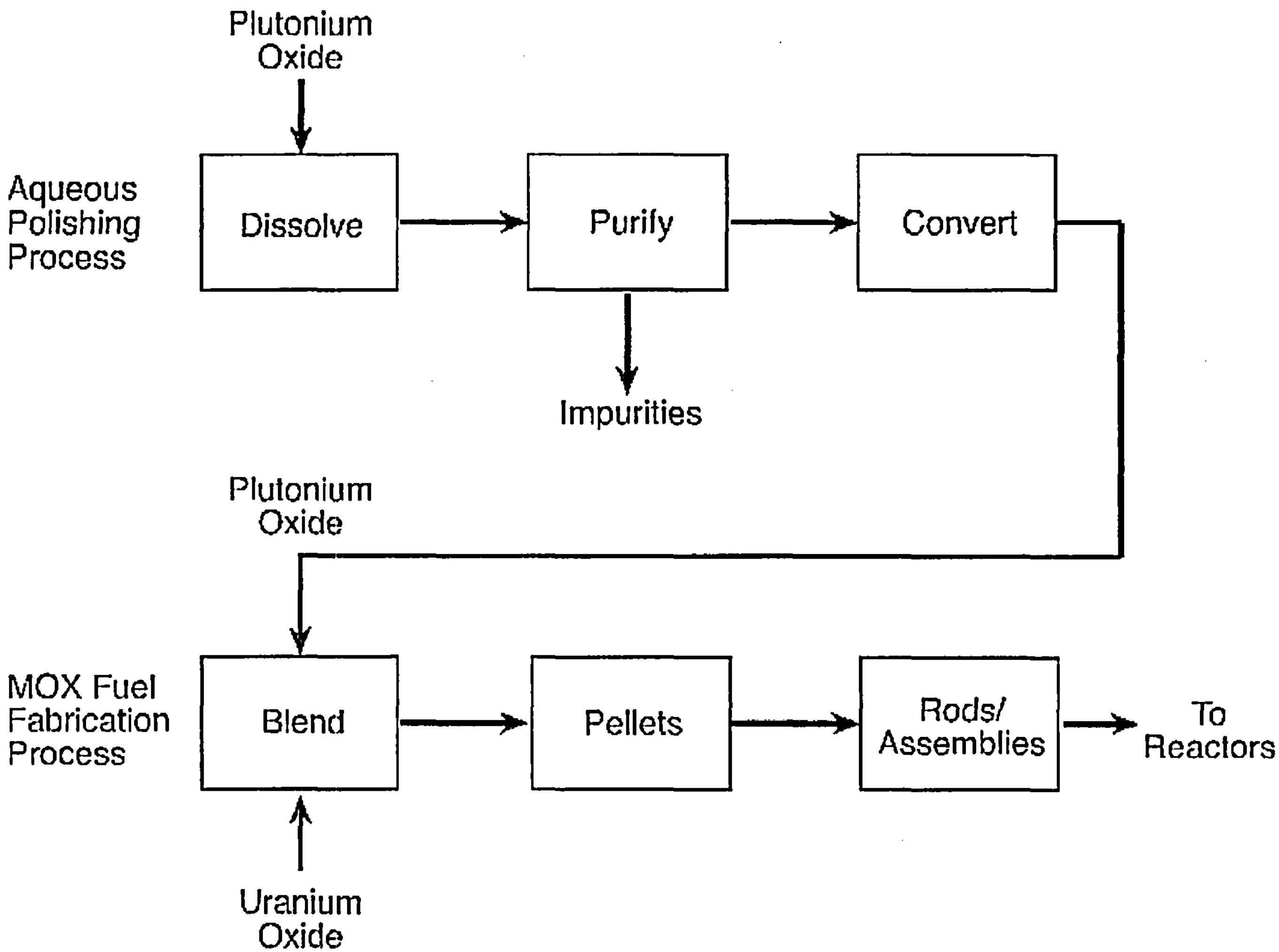


Site Description

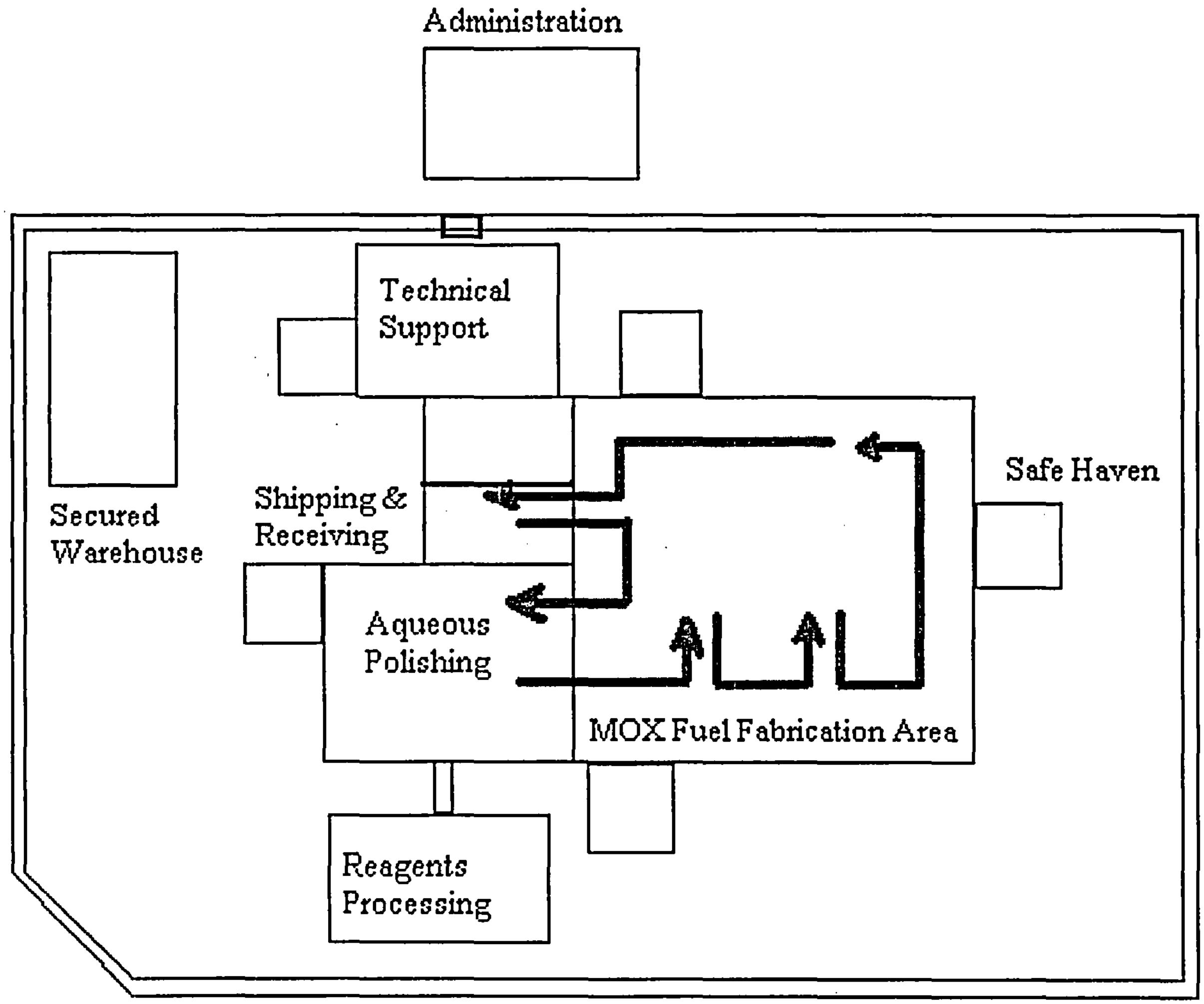
- Natural Phenomena Hazards for which design bases of PSSCs are provided (43 considered):

- Extreme Wind
- External Fire
- Rain/ Snow/ Ice
- Lightning
- Seismic / Liquefaction
- Temperature Extreme
- Tornado
- Tornado Missiles

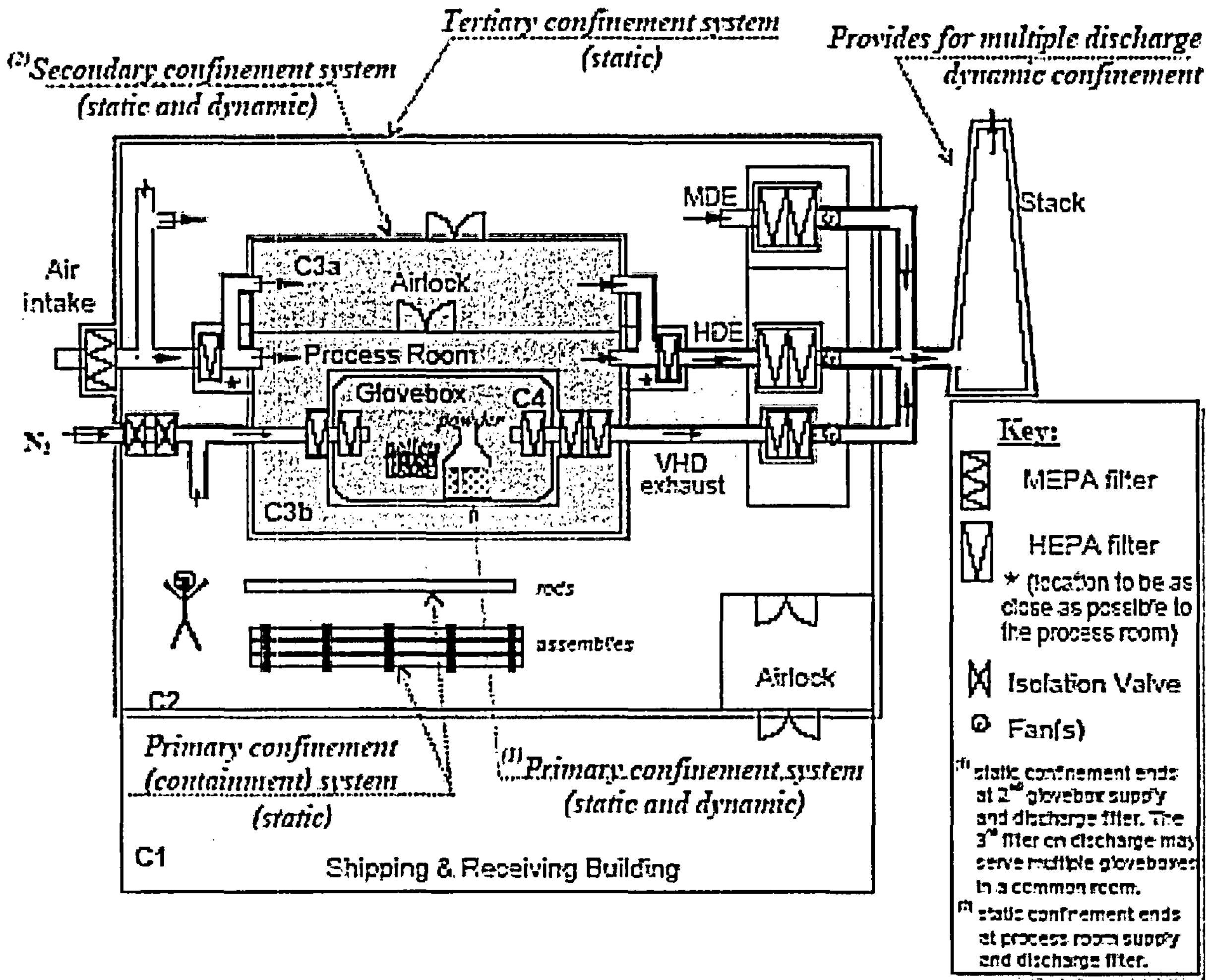
MFFF Process Description



Facility Layout



Tertiary Confinement System



Safety Assessment Methodology

- Hazard Identification
  - Radioactive / Hazardous Material and Hazardous Energy Sources
  - Natural Phenomena Hazards (NPH)
  - External Man-Made Hazards

Safety Assessment Methodology

- Hazard Evaluation
  - Event type designation
    - loss of confinement, fire, drops/crush, explosions, criticality, natural phenomena, external man-made, external radiation exposure, and chemical release
  - Unmitigated event description
  - Postulated causes (to determine feasibility)
  - Unmitigated consequence estimate

Safety Assessment Methodology

- Hazard Evaluation
  - Internal events screened by consequence
  - No internal event was screened out due to likelihood considerations
  - Credibility of NPH or external man-made events based on likelihood

Safety Assessment Methodology

- Preliminary Accident Analysis
  - Event screening using consequences
  - Identification of event groups
  - Development of safety strategy
  - Selection of PSSCs
  - Design bases of PSSCs
  - Support functions related to PSSCs
  - Bounding mitigated consequence analysis

Safety Assessment Methodology

- Likelihood definitions
  - Not unlikely
    - May occur during the lifetime of the facility
  - Unlikely
    - Not expected to occur during the lifetime of the facility

Safety Assessment Methodology

- Likelihood definitions (continued)
  - Highly unlikely
    - Sufficient PSSCs applied to reduce likelihood to an acceptable level using deterministic design criteria (next slide)
    - Index score of (-5) in supplemental assessment for selected events

Safety Assessment Methodology

- Deterministic Design Criteria
  - Single failure criterion or double contingency principle
    - Upon failure of a single contingency, another unlikely, independent, and concurrent failure or process change must occur prior to occurrence of the event.
  - Application of 10 CFR 50 Appendix B, NQA-1
  - Application of industry codes and standards
  - Management measures, including IROFS failure detection

Safety Assessment: Example

- Fire in MP process glovebox
  - Several causes (ignition sources), with combustible material present, and which involves plutonium dioxide
  - Unacceptable risk due to high unmitigated consequences to facility worker and individuals outside and the environment.

Safety Assessment: Example

- Fire in MP process glovebox
  - Safety strategy is to mitigate this postulated fire event group
  - Administrative PSSC for facility worker – escape
  - C4 and C3 ventilation confinement systems are PSSCs to reduce consequences to outdoor receptors
  - Also, fire barriers restrict fires to a single fire area
  - C2 confinement and fire detection and suppression provide defense-in-depth

Safety Assessment: Example

- Fire in MP process glovebox
  - Example of applicable design bases for C3 ventilation confinement (secondary confinement):
    - Safety function: remain operable
    - Spark arrestors
    - Dilution of high temperature exhaust streams to ensure 450F HEPA filter rating is not exceeded
    - Soot and pressure conditions do not exceed HEPA filter capability

Safety Assessment: Example

- Fire in MP process glovebox
  - Later license application and ISA Summary will document:
    - the transition of system level PSSCs to component-level IROFS;
    - that IROFS will be sufficiently effective, reliable, and available to meet the specified design bases (management measures)

Summary

- Staff have resolved all former open items
- Recent revisions to the Construction Authorization Request address former open items

Summary

- **The NRC staff concludes that:**
  - the design bases of PSSSs at the proposed MFFF provide reasonable assurance of protection against natural phenomena and the consequences of potential accidents;
  - DCS has addressed the baseline design criteria in its safety assessment of the design bases;
  - the proposed MFFF design and facility layout are based on defense-in-depth practices, including a preference for engineered controls over administrative controls, and features that enhance safety by reducing challenges to PSSCs