ACRST-1472

UNITED STATES NUCLEAR REGULATORY COMMISSION

IN THE MATTER OF: DOCKET NO:

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

SUBCOMMITTEE ON DECAY HEAT REMOVAL SYSTEMS

ORIGINAL

LOCATION: WASHINGTON, D. C. PAGES: 209 - 446

DATE: TUESDAY, DECEMBER 3, 1985

ACE-FEDERAL REPORTERS, INC.

Official Reporters
444 North Capitol Street
Washington, D.C. 20001
(202) 347-3700

NATIONWIDE COVERAGE

PUBLIC NOTICE BY THE

UNITED STATES NUCLEAR REGULATORY COMMISSIONERS'

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

TUESDAY, DECEMBER 3, 1985

The contents of this stenographic transcript of the proceedings of the United States Nuclear Regulatory Commission's Advisory Committee on Reactor Safeguards (ACRS), as reported herein, is an uncorrected record of the discussions recorded at the meeting held on the above date.

No member of the ACRS Staff and no participant at this meeting accepts any responsibility for errors or inaccuracies of statement or data contained in this transcript.

CR25279.0
BRT/dnw

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

SUBCOMMITTEE ON DECAY HEAT REMOVAL SYSTEMS

Nuclear Regulatory Commission
Room 1046
1717 H Street, N.W.
Washington, D. C.

Tuesday, December 3, 1985

The subcommittee meeting convened at 8:30 a.m., Mr. David A. Ward presiding.

ACRS MEMBERS PRESENT:

MR. DAVID A. WARD

MR. JESSE EBERSOLE

MR. HAROLD ETHERINGTON

MR. CARLYLE MICHELSON

MR. GLEEN A. REED

MR. CALTON, Consultant
MR. DAVIS, Consultant
MR. MARCHESE, Consultant
MR. ERICSON, Consultant

P R O C E E D I N G S

MR. WARD: The meeting will now come to order. This is the second day meeting of the Advisory Committee Reactor Safeguard Subcommittee on decay heat removal, decay heat removal systems. I'm David Ward, the Subcommittee Chairman. We'll continue the meeting with the agenda item on status of USI A-45 resolution.

I would like to remind the committee that this is not our final meeting on the topic. The Staff has not yet finished their work, but we've asked them to come in and give us a status report so that hopefully we can more quickly react or get on board with the final report coming up in a few months, we hope.

I would like to ask Mr. Marchese of the Staff to make some remarks.

MR. REED: Mr. Chairman, unfortunately I didn't make it yesterday. I'm very sorry. I wanted to be here for the auxiliary feedwater part of the meeting.

I do want to make a point that, from the operator's point of view -- and I'll try to represent operators -- auxiliary feedwater systems, that technique is the technique for removal of decay heat, is a bit complex. It involves four systems functioning: service water, auxiliary feed, the circulation primary system and various electric systems. And it bothers me that we have had so

many near misses in the last few years.

I think you get this because of the complexity, trying to move steam and water in common pipes and the water hammer events and all the other events and the leakback events and the valve problems that go along with it.

I guess from yesterday's meeting you didn't find out too much about the reliability, but I like to think that auxiliary feedwater is a key system to decay heat removal. I'm not so sure that its reliability is good enough to take care of this very serious core heat need.

MR. WARD: Thank you.

MR. MARCHESE: Good morning, everyone. My name is Andy Marchese, I'm the task manager for the USI A-45 resolution and chief on shutdown heat removal requirements. As Mr. Ward mentioned, this is a status briefing on where we stand in the program at this particular point in time.

As you know, we have had numerous meetings with the Subcommittee -- I think a total of about 16 over the past several years -- and I envision having quite a few more in the months ahead.

(Slide.)

This is a list of the items that we plan to cover today. We are going to start out with a discussion of the plant analysis revision activities that have taken

place over the last several months; specifically, since we met last May. And then we are going to focus in on the results of the revised Point Beach and Quad Cities plant analyses.

After that, we'll review the results that have -- or the analysis results that have been generated on two specific systems that I think you've asked for. One is the dedicated primary blowdown system that Mr. Reed has proposed, and coupled with that, we'll also discuss the preliminary analysis results that have been generated on a high pressure RHR system. We'll discuss those together later on.

The next item, you have also asked how input from A-45 will be factored into reaching a decision on the need for PORVs on those cluster engineering plants that don't have them. I'm going to try and explain how the results of this program will be factored into that decision process. And after that we are going to discuss the sabotage analyses that have been conducted under A-45.

By the way, this part of the meeting will have to be closed since there is safeguarded information that will be presented.

And, finally, we'll give you the latest estimate of the major schedular milestones on the program.

(Slide.)

Okay. By way of introduction, as you know, rough draft reports for Point Beach and Quad Cities were issued in May. We had a meeting with the Subcommittee on May 30th. During the month of June, there were detailed comments on those two reports that were issued by the Staff; specifically, the reliability and risk assessment. Staff members of NRR did a detailed review of those reports and they had quite a few detailed comments.

There was a lot of Staff discussion of these comments with Sandia, meetings, numerous meetings were held in terms of trying to reach agreement on how best to handle these comments in terms of the analyses that were being done on Point Beach and Quad Cities.

Finally, agreement was reached on how to handle these items, and it turns out that, as Dr. Ericson will explain a little later, to factor these comments into the analyses took a lot of additional work, which is one of the reasons why we are back here again, discussing these reports, because the results have changed significantly because of the comments that were factored into the analyses. You'll be hearing more about this later on in terms of how the results have changed.

(Slide.)

This is a list of the items that the Staff took exception to in the review of the original plant analyses

for Point Beach and Quad Cities. As I mentioned, a considerable amount of time was spent on reaching agreement on how best to handle these areas.

The most important areas that required significant additional analyses, let me just point a couple of these out: The treatment of common mode failures took a lot of additional work. I think the Subcommittee at the May 30th meeting was also concerned about this.

Support system initiators was another important one; for example, loss of DC bus as an initiator -- that required a lot of additional work.

Treatment of feed and bleed -- and this relates to how we handle the auxiliary feedwater system in terms of common modes -- also took a lot of additional analyses and a lot of -- had an important effect on the results.

The next one, insensitivity of person-REM to source term used, this has to do with the way the CRACO handles calculation of off-site releases, and we'll be getting into that a little later on.

And then finally, the other important one was there was some inconsistent treatment in the way station blackout was handled in Point Beach and Quad Cities; and now we feel both of the reports are handling station blackout sequences in a consistent manner. We'll go through some of these as we go through the plant analyses.

I'm going to come back later on and talk about the CE/PORV issue, schedule and so forth at the end of the day. But at this point, I'd like to turn the meeting over to Dr. Dave Ericson, from Sandia, who is a program manager at Sandia Labs; and Dave is going to discuss the plant analysis revision activities and plant analysis status at this point in time.

MR. WARD: Andy, first a question. Is someone going to talk about the coolant pump seal LOCA, further?

MR. MARCHESE: In terms of how we are handling it in the program?

MR. WARD: Yes.

MR. MARCHESE: Yes. I think we can get into that a little later on.

MR. WARD: Okay.

MR. DAVIS: Excuse me, Andy, I also had a quick question. Did the utilities have an opportunity to review the draft?

MR. MARCHESE: Yes.

MR. DAVIS: Did you receive any comments from them?

MR. MARCHESE: No. We submitted the revised reports to them and asked for their review, I think by mid-December.

MR. DAVIS: Thank you.

MR. WARD: Any other questions for Mr. Marchese? Thank you.

MR. ERICSON: I will attempt, in these few introductory remarks, to be even briefer than Andy and maybe we can get a leg up on our schedule today.

(Slide.)

As Andy has indicated, as a result of the review by the Staff and then the subsequent dialogue with us, we have reworked the internal analysis on Quad Cities and Point Beach, and at the same time adjusted and made some adjustments into the analyses we are doing on the other plants.

Basically, if you go back through that list of questions, what it has amounted to is that we have gone back with a broader treatment of common mode, some additional treatment of the way -- or some additional inclusion of actuation in the modeling; specifically, looking at long-term blackout and, where appropriate, we have gone back and done a modest reexamination of human factors and recovery issues. Most of that in the basic risk assessment mode.

The special emergency people -- that would include the seismic, the fire, spray, flood -- have indeed gone back as a result of some of the comments. We have done some review and have modified a few things. In

addition, the seismic area, modeling was coming along, and we've changed a few things to better reflect a way to do that modeling.

In the sabotage area, what we discussed in an earlier meeting was a very qualitative approach. We have since gone back and done what I choose to call a modest conditional quantification. We'll get into more of that, obviously, later this afternoon. You are aware, of course, that there are a number of efforts going on, attempting to quantify or put -- perhaps put sabotage into more of a risk perspective. We have done some things in that regard on a conditional basis, and we'll get into those details later.

(Slide.)

As to where we are, then, in the entire scheme of preparing the specific analyses for submission to the Staff for their use in preparing the subsequent documentation, the resolution package, Quad Cities has been submitted. The revision is in to them. They have had it for a while now. It has also progressed through our own internal management channels; copies are at Commonwealth Edison for comment. We requested their comments by about the middle of this month.

After receiving those, the document will be submitted to the Staff for publication. It is, so far as we are concerned, as a study it is ready to go.

Point Beach is in a somewhat similar situation. Our draft is in. It is now in our line management approval process at Sandia. A copy has gone to Wisconsin Electric for comment, and because we have just a lot of cleanup things, in terms of artwork in order -- for publication, the actual printed version in terms of the NUREG CR probably won't be able to go until probably the February time frame.

It indicated here that the Cooper draft would be submitted. I had planned to bring it along today, however, we still have a few tables in the typewriter when Steve and I left yesterday, so it will be coming in to the Staff next week, and also entering the internal Sandia review process at the same time. This will be the first time that the Staff has seen the Cooper report. That will be a new document to the Staff.

Turkey Point is the -- the draft of that is imminent. Gary Sanders is responsible for that analysis and he's in the process of wrapping up the final sections of the value impact now. In fact, I think most of it is at home, waiting to be typed. When we get back we'll go through the final reviews ourselves and double-check numbers and this sort of thing. So we expect to have that back in here before the holidays, certainly.

Saint Lucie is under way. In fact, the internal

PRA-type things are in the first stages of quantification. The internal emergency people are off and running on their things. And our target date for submitting a draft is February; part of the reason for that being -- is that in order to do the job right we make a second plant visit, you will recall, after we propose the modifications. And due to plant schedules, holidays and that sort of thing, we won't be able to do that, until January. We are shooting for early January to do that and so the report, then, subsequently will have to come in February.

MR. WARD: That's a more pleasant time to visit Saint Lucie.

MR. EBERSOLE: I'd much rather go to Saint Lucie in January than Point Beach. I think Chuck is here this morning; it's kind of grim up there these days. In fact, Mr. Reed could probably tell us a lot of stories of what it's like on the shores of Lake Michigan in January.

ANO 1 is on way; we have the fault trees available for some time initially and entered into computer. Wally has been going back through those, double-checking them, making sure they are consistent with what we've added since we went back through the Point Beach analysis, and he will be beginning to crank out numbers from the internal part of that analysis when we go back next week. The special emergency work is in progress, and, again, we have

a target date of February because we won't make a plant visit until after the first of the year, probably.

Trojan is temporarily on hold at the moment. That's primarily an internal problem for me. Some of my younger staff members have been lured by the siren song of other opportunities and so we are down temporarily on staffing, but we expect to have that one back up and running very directly. We put it on hold because it is, of course, another Westinghouse plant, so we felt we should get the others done first and then come back to that.

MR. WARD: What was unique about Trojan?

MR. ERICSON: Trojan just completes the family. Then we go 2, 3, and 4 loopers.

MR. EBERSOLE: Mr. Ericson, could you comment about how you can draw a line down between the total efforts between the boilers and the PWRs and how the work is going and what's the extent of it in front of us and behind us?

MR. ERICSON: As far as specific plant analysis we are done with boilers. We have had two and they are done. At this time.

MR. EBERSOLE: Okay.

MR. ERICSON: And -- well, the next viewgraph -- let me comment on where we are in terms of pulling things together.

MR. WARD: Let me ask you just to clarify -- maybe it's our record. At one time I had the impression that the combustion engineering plant you were going to do was SONGS. In fact, we quote you in a set of our minutes as saying it was SONGS. That may be an error, that's why I want to clarify.

MR. ERICSON: At one time I recall we discussed rather extensively doing "a newer design," and we were asked to look at the possibility of doing several new ones and we suggested, I think, if we did SONGS and perhaps Grand Gulf or something like that might be the ones to do. But we have not specifically put those on the agenda at the present time.

Our model -- we've always had Saint Lucie as the one for the detailed analysis at this point in time.

MR. WARD: Okay. Insofar as studying the impact of PORV or no PORV, you can do that with any plant, I guess; is that your argument?

MR. ERICSON: Yes. In fact, I think Andy may have some comments, and we will, too. In fact, Wally will show you a sensitivity to feed and bleed on Point Beach. We are doing the Saint Lucie sensitivity on all the pressurized systems.

MR. MARCHESE: Let me just comment, we originally had nine plants in the program. The last two

were more recent vintage. We were considering, as Dave mentioned, doing San Onofre or Palo Verde, which are more recent Combustion Engineering plants. We also had a more recent vintage BWR, such as Grand Gulf. However, about six months ago we decided to drop those two plants because of budget and schedule problems that the program is having. So right now they are not in the program.

MR. EBERSOLE: May I ask this question? In the case of the two boilers you looked at, General Electric has finally, after some 15-odd years, agreed to an ultra-simple open cycle boiling process they refer to as UPPS, which appears to have some of the merits of an extremely simple boiling process just to keep the core covered and do preliminary cooling through the special cooling and subsequent discharge to the atmosphere, which implies the only active cooling you have to have to continue the cooling indefinitely is a low pressure pump and source of water. Was that incorporated into your studies?

MR. ERICSON: We did not attempt to do a cost estimate of backfitting. It was commented on and looked at in both plants but we did not go into a detailed examination of backfitting.

MR. EBERSOLE: The degree this would be able to cope with most emergencies has not been defined.

MR. ERICSON: In addition to these plant studies,

of course, there are a number of what I have chosen to call "special topics."

(Slide.)

First of all, let me say that as far as a summary report, pulling these seven plant studies, which all make rather handy doorstoppers when they are laid down on the floor, we will, of course, eventually pull the summary report together.

As a first step of that, we are beginning to put together, now, insofar as we can based on the few plants, some generic conclusions, observations, call them what you will. And we will be providing that to the Staff in January, not so much as a report per se but as input to some of the work going on. It will be more in letter report format. But to begin to help Andy and his colleagues put some things together.

We have also looked at some special issues. For example, what happens, given that some people have argued, if there should be another major incident and somebody says, well, let's close everything up? What are the costs, the values associated with that? We have done some looking at that with our consultants at UCLA. We have had a rough cut at that, or first cut. I shouldn't say "rough"; a first cut. That is being revised at the present time and we hope to have that available to the Staff sometime after the

first of the year.

We are also assisting as we can -- the regulatory analysis is a Staff function, but we are providing all the assistance we can in terms of getting numbers in the right format for them and attempting to pull together insights that we see in the data or in the information we generated.

We also have a summary report on value measures and the value impact structure, which is in progress. UCLA is preparing this for us.

The value impact approach we have taken, of course, is that -- is based upon the B&L handbook, internal NRR guidance that they have been using since late 1984. We have kind of pulled a lot of that together. If you will, in some instances, a cookbook format for our uses. It has been documented, so the approach will be available; and if someone really wants to dig into how we are doing it, it's there.

Of course, in each of the plant reports there is an appendix that describes these things, but we will be pulling a lot of this stuff together in one place.

MR. WARD: Dave, is this -- I mean the B&L handbook -- does that include just on-site costs? Or off-site costs? Does it include on-site costs, loss of replacement power --

MR. ERICSON: I think it does, but certainly not to the extent that we have done it and the options we have looked at. We have added a lot of the on-site stuff as we have been seeing things, of course, in the course of the program. UCLA has assisted us in pulling those things together in terms of a consistent format.

MR. WARD: But in your treatment you are displaying both -- in both ways?

MR. ERICSON: Value impact based on off-site dose only and display value impact based on off-site and on-site together.

MR. WARD: Okay. Thank you.

MR. ERICSON: We display both. And now we'll be displaying several alternatives.

MR. ETHERINGTON: Do you and your contractors have several groups working in parallel on different projects?

MR. ERICSON: Yes. UCLA is working -- at the present time we have, essentially, about four contract groups. We have outside assistants in the special emergency areas with seismic analysis --

MR. ETHERINGTON: That wasn't quite the question. Do you have groups working in parallel on different projects or do you clean up one project first?

MR. ERICSON: Do you mean plant studies?

MR. ETHERINGTON: Yes.

MR. ERICSON: Yes. Two in parallel, and right now, three in parallel.

MR. ETHERINGTON: And the same with the contractors --

MR. ERICSON: It's an integrated team. Contractors and Staff are working together on a plan. Some parts of the analysis, special purchases in particular, we have contract support. The internal PRA work we are doing in-house at Sandia, using our internal resources.

MR. ETHERINGTON: I see.

(Slide.)

MR. ERICSON: At this point, then, I'm going to ask -- unless there are other questions, I'm going to ask Mr. Wally Crammond from our organization, from our Staff, to come up and begin a look at the Point Beach work.

I might point out in the handout we'll switch the order in a couple of places, but Wally will point that out as we go. We have decided to combine things slightly differently.

(Slide.)

MR. CRAMMOND: My name is Wally Crammond and I have been responsible for the Point Beach analysis and in the beginning, some of the methodology of how we would go about doing the analyses.

(Slide.)

As Dave pointed out, we have submitted this a second time. I'll put this viewgraph up just briefly to show the connections between the transient event trees, and the LOCA event tree; and the branches that we do sensitivity analysis on, the secondary blowdown branch and the feed and bleed branch.

In the second go-around of the analysis, we have included loss of a DC bus and loss of an AC bus.

(Slide.)

That's essentially the same as the other transient event trees.

This is just showing the containment event tree, and one thing that's a little different about our analysis than some analyses is the fact that we separated the containment events from the core melt events. So the first thing we do is come up with a core melt frequency and then we associate with each sequence that's significant, all the possible containment failure modes. And then from there we obtain, or we determine which sequences fall in which release categories and extrapolate into the risk space.

(Slide.)

MR. MICHELSON: Your containment failure modes are as a consequence of core melt? Is that what you are saying?

MR. CRAMMOND: Yes. We only look, in fact, for the significant ones to cut down on computer time.

MR. MICHELSON: Did you also look at a possibility of having a core melt in conjunction with a failure to isolate the containment to begin with? In other words, the purge valves would not close --

MR. CRAMMOND: No. One thing we did do, we assumed that failure of the containment would not in itself lead to core melt, as has been assumed in the past.

MR. MICHELSON: No. I think that's probably not too bad an assumption. My postulation is that you have a core melt scenario developing, and during the process you were unable to isolate the containment which was, perhaps, normally opened.

MR. CRAMMOND: We didn't consider that.

MR. MICHELSON: Is there some reason why that wouldn't be a fairly high probability scenario? On what basis did you discount it?

MR. MARCHESE: Mr. Michelson, this program, I think we mentioned this at some other meeting, we are concentrating on small break LOCAs and transients. We are examining the systems that respond to small breaks and transients. We specifically excluded at TWS, large LOCAs, event --

MR. MICHELSON: The containments have to bottle

up for small LOCAs, too, very definitely.

MR. MARCHESE: I think you are talking about RHR.

MR. MICHELSON: I'm talking about the purge valves, containment ventilation. If they don't close, it's a loss of containment.

MR. MARCHESE: We did not look at that.

MR. DAVIS: I might mention, that has been looked at, Carl, in some of the recent PRAs. No one has found it to be a significant risk contributor yet. Generally the probability of isolation failure is 10 to the minus 3.

MR. MICHELSON: The problem is, I think, you don't have any reliability data whatsoever on the ability of these valves to close under the dynamic conditions of an accident.

MR. DAVIS: For the accidents they are looking at there won't be much in the way of dynamic conditions. These are small breaks.

MR. MICHELSON: If they are small breaks they should not be much worse than a normal test, that's right. I assume you use normal surveillance data for your reliability numbers.

MR. REED: I could be in conflict of interest on Point Beach, but I think I can give a factual statement. The purge valves at Point Beach are run in closed condition

and are never opened above 200 degrees Farenheit primary coolant.

MR. EBERSOLE: I would like to have you discuss just for a minute why you believe a containment failure could not initiate a core melt. In view of the fact you have abnormal environmental conditions in the containment, you might have destructive rupture of the containment which would destroy piping and components and equipment. I don't see how you can eliminate containment failure unless you do a very selective identification of how it fails as an initiator of core melt. As a matter of fact, in the boiler it's the royal problem -- because of their self-contained heat sink and loss of AC power --

MR. CRAMMOND: The basis we used for not considering it was the traditional idea that if the containment failed the sump would flash and you would lose the water for recirculation and fail the low pressure recirculation pumps. That we concluded, after talking with the plant and other people, that that really isn't the way it goes, in fact.

MR. EBERSOLE: That's just a point failure of a singular kind. There are many other ways of failing those systems besides that.

MR. CRAMMOND: In terms of the conditions in the containment we didn't address that.

MR. EBERSOLE: I don't see that your analysis is complete by any means.

MR. CRAMMOND: There are a lot of things that are -- we didn't do for which you can claim we are not complete, ATWS and interfacing ATWS --

MR. EBERSOLE: Or any containment failure initiated meltdowns.

MR. CRAMMOND: Yes. That has to be true.

MR. MICHELSON: Just for clarification now, what you are going to present to us applies to Point Beach specifically, but are these techniques the same ones applied across the board or just to apply to Point Beach?

MR. CRAMMOND: Essentially the same techniques that we use for all our analyses; in particular, the PWRs. The BWRs would be slightly different, but --

MR. MICHELSON: Is it safe to assume that as you go from one plant to another that you adjust these techniques for the plant-specific conditions?

MR. CRAMMOND: If there are plant-specific conditions.

MR. MICHELSON: For instance, if purge valves are normally open, you would adjust your reliability study accordingly. If they are normally closed, you would leave it out, obviously. But these are general techniques, I assume?

MR. CRAMMOND: Yes.

MR. MICHELSON: Okay. So in general you did not consider the purge valve question in your studies; is that correct?

MR. CRAMMOND: That's true.

MR. MICHELSON: Thank you.

MR. MARCHESE: Let me comment, I think containment-initiated core melts are more likely for the BWRs. Later on when we talk about the Quad Cities results we'll have more to say on that.

MR. EBERSOLE: Okay.

MR. CRAMMOND: The two things are containment failure due to overpressure and post-accident radioactivity removal. Those two functions.

(Slide.)

This shows the results, the dominant accident sequences and the probabilities before and after recovery is applied; and essentially this is the number that we are looking at: 1.4 times 10 to the minus 4 for the internal events alone.

MR. DAVIS: Excuse me, Wally, I had a question. On the top sequence I think is a failure to recirculate, and you don't have any adjustment for the recovery part of that even though there's two to four hours, I believe, for the operator to do something. Could you explain what you

used as a recovery criteria and why that particular sequence doesn't change?

MR. CRAMMOND: I probably couldn't remember the details of that. But, on the recovery we applied a number of recovery factors based on -- we looked at each of the cut sets in each of the sequences and we looked at the elements in the cut set, and we had recovery factors for diesel generators, for batteries, for loss of off-site power, for LOCA faults where it could be remedied from the control room, or where you'd have to go down to the place and change a valve, for example. And each of those, we had four or five different times: 30 minutes, an hour, two hours, four hours, eight hours; and we had a matrix of numbers that you can find in the report that we used.

In this particular instance, I don't recall why. I believe that was probably the failure to change over to recirculation at the proper time and the probability was all wrapped up in the one number. Instead of applying another human factor number, would he -- if he failed, he failed. And that was in the original number. We didn't give him another number, another chance to fail, because it was already in the initial number. Some of them did change and some of them didn't.

MR. WARD: Does that make sense to you, Pete?

MR. DAVIS: Yes.

MR. WARD: Okay.

(Slide.)

MR. CRAMMOND: Now, we obtained a number of excellent comments from the NRC as a result of their review of the first analysis. These are not necessarily changes, but in some cases, changes -- in many cases, additions to the analysis to account for their comments, including long-term station blackout, control circuit failures to pumps and valves, and test and maintenance down time, which we hadn't included, and some past PRAs hadn't included either when we reviewed that. And so on. I won't read all these. But all of these changes and additions, I believe, improve the analysis immensely but also took a lot of time.

(Slide.)

MR. DAVIS: Excuse me again, Wally, I want to go back to Dave's question on the pump seal LOCA. I don't see that on this list.

MR. CRAMMOND: That was one of the comments that we addressed and decided that we would not change anything to reflect that.

MR. MARCHESE: Well, wait a minute. We assumed that the other generic issue on sealed LOCAs would fix that problem.

MR. CRAMMOND: That's right. So we did not need to address it.

MR. DAVIS: You assumed there would not be a pump seal LOCA associated with loss of AC power?

MR. CRAMMOND: It was such an important issue that it would be solved by the other generic issue, so we assumed it would be solved if it were a problem, for our analysis.

MR. DAVIS: To my knowledge it hasn't been solved, and I'm not sure what the disposition is.

MR. WARD: I think the latest indications are that it may not be a problem. But I'm not sure the Staff has accepted that yet.

I'm not sure that's true. Does anybody have a position on that?

MR. MARCHESE: I think they are still negotiating with Westinghouse on the sort of testing to be performed. I don't think it's finally resolved.

MR. WARD: I thought there were some tests which, foreign tests which showed -- a year or two ago there was some evidence that the leakage might be as high as 250 or 300, but there were some French tests, analyses, which showed it much lower than that. But I'm not sure that applies to all the plants. I guess the Staff hasn't yet accepted that?

MR. MARCHESE: Right. I might point out that one of the dedicated system options that we are considering

has the capability to cope with small break LOCAs, so if the leak is within a certain range that system can cope with a seal LOCA.

MR. WARD: In any rate, Pete, it seems to me this is a reasonable approach; although it hasn't been resolved it looks like they are moving in that direction --

MR. EBERSOLE: When you look at the PRV performance or, for that matter, the performance of any electric at apparatus which is in the nonqualified configuration, in the open standard industrial configuration, I noticed that NRC has adopted the somewhat permissive philosophy that you can immerse those devices in steam and suffer the consequences of surface condensation on terminal blocks and equipment and go through the rather speculative process of examining whether the leakage currents can lead to short circuits and failures of the electrical process in question. Which view did you take here?

MR. CRAMMOND: We didn't address the environmental qualification of equipment in the containment per se.

MR. EBERSOLE: How can you rationalize you can even prolong PORV functions to keep them open?

MR. CRAMMOND: We didn't take that as an issue. Andy, do you have any comments on that?

MR. ERICSON: Mr. Ebersole, we have addressed this, as we have stated from the very beginning, using generic data. We have not gone into plant-specific: Where is the PORV, where might it get this, where might it get that?

MR. EBERSOLE: Do you consider that open standard exposed apparatus will work in a condensing environment?

MR. ERICSON: We have not addressed that question, what condenses on it or what doesn't.

MR. EBERSOLE: Okay. That's a no --

MR. CRAMMOND: We have to see what works.

MR. EBERSOLE: Sure.

(Slide.)

I will show this very briefly. This is a comparison between the initial analysis, or the original analysis, and the current analysis. The dominant sequences change slightly and the core melt frequency increases somewhat.

(Slide.)

Again, very briefly, the next two viewgraphs show the dominant action sequences grouped.

(Slide.)

And, with the failure probability for each group, its contribution.

(Slide.)

But more important than that is the vulnerabilities. And the following viewgraphs show the vulnerabilities. 1 was the failure to switch over from emergency core injection to recirculation. That shows up in three accident sequences for a core melt probability of 3 times 10 to the minus 5. One of the more important vulnerabilities.

The vulnerabilities aren't numbered by importance. They simply got numbered. So the next one is slightly lower, the station blackout due to battery failure, and station blackout due to diesel generator failures, is down to the 10 to the minus 7 range.

MR. MICHELSON: Excuse me, before you leave that slide, your circulation, for instance, where you have to make a switchover, involves the operation of a number of probably motor-operated valves; in some cases they may be air-operated.

What do you use to measure the reliability of these various valves? What's your source data bank for knowing how good the valves really are under the conditions that they will be experiencing?

MR. CRAMMOND: The data we used was data from IREP and ASAP; and as far as LOCA faults were concerned, and we used the human reliability number from some of Swain's work.

MR. MICHELSON: The IREP data, was it available for Point Beach? Was that one of the plants analyzed?

MR. CRAMMOND: Yes -- oh, no, no, not for Point Beach specifically. But generic data.

MR. MICHELSON: You are using generic data from some other plants, then, for each of these?

MR. CRAMMOND: For the most part we used generic data. In cases where generic data doesn't exist and we have information from the specific plant, we use that.

MR. MICHELSON: When using generic data from other plants, I assume you were careful to see if these were comparable valves and so forth?

MR. CRAMMOND: No. We didn't go in that detail.

MR. MICHELSON: You mean you just take the numbers?

MR. CRAMMOND: We took the numbers from the --

MR. MICHELSON: If they were air-operated you certainly didn't use them for motor-operated, did you? If there were air-operated valves on a particular plant you didn't use motor-operated valve reliabilities did you?

MR. CRAMMOND: No. We did different numbers for air-operated valves, motor-operated manual valves, check valves --

MR. MICHELSON: But only those developed from the IREP data where it was available?

MR. CRAMMOND: Really it's ASAP data and that depends on IREP data. They are all folded together. So we looked at several data sources and tried to come up with the best, most representative number that we could come up with.

MR. MICHELSON: Okay. Thank you.

MR. MARCHESE: I would like to point out, Mr. Michelson, that in a generic program like this we feel it's appropriate to use a generic data base.

MR. MICHELSON: I have no quarrel with it. I was just trying to determine whether you had to fall back to even older, less useful numbers or whether these are state of the art numbers. I gather it's state of the art numbers.

MR. MARCHESE: I gather you'll find in some of the more recent PRAs coming out, where they are doing a level 3, detailed ones, they are trying to get into plant-specific data if it exists.

MR. CRAMMOND: We also talked to GPU people on their numbers, realizing they are doing a BWR; and for a PWR there are some similarities, like valves, for example. We tried to use the latest data we could.

MR. DAVIS: On that question, Wally, the number 1 sequence is the small break LOCA in terms of core melt probability. And you used a probability of .02 per reactor

year, which seems to be quite high. It's quite a bit higher than what was used in the IREP studies the NRC used previously. Do you know what has happened to cause that number to go up? It's also more than a factor of 10 higher than WASH-1400.

MR. CRAMMOND: That's the same IREP number.

MR. DAVIS: Do you know what's that based on? That would mean for 100 reactors you'd have a couple of events per year. It doesn't seem to me like we are having that many.

MR. CRAMMOND: Okay. In the IREP data that comes more from ANO, the IREP procedures guide, the .02 is the total of two small LOCAs: one that goes up to something less than an inch, and then one that goes from that number to 0.166 inches. So we said that our S-2 LOCA was going to be the sum of both of those. So really it's the lower, the small, small LOCA, the very smallest one, less than an inch, that contributes the most to the .02 number. Actually, the slightly larger LOCA, which is still a small LOCA, is probably in the order of magnitude -- an order of magnitude lower than that. That's probably due to PORVs, the majority of that .02. But that's effectively, right out of the IREP.

MR. DAVIS: Thank you.

(Slide.)

MR. CRAMMOND: Number 4 is failure of the ECC recirculation due to RHR pump cooling failure caused by a valve in the service water cooling system.

V·lnerability 5 -- that's a fairly big one, 1 times 10 to the minus 5.

Failure of the emergency core cooling injection due to the component cooling water failure, that's a 1 E to the minus 6, not a particularly large one.

I might point out on all these vulnerabilities, I'll point out later, we don't address all of them as far as modifications because some of them we don't know anything to do about them. Anything we thought of didn't do anything to prove them.

(Slide.)

Here the major one, common mode, that affected every major sequence, 2.4 times 1 to the minus 5, and it's one we had no modifications that we could place in the alternatives. But it's nevertheless a vulnerability.

(Slide.)

Number 7, common mode failures of safety system valves. That one you might be able to do something about. The failure of the low pressure injection system in the recirculation mode, and then the failure of the aux feedwater turbine-driven pump.

(Slide.)

What we found in the second time around, that we had more vulnerabilities and the probability, core melt probability was distributed in more vulnerabilities than it was before, and the probability also went into more cut sets a little deeper than it had before. So when you disperse them it makes it more difficult to come up with discrete modifications to address those vulnerabilities.

Number 10, failure of the component cooling water pumps.

And then last but not least, the long-term station blackout caused by depletion of the batteries or the condensate storage tank, for almost 4 times 10 to the minus 5. That was one of the changes that we had made from the original analysis, or additions.

All this, so far, has been the internal analysis. The internal analysis models have been used by the external analysis people and it changed to fit their particular analysis. In particular, the seismic people used it extensively. This is the seismic analysis. This is simply showing the frequency of the earthquakes, various levels, and the three kinds of seismic initiating events that were considered, small LOCA and two kinds of transients.

(Slide.)

MR. WARD: The earthquake frequencies, what are the numbers there? 1 to 2 SSE? What does that mean?

MR. CRAMMOND: Somewhere between 1 and 2, say shutdown earthquake level, 2 to 3, 3 to 4, 4 to 5.

Why he didn't just say 1, 2, 3, 4? I don't know. It's something between a 1 and a 2. Anything below a 1 we are not considering as significant, obviously.

MR. WARD: But if you had a curve there'd be a precise number on a curve. 1.5 times SSEC?

MR. CRAMMOND: That would be the interval between a 1 and a 2.

MR. WARD: All right.

(Slide.)

MR. CRAMMOND: The seismic core melt frequencies for those 4 levels, and the 3 transient initiates are shown here, and the sum being 6 times 10 to the minus 5. The vulnerabilities that contribute to this are the refueling water storage tank, and then there's three vulnerabilities included here on the second line: the anchorage of electrical buses, transformers, inverters, and then batteries, and then the battery racks themselves and the instrument air system for the PORVs.

MR. MICHELSON: Excuse me. As you go to the much larger level earthquakes, how do you know the response of the relays and instruments to possibility of a relay chatter at these higher levels -- these are well beyond, perhaps, the data you have available.

MR. CRAMMOND: Go ahead, Dave.

MR. ERICSON: The question of relay chatter has come up several times, Mr. Michelson. We have not looked at it here. It is being examined by -- under a separate effort I'm aware of now. In fact, the people looking at that have been looking at what we were doing under the south ERA -- we have not looked at relay chatter here. That can be an issue.

MR. MICHELSON: In terms of mountings within racks, how do you even know the equipment stays in place, because you haven't necessarily shaken the equipment at these kinds of levels.

MR. ERICSON: That's right. However, it's our understanding through our seismic people who have been involved with the broader seismic issues, A-46 and related, that what we see tends to be whole cabinets moving rather than components jumping out of cabinets and this sort of thing.

MR. MICHELSON: That's to some extent probably correct, but there have been a number of exceptions on occasion where we find that little holding devices don't hold the relays in the cabinets at higher levels --

MR. WARD: Wally -- Dave -- on the reactor coolant plant or seal LOCA, you deferred to a generic issue to solve that.

For the seismic vulnerabilities, such as, well, we are talking about anchorage of cabinets and so forth, there is a generic issue, I guess, a USI A-46 on that. How come you haven't treated that the same way? You haven't credited resolution of A-46, where you apparently have credited resolution of the generic issue on the seal LOCA.

MR. CRAMMOND: I think because it's not clear the seal LOCA would change our analysis and it wouldn't be included in the LOCA that we have, whereas in the seismic analysis, I believe our seismic person, Mike Bond, felt he could address seismic in a very satisfactory way. I don't know the details of his analysis, but I think he was pretty confident that he had covered things adequately.

MR. ERICSON: What you are seeking, Mr. Ward, is just that: that the kinds of things we have seen are being identified elsewhere, you know, tied down in cabinets, additional anchorage. That seems to be what's coming out, as I understand, most of the seismic work is anchorage problem. So it's straightforward enough that we have included it.

MR. WARD: You have included it as being anchored and as being a problem?

MR. ERICSON: Well, if we felt they were based on our analysis we felt it -- we sought additional tie down.

MR. WARD: But under A-46 there may be a fix to

all plants to eliminate problems of relay cabinets tipping over. So you have wouldn't -- if you credit that, then the risk you've shown here of 6 times 10 to the minus 5 may be quite smaller.

MR. ERICSON: In one of our modifications we do go in and tie those down and show you specifically the change of risk.

MR. MARCHESE: Modification is consistent with what A-46 has recommended.

MR. CRAMMOND: Here it is.

(Slide.)

This is seismic also. And it shows the core melt probabilities, given that you apply the modifications, and it's down an order of magnitude. And the modifications are essentially replacing the battery racks and safety class nitrogen bottle and tie down the buses and inverters, and alternate source coming from the spent fuel rather than the refueling water storage tank and the appropriate timing to do that.

So, it can be solved. And I guess you are right, there is a slight difference in our approach there. This one we could address if we knew what to do and we did it. In the case of the pump seals, we weren't even sure whether that was going to be an issue or not. We decided if it were to be important it would get solved. If it weren't

important than we didn't need to address it anyhow.

MR. MICHELSON: How did you deal with the nonseismically qualified equipment, whose failure, particularly in multiplicity, could lead to further difficulties with shutdown during these very large earthquakes that you are predicting -- trying to calculate here? How did you deal with failure modes and effects of nonqualified equipment?

MR. ERICSON: The seismic analysis has done a fairly extensive look at individual component fragilities where those show up at the cut sets.

MR. MICHELSON: Well, did the interactive effects of those components even enter into your fault trees? A water tank on the roof will fall through the roof and so forth -- you have considered all the effects of the nonqualified --

MR. ERICSON: I'm not going to be so bold as to say "all." I know better than that. Yes. Commonly located failures in a room and that sort of thing.

MR. MICHELSON: Okay. Now, in dealing with that question, then, did you consider the possibility that more than one thing will happen at a time during the earthquake to nonqualified equipment? In other words, not just one tank will rupture, but perhaps the tank will rupture and several other pipes will break and so forth in the process,

or did you deal only with one at a time?

MR. ERICSON: I don't know the detailed answer to that.

MR. MICHELSON: That's generally where you get into the difficulty. Dealing with one at a time is usually not too bad to handle, but dealing with several of these at once, it can be difficult.

MR. ERICSON: This is Steve Hatch from our Staff.

MR. HATCH: Components were linked, fragilities of components were linked in the seismic analysis. If two components would see the same acceleration and had the same fragility, their the failures would be coupled in the analysis.

MR. MICHELSON: Perhaps you answered the question. Maybe I didn't understand it. In essence you are saying that you looked at the possibility of failures in various parts of the building occurring concurrently?

MR. HATCH: Yes.

MR. MICHELSON: Okay. The other question you get into is some of these failures might involve equipment, oil lines and so forth, which then lead to fires as a result of these failures of nonqualified equipment. Have you dealt with the fire consequences in this analysis?

MR. HATCH: I'd say in general we did not look at seismically induced fires or seismically induced floods

for the most part.

MR. MICHELSON: Wait a minute, I thought you just told me you dealt with tanks falling and so forth. I hope you dealt with the contents of the tanks as well? You know the flooding consequences of these failures is perhaps the more troublesome one in many cases, particularly when water gets around into electrical equipment that you are having to depend upon. I assume that you chased the water and not just chased the pipe? If you haven't, you haven't really dealt with the issue at all, I don't believe. If you are just considering it a missile only.

MR. HATCH: The only case where I know that came up was the Cooper analysis; we did have a damn upstream of the plant failing due to a seismic event, but I think that was the only case where we looked at --

MR. MICHELSON: Within the plant? If, for some strange reason had you a nonqualified water pipe running through the control room and ruptured and dumped the water onto the bench board, you certainly would want to deal with the consequence.

MR. CRAMMOND: We looked at that rupture in the flood whether caused by seismic or not.

MR. MICHELSON: The problem is in the past we have dealt with these questions one at a time. A long time ago it was asked to be dealt with but only one event at a

time, and now in the seismic case, several of these nonqualified pieces of equipment are going to be challenged concurrently. I was kind of wondering what kind of assumptions you make concerning the numbers of such failures you have to deal with and how you handle this in your analysis?

MR. CRAMMOND: Let me ask Gary Sanders, who is also working on this project doing the Turkey Point analysis, if he can add anything to that.

MR. SANDERS: Gary Sanders. Internal analysis goes through -- internal flood analysis goes through and looks at each specific water tank, where it is, where the tanks run, what components are vulnerable, what cabinets are vulnerable and identifies vulnerabilities throughout the plant. Some points, li:. Turkey Point, everything sits outside. If you have a seismic-induced flood, it doesn't go anywhere except back into the Atlantic Ocean, so they can couple them any way they want and not get --

MR. MICHELSON: Okay. This is the standard approach to dealing with pipe breakouts the containment. You looked at these individually. My question wasn't that, but rather: In the case of a seismic event, now, how many of these breaks do you assume are going on concurrently, and that you do the analysis of the consequence on? When several of these breaks happen at once instead of just one.

MR. SANDERS: From the internal flood analysis they know which pipes are going to affect which cabinets, components. In the seismic analysis, as Steve Hatch indicated, they have fragilities on several pipes and they looked at common mode failure of several pipes at one time. I don't know what the number of pipes are concurrently, but I know they do look at concurrent failures of pipes.

MR. MICHELSON: I guess I can find that somewhere in the description. I wasn't able to find it, but I assume you can find me some material to read on how you deal with the assumptions concerning the number of concurrent failures during an earthquake. If you just tell me where to read it, I'll be in good shape.

MR. MARCHESE: There is an unresolved safety issue, A-17, systems interaction, that we have been struggling for a couple of years with this very question you are asking. I think the conclusion they are coming out with is it's pretty difficult, based on the analytical tools that are available, to handle these kind of things.

MR. MICHELSON: I agree with you completely, but I thought I was getting answers like you were handling -- I'd like to read about it. And if you aren't handling it, just tell me so we know what the assumptions are in the study.

MR. MARCHESE: We are approximately handling it,

but I would point out that one of the options that we're handling that would handle these kinds of things is the dedicated system that's complete self --

MR. MICHELSON: I'm just trying to determine what the scope of your study is and how you handle this particular issue, that's all.

MR. CRAMMOND: I think the answer to this is that I would like to think that we have but I'm not sure. I don't want to say that we have because I'm not sure. But we had a rather long seismic analysis appendix, and I just don't remember.

Gary? Can you add to that?

MR. SANDERS: On the internal flood analysis the plants we looked at so far, we haven't found more than two or three places in a plant where there is large enough water sources to damage the equipment. It usually comes down to two or three specific places. So in the seismic analysis I know they are looking at two and three pipe breaks simultaneously. Beyond that, if they have 4100 pipe breaks, the other 97 don't seem to be affecting safety grade equipment.

MR. MICHELSON: I would strongly urge you read your LERs more currently. There's numerous LERs of late where they are broken, just leaks, and they get into the electrical equipment and strange things happen, relief

valves open, a number of things.

On a probability basis this ought not to be happening very often if we know that most all breaks will not cause of any of these consequences. So I'm really wondering how good we understand the effects of water getting into our systems.

MR. WARD: Carl, I think at the onset of this program in A-45 I think there was agreement that the analysts were going to use the existing technology for ERA and FMMEA, and accident analysis, source terms, but they weren't going to be able to or be responsible for advancing the state of the art in each of those areas. That's just too much. We'd never get on with the issue of A-45.

MR. MICHELSON: I don't disagree with that provided they make it clear that this is what they are doing. When you come to your bottom line you should always indicate what some of the things are you have left out. You can't quantify them, obviously, because you don't know how to yet, but it's very important to indicate what your assumptions are on earthquake effects when you start talking about 4 or 5 SSE.

It's crazy to talk about such big earthquakes without recognizing that it's only a very limited study of those effects they have done here; mainly it's kind of a structural study, apparently.

MR. MARCHESE: I think that's a good point. We'll try to do a better job on qualifying what the analysis includes and what it doesn't and specifically giving -- what we are giving in the nature of assumptions.

MR. CRAMMOND: I'd be surprised if it's not discussed in there, but I don't remember.

(Slide.)

In the fire analysis there were two rooms that were vulnerable: one the aux pump feed room and the other the 415 switch room. Those reduce the probability from the 10 to the minus 5 range to the 10 to the minus 7 range, those modifications.

MR. MICHELSON: In looking at vulnerability to fire, did you look at vulnerability to inadvertent actuation of the fire protection features that might cause a loss of the functionality?

MR. CRAMMOND: I don't remember that.

MR. MICHELSON: Because, again we have seen some inadvertent actuations in the last year or so which lead to equipment not functioning the way you might have thought.

MR. CRAMMOND: I believe we did consider that in the internal flooding; in particular, in the pump house. There's a fire main that runs across the top of the pump house and a rupture in that line spraying on the service water pumps could fail them, and that's the next

vulnerability.

(Slide.)

MR. MICHELSON: Fire protection itself in inadvertently actuated in any area of the plant where deluge systems are used, which I find are a little more prevalent than I thought: When a deluge system is set off equipment becomes involved. The real danger is during an earthquake or extensive fire, deluge systems will be set off in an area where there are no fires. If this were to happen, and it's not qualified not to happen, you've got to deal with a far more extensive loss of equipment than you might have first thought, and therefore these probabilities of core melts and so forth, I would think, might change.

MR. CRAMMOND: I believe that was covered in the internal flood analysis.

MR. MICHELSON: I would like to read about it because it's an important subject. If you just, again, get me the reference where you cover the inadvertent actuation of fire protection and how you deal with that on a probabilistic basis, that would be very helpful.

MR. MARCHESE: In terms of a quantitative treatment, if it's in the data base we have attempted to treat it quantitatively. However, I think you are bringing up a number of events that either the data doesn't exist or the analytical tools are not available. In this case, we

are going to have to fall back on a deterministic treatment of these things.

MR. MICHELSON: Sure. But that's what I'd like to read. The paragraph that explains: Here are the things we can't deal with and it could have a significant effect on bottom line. Without that people read: Gee, fire is no problem, flooding is no problem, because they only see a piece of the problem.

MR. MARCHESE: I think we have to do a better job on giving you the limitations on the quantitative treatment of these things.

MR. CRAMMOND: I'm not sure that we haven't discussed some of that in fair depth in chapter 3, and certainly in the appendices. But it's been some time since I read them, and I don't remember, but I feel quite sure that they have looked at breaks. Every room where there's a possibility of something failing they looked at the pipes in that room and looked at a break or inadvertent operation of something or test and maintenance problem, a valve open or something of that sort, that would lead to internal flooding or spray. But not necessarily two rooms at one time.

MR. MARCHESE: Okay. Let's leave it. We'll get back to you on that.

(Slide.)

MR. CRAMMOND: This is the viewgraph showing the internal flood analysis where, effectively, it was the firewater header in the service water pump room that was the culprit and, by increasing a shield barrier, it was made to be negligible.

(Slide.)

Now, when you take all the internal vulnerabilities and the external, or special emergency vulnerabilities, it turns out that we had 31 identified vulnerabilities distributed as shown here, and 16 of these were considered in the impact analysis that -- that wasn't necessarily the top 16, but it was top 16 based on those that we could do something about. Those that we couldn't or didn't know what to do about, didn't get carried into the impact analysis.

MR. MICHELSON: Before you leave that slide, could you tell me to what extent you looked at the vulnerability, perhaps, due to loss of room cooling, and particularly in sensitive rooms that might contain solid state control circuitry and how you dealt with that on a probabilistic basis, because that, again, has been showing up in LERs on a couple of occasions where they lost room cooling and, sure enough, funny things do indeed happen.

MR. CRAMMOND: As a general principle on all our analyses we model room cooling if it's deemed to fail

anything in the room.

MR. MICHELSON: How do you do that, because you have lots of possibility now on solid state control panels as to failure modes and effects. In fact the experts can't tell me, they can't even predict which way circuits are going to flop.

MR. CRAMMOND: There are only certain rooms that have cooling. If it's in the open area --

MR. MICHELSON: In dealing with the rooms that have this potential question, how did you incorporate that in your analysis? Or did you not incorporate it? That's a good answer. I just would like to know, do you deal with that question?

MR. CRAMMOND: If, for example, it's the control circuits to a pump and those control circuits are in the pump room, for example, and that pump room requires cooling, then in the case that says "pump fails" underneath it says "LOCA faults to the pump, test maintenance" and so forth, and room cooling. Then you develop room cooling underneath that.

MR. MICHELSON: In a solid state control cabinet room -- this is a room which contains half of all plant control systems in some cases, and it has a very critical ventilation requirement, then. If that were to fail there's not just pumps involved there, half of everything

in the plant is potentially involved.

Did you deal with that particular question?

MR. ERICSON: As an initiating event? No. No.

MR. MICHELSON: Loss of room ventilation, and, if not, is this a potential concern? You must have had some basis for not dealing with the loss of ventilation.

MR. CRAMMOND: In conjunction, assuming that there is a room like that in this plant --

MR. MICHELSON: And there may not be in Point Beach. I don't know.

MR. CRAMMOND: I believe that's true. But it was considered for -- in the model of the systems that it applies to we didn't consider it as an initiating event, just as we didn't consider, for example, a service water failure as an initiating event. There's this limitation on how many things we could try. That's a good one.

(Slide.)

I won't go through all this, but this is a list of the modifications that were proposed for the internal analysis.

MR. ERICSON: They need to skip a page or two here or there.

MR. CRAMMOND: Yes. You have to skip a page or two over and then come back, but all we are doing here is depicting the fact that we had seven vulnerabilities that

we proposed modifications to. Then when we get to the alternatives, the alternatives will be different combinations of these modifications in conjunction with external event modifications.

(Slide.)

In fact, here is the constituents of the four alternatives. The first alternative was to do all of these, including the dedicated diesel generator startup battery, RHR pump cooler valve improvements, and backup air supply for PORVs -- that's a seismic one -- and so on.

And then alternative 2 was all the above plus an additional condensate storage tank.

Alternative 3 is all the above from 2 and 1 plus a -- the diesel generator exhaust, stack -- that's a wind vulnerability, and independent diesel-driven aux feedwater pump and so on.

And then, last, alternative 4 is the add-on shutdown decay heat removal system, all by itself. Nothing else.

(Slide.)

Now we get to the chart that you have probably already come to. This has always caused some difficulty in interpretation, but essentially what we are saying here is: These are the vulnerabilities that we are addressing out of the total, some of which we can't address.

These are the four alternatives. And alternative 4 is just an add-on shutdown decay heat removal system. That's not a vulnerability.

Alternative 1 says if you modify internal 1, which is the failure to switch over to recirculation, and internal 2, 4, and so on -- if you make all those modifications, that combination is alternative 1.

Alternative 2, then, is effectively, all the same ones we had before, plus the station blackout modification.

So, each of these columns represents the modifications to the vulnerabilities identified on the left. And that constitutes the alternative, or a solution to the potential plant problems -- whatever you might determine it.

MR. WARD: That's just another way of stating what you had on the previous page.

MR. CRAMMOND: That's right. It's a chart that caused some difficulty --

MR. WARD: It does because your alternative doesn't fix anything, is the way it looks. I know it does so that has to be my next question. If you won't put Xs under alternative 4, will you tell me which one of those vulnerabilities you believe the add-on shutdown heat removal system --

MR. CRAMMOND: If you look at it, shutdown

capability does something for everything at one time: wind, seismic, internal flood, everything -- across the board. When you get your bottom line number, the add-on probability multiplies times it. And it's essentially like a point 1, approximately. So you improve everything across the board, and that's one of the beauties of the add-on for those people that are add-on advocates. It applies to all the vulnerabilities at once, whereas in this alternative you only fix the ones where we have the X, because that's the one where you applied resources, money, to shore up the battery racks or put another pump in or whatever.

MR. EBERSOLE: Patchwork.

MR. CRAMMOND: That's one term. Yes.

MR. ERICSON: You are correct, we could have Xs the whole way down the column, just like we do for 3, and then a big plus sign and say "others."

MR. CRAMMOND: This means a specific fix, like adding another pump. This means another building with its internal systems, totally separate from these, totally different.

MR. WARD: One big patch.

MR. EBERSOLE: The model is a little barn which is nothing but a bunch of patches that hold it together.

MR. CRAMMOND: That's certainly one interpretation, and when we get to the value impact

analysis we are going to look and see just what you get for alternatives 1, 2, 3 versus 4 and see if it's beneficial. It may turn out that some of those are beneficial but they still don't do the whole job but they are worthwhile.

MR. EBERSOLE: As you get deeper and deeper into the interdependencies and complexities of them, doesn't it occur that sooner or later you are dealing with an infinite source of problems and sooner or later you have to walk away from this crud, so to speak, and step off into a new environment where things will work.

MR. CRAMMOND: You can think of it as a pyramid. Can you address the top one, then top two or three or four, and as the pyramid gets wider and wider, you find you get to the point to make one more incremental improvement you have to fix a whole bunch of things, and then it becomes awkward to do anything.

MR. EBERSOLE: And then you pick up with the notion, as we do on an airplane, that is a parachute is what you need, or a lifeboat on a liner, rather than trying to find how many more dozen ways it could fail.

MR. CRAMMOND: Our charter was to look and see what we could do on an individual modification basis and compare that to the add-on. I wouldn't want to defend either one. We are just trying to show you what you get.

(Slide.)

So, if you look at core melt probability before the modifications -- this includes all the external and internal -- 3.6 times 10 to the minus 4, then you look at the various alternatives. The first alternative, 1.4 times 10 to the minus 4 all the way to 3.6 times 10 to the minus 5, which reflects an order of magnitude improvement for the shutdown decay heat removal system add-on.

Now, that's the output from the analytical analysis, the value analysis.

The impact analysis, we get cost of equipment and installation, and replacement power costs, annual operation and maintenance, inspection cost, all in 1985 dollars, and the radiation exposure involved in the installation in person-REM. These are going to be the impact measures.

Again, here the core melt probabilities -- 3.5 times 10 to the minus 4, broken down by internal and the various external --

(Slide.)

-- vulnerabilities. This breaks down the modification, showing you what the it was before and after. I say "approximate" because I didn't go through and break out all the cut sets and identify exactly what the improvement was. This was an estimate. It's a good estimate, however. And there's other things that aren't in

here. So if you add those columns up you wouldn't get the number that's here.

MR. EBERSOLE: That does not include the environmental dependencies, as you said earlier? You said you did not accommodate such things as environmental capabilities of PORVs or --

MR. CRAMMOND: Or qualifications of components? That's right.

MR. EBERSOLE: Since those can affect the multiple systems, they are -- tend to be compounded?

MR. CRAMMOND: That's right. And we get in the rut of calling this our core melt frequency. We have to always remember that interfacing systems, large LOCAs, ATWS, things that were specifically included in our scope of work aren't in there, so this is not the total core melt problem event, it's probably something on the order of 40 percent to 60 percent. I don't know.

MR. EBERSOLE: It would be well to put an asterisk on that and parenthetic addition in the bottom of the page wherever you use it, to keep it from being read out of context.

MR. CRAMMOND: That's a good idea.

(Slide.)

The impact analysis, I won't spend any time on this. This simply tells you that what they did was,

initial design report, then they show up at the plant prepared with how they plan to do things and then try to be congenial with the plant people because we really aren't saying we are going to rip things out and change things. We are saying we are just doing a study.

We have a site inspection plan. We go out and do that the at the plant visit, we pick up local costs, look at congestion in work areas, things of that sort, and then they come back and come up with a final modification plan and get numbers like these.

(Slide.)

Now, for the four alternatives, these are the engineering and installation costs, operations and maintenance, and the installation dose, occupational dose.

As you can see, the add-on has the greatest occupational dose because they have to get into the containment to do it. If we look at the summary of the core melt probabilities for the alternatives, starting with the base case --

MR. WARD: Wally, I guess you don't include some ongoing, annual occupational dose due to additional equipment inside the --

MR. CRAMMOND: Yes. It's looked at. That's right. In fact, the replacement power was also zero because in this particular analysis -- it wouldn't hold

true under other plants necessarily -- they determined it could all be done on routine outages. In this case we are showing the delta core melt probability between the base case in alternative 1, base case in 2, 3, and 4. And this "I" was the improvement factor in core melt probability from the base case. These numbers will be used in the value impact analysis, as all of these will be used, as positive impacts and negative values.

(Slide.)

This is simply showing the CRAC output, low bound, base case, and upper bound, for each of the alternatives. If you take the difference between alternative 1 in the base case you'll get the averted off-site dose for alternative 1, and so on. Lower bound, central, and upper bound. Those are --

MR. ERICSON: Wally, you might point out that these three source terms, again, are arbitrary for terms of our study. Because there's an ongoing discussion about what are the source terms, we simply said let's take the reactor safety study and two variations thereof, arbitrarily, and display them. We are not arguing that one is better than the other. There they are.

Then, the averted, that's the product of the remaining life, times the annual, times the core melt and everything cranked into it.

MR. CRAMMOND: Not yet.

MR. ERICSON: That's not the annual, is it?

MR. CRAMMOND: That's not the annual. That's just for the accident, and then it's all cranked in.

MR. WARD: For the life of the plant? Isn't that what those numbers are?

MR. CRAMMOND: No. I think this is per accident.

MR. MARCHESE: Per reactor year.

MR. CRAMMOND: You multiply it, per accident, and take into consideration the remaining plant life and then that comes out in the impact analysis. This is just the raw data that goes into it, just like impact analysis raw data and core melt probability raw data. We have set the stage with all the raw data that comes into the analysis and then I will jump over all the details, rather than get bogged down in all the formulation of how we arrive at the value impact analysis. This is written up in great detail in the report.

(Slide.)

I think it's in chapter 8, and also in appendix L.

MR. WARD: Wally, I'm sorry, could you go back to the previous one, please?

MR. CRAMMOND: Sure.

(Slide.)

MR. WARD: If I look at the bottom section there,

alternative 1, 100.8. That's the averted off-site dose in person-rem per what?

MR. CRAMMOND: Per accident.

MR. WARD: For what accident?

MR. CRAMMOND: Dave? Enlighten me.

MR. ERICSON: The expected value of the population dose, the core melt probability is cranked into that; right?

MR. WARD: But it has to be per accident or per reactor year or lifetime or --

MR. ERICSON: Expected values per year.

MR. CRAMMOND: I did the cardinal sin here, I didn't put the units on.

MR. WARD: It looks looks reasonable for an accidental probable annual averted off-site dose for all accidents or something like that. It looks like a reasonable number to use for that, but it has got to have some other definition than what you've shown here.

MR. CRAMMOND: Well, perhaps we shouldn't take the time here. Without looking further, I think it's the averted dose per incident.

MR. WARD: For what kind of accident, though?

MR. CRAMMOND: The core melt. And then you have to multiply that by the probability of the core melt and then you look at the remaining life of the plant to come up

with the actual measure of dose averted and then come up with a value or impact, whether it's a negative value or positive impact or whatever.

I could have viewgraphs showing all the equations, but we didn't think that that would be of interest.

MR. MINNERS: Wally, if you multiply that times 10 to the minus 5 and 100 reactor years -- nowhere.

MR. WARD: That's a pretty small number.

MR. MINNERS: That's 1/10th of a man-rem.

MR. HATCH: It has the core melt probability in there already. That's the averted dose per reactor year. It has the core melt probability already cranked in, and you have to multiply it by the remaining lifetime to get the lifetime dose.

MR. CRAMMOND: It has one of the factors in, not the other. I couldn't remember that. You get so bogged down in doing the arithmetic, sometimes you don't remember the details.

Thank you, Steve.

MR. CATTON: In this report where do I find a description of how you arrived at your costs for various alternatives?

MR. CRAMMOND: I think it's appendix J.

MR. CATTON: In the impact analysis?

MR. WARD: Yes.

MR. CRAMMOND: It's also described or summarized in chapter 7, I think.

MR. ERICSON: 6.

MR. CRAMMOND: 6.

MR. DAVIS: Wally, when you say .1 of RSS, you don't apply the .11 to the noble gases, do you?

MR. CRAMMOND: No.

MR. DAVIS: So it's not really 10 percent of the their entire release spectrum of radionuclides?

MR. CRAMMOND: Steve, do you want to say something about that?

MR. HATCH: We didn't change the noble gas release, but all the other isotopes were manipulated one way or the other and the central estimate. The upper bound is essentially WASH-1400, and then .3 and .1 of the isotopes of other than noble gas.

MR. DAVIS: There was also one issue you said made a big difference, that was the discussion with the Staff about the CRAC analysis.

MR. ERICSON: That's coming.

(Recess.)

MR. WARD: Mr. Crammond, if you will continue, please?

MR. CRAMMOND: I was just about at the punch

line. This is, for the alternatives, this chart shows the change in core melt probability which we showed you before an averted off-site dose and on down to the value impact ratio and net benefit in dollars per man-rem, based on off-site cost only and off-site and on-site costs.

In particular, if you look at the dollars per man-rem, you find if it's just based on off-site costs, it varies from $2- to $13,000; and in the case of based on off-site and on-site costs, $833 up through $12,000. So it becomes more beneficial, essentially.

(Slide.)

Obviously, add-on decay heat removal system is much more expensive in terms of dollars per man-rem than are the internal, or the other alternatives. However, the improvement in core melt probability may not be what you want with the other alternatives. This chart simply gives you the comparison between the alternatives and what you buy with each of the alternatives.

All the equations from which these were developed are in the report, with the appropriate plant lifetime, and we have positive and negative values and positive and negative impacts, depending on how the value impact handbook prescribed.

We can come back to this, but I want to show you a couple of other things first.

(Slide.)

Before I show you what we did -- I have to put the microphone on here -- before I show you what the results change to when you don't consider interdiction and contamination in the CRAC model, I want to show you the sensitivity analysis that we did, very briefly.

This is just those sequences that apply to the particular thing we are talking about. There's other sequences and you add those sequences to this and you get the total core melt probability in the context of what we studied without ATWS and large LOCAs, for example, but just the feed and bleed sequences were 3 times 10 to the minus 5 with feed and bleed. That was our base case. If you take the feed and bleed out those sequences, increase by 2 times 10 to the minus 4.

If we look at the secondary blowdown we find -- this is with secondary blowdown, which was our base case, and without secondary blowdown, it increases 5 times 10 to the minus 5. It's not nearly as significant as the feed and bleed.

And then, if you look -- this, incidentally, although I haven't said it here, was with recovery. I didn't apply recovery to this one because it didn't look as though it was going to make a big difference.

If we look at the feed and bleed with the PORVs

blocked, that was our base case. If you say what happens if they were unblocked, if that's the way the plant were running when the incident occurred, then you would have an improvement of 1 times 10 to the minus 5.

MR. WARD: I don't understand that. With the PORVs blocked, in that case base -- that number is different from the other. Tell me what you mean by that.

MR. CRAMMOND: That's because I only considered those cut sets, or sequences where this made a difference, just the sequences where it made a difference. So this is a different set of sequences than this and a different set than this. So those are not the same sequences.

I didn't go back and do the total core melt probability. I just looked at those sequences where it made a difference.

MR. WARD: Okay. I understand that. When you say "PORV blocked," that means just opened and left open?

MR. CRAMMOND: No. The block valves are closed. They run with the block valves closed.

MR. WARD: Okay. With the normally closed block valves.

MR. CRAMMOND: Normally blocked, so that the PORVs are essentially negated for relieving pressure in the short time situation.

MR. EBERSOLE: Could you comment on the --

MR. WARD: But have you credited -- let's see -- where do you -- the existence of a PORV brings with it a certain amount of bad news and potential for a LOCA due to PORV leakage. Is that factored in here in any way?

MR. CRAMMOND: No. Just the effect on feed and bleed. What improvement would you have on feed and bleed with the PORVs unblocked? Because, if you have to open them, then there's a likelihood that they won't open.

MR. WARD: Right.

MR. CRAMMOND: The blocked valves, that is.

MR. EBERSOLE: Could you explain the merits of secondary blowdown in the context of pressurizing and cooling the primary as well as enabling water from a variety of sources being put into the secondary?

MR. CRAMMOND: Where we use that --

(Slide.)

-- is in this branch here. We are saying that given that aux feedwater system is operable, if your high pressure injection system fails, then, in order to inject, if you can depressurize -- and that's the secondary blowdown; event X we call it -- if you are able to depressurize by opening up the PORVs, or anything else, using the aux sprays in the pressurizer, then you can get to the pressure where you can use the low pressure system. So that becomes a backup system.

If you can do that, then you have that possibility and that's --

MR. EBERSOLE: You said "using the aux sprays in the pressurizer." What if you don't have them; because they are derived from the main coolant pump output, aren't they?

MR. CRAMMOND: No. The aux sprays come from the CCV CS. If you don't have them then it's cranked into the model for X. We model both the main and aux sprays and CVCS, which contributes to the aux sprays, and the PORVs. It's a combination; the criteria for success depends on so much of this and that.

MR. EBERSOLE: We learned from the Palo Verde discussions that if you don't have the sprays, it's -- depressurization of the secondary doesn't produce a substantial depressurization of the primary for quite a long time.

MR. ERICSON: That's correct. That's true. And the Los Alamos studies on the other PWRs bear that out. A long, slow process.

MR. CRAMMOND: This is depressurization of the primary we are talking about.

MR. EBERSOLE: What it means is that you would continue to have leakage over that long interval, if that was the problem?

MR. ERICSON: Yes. If you can't depressurize the primary with your sprays or with PORV, that's right. You are still going to have cross leakage.

MR. CRAMMOND: You lead to core melt, then. There's no alternative. If you don't have X, or it fails, you go to core melt.

MR. EBERSOLE: What is the time factor you looked at here? Given the fact you don't lose pressurization in the primary no matter how much you bleed the secondary, except for, you know, after 12, 15 hours --

MR. CRAMMOND: We are bleeding the primary.

MR. EBERSOLE: No. If you are bleeding the secondary to bring it to low temp and pressure, it doesn't reduce the primary for many hours so it would continue to leak at high pressure.

MR. CRAMMOND: That's right. If you can't apply a primary blowdown, then it's straight to core melt.

MR. EBERSOLE: I see. Okay.

MR. CRAMMOND: That would be the case where you don't have secondary blowdown. Then, if the high pressure injection system fails, then even though the aux feedwater system is operating then you are losing inventory and you lead to core uncovering.

MR. EBERSOLE: Are any of these studies valuable from the point of view of "what else"? You have the case

of failure in the PORVs, analogous to having no PORVs at all, which is Palo Verde. One can deduce from your studies what state Palo Verde is in. They don't have any PORVs.

MR. CRAMMOND: Not precisely.

MR. ERICSON: You have to be careful with that statement. We are showing on all of the PWRs the very thing that he just had up. Go back to your other one.

(Slide.)

MR. ERICSON: You can see the benefit in the risk space of the capability to feed and bleed. Again, this comes back to the question we talked about before, that this is in risk space only, this doesn't address a lot of the environmental issues. If I'm opening PORVs and dumping into containment, you have all those problems to contend with. But this says in this particular situation the benefit is about 2 times 10 to the minus 4 to be able to feed and bleed, and Point Beach has the procedures and said they would if they had to.

MR. WARD: Wait a minute. Jesse's concern about the environmental -- what problem is in the risk space. He's worried about that because he thinks you may not have an accurate estimate of the risk if you don't --

MR. ERICSON: Right now I don't know how to quantify the degradation in PORVs in risk space. Don't say because it's 2 times 10 to the minus 4 in this study,

particular limited study for Point Beach, it's the same number for Palo Verde, because there are other systems that have to be considered as you are doing that analysis. But, clearly, here there is a benefit. No question.

MR. MARCHESE: I think if the final resolution of A-45 says that bleed and feed is the option to go forward with, I think we would have to address the environmental qualification issue as part of that.

MR. EBERSOLE: Yes.

MR. MARCHESE: I think my viewpoint on that is that we would have to insist that the valves have the capability to operate in the environment that that's created.

MR. EBERSOLE: And probably not operated on sustained low voltage, but merely go to a position and stay there and be recoverable to another by motor-operated valve. Get rid of these funny things called PORVs.

(Slide.)

MR. CRAMMOND: Let me refresh your memory. This is the base case result where, from off-site to on-site, where you run from less than $1000 per man-rem to $12,000.

If we now consider the case where we do not have interdiction and decontamination and we do the CRAC2 code and go through all the calculations, all the same charts that we had, that I didn't show you, leading up to that

final chart I just took off, we find --

MR. WARD: Is this table 9.9? Or what?

MR. CRAMMOND: This is table 9.9. That's correct.

MR. ERICSON: Last page.

MR. CRAMMOND: I'm going to wipe off the 1, 2, 3, 4, on the other side, 1, 2, 3, 4 -- now we see, whether it's off-site costs or on-site costs, the dollar figures are, for dollars per man-rem, are much, much lower. That is simply if you don't have interdiction and decontamination, then everything looks much more beneficial.

Now, whether that's a reasonable assumption, that's another issue. But we did what we were asked to do and looked at what it would be like if we didn't have interdiction and decontamination.

MR. ERICSON: But everything else is done the exact same way.

MR. CRAMMOND: Installation costs, et cetera, same delta core melts for each alternative. So that's a big difference.

MR. WARD: Okay. Wait a minute. Go a little slower here. Let's compare some numbers.

MR. CRAMMOND: Okay. Let's see if we can put those on the same time.

MR. ERICSON: Lock at 9.6 and 9.9. Slide up a

little further, Wally.

(Slide.)

MR. CRAMMOND: Higher? If we look at the central values, which I tried to put in orange here for off-site and on-site combined, we have $23 per man-rem versus 833; 64 versus 2335; 111 versus 3990; and 308 versus 12,104.

The reason is that you are finding that you have much, much larger man-rem. In fact, I have those charts.

MR. WARD: They are dramatically different. But is there any reason, I mean, to consider no interdiction or decontamination as an alternative? What's the reasonableness of that assumption?

MR. CRAMMOND: Andy, do you want to address that?

MR. MARCHESE: I'll try. It's going to be difficult.

Some members of the Staff have highlighted this to management in terms of making sure that everyone understands how the off-site releases are calculated, via the CRAC code.

The CRAC code presently has hard-wired into the code, models on interdiction and decontamination. As you know, these are off-site mitigation measures.

It has been questioned as to whether or not, really, it is appropriate in a program such as A-45, that's

examining changes internal to the plant, that is preventative measures internal to the plant, as to whether or not it is appropriate to be mixing the value of those changes in with the value that you get from off-site mitigative responses.

What is happening is when you include interdiction and decontamination into the calculations, it is distorting the true value of a change, internal to the plant. And what you find is that you have a real insensitivity to internal changes at the plant.

That is, you look at the base case -- okay? -- and then you make a modification to the plant. You add a pump or system or whatever, and you calculate the value of that change, that is reduction in core melt frequency, reduction in off-site releases. Well, that delta is very much influenced by whether or not you have interdiction and decontamination in your calculation. And what some people are saying is that you are really distorting the true value of an internal change to the plant, that is a preventative measure.

Other people would argue that in the final analysis, there is really going to be some off-site response. The question is: What is it going to be and is the CRAC code modeling really realistic?

So, for the time being we have highlighted this

to management. We have told them there is a significant effect on the results, in terms of value impact; and for the present what we are doing here is calculating it both ways until we get some guidance on how we should go forward on this program.

MR. WARD: Okay. Presumably, the CRAC code includes some cost for the interdiction and decontamination activities, as well as the reduction in person-rems. So this is coming out with sort of a net cost or net benefit or whatever? But the question is: How well is that done? It's so important it shouldn't be just buried in the results.

MR. MARCHESE: Right.

MR. EBERSOLE: Does the cost to interdiction and decontamination appear to be cost beneficial?

MR. MARCHESE: It's very cost beneficial.

MR. WARD: Better than another pump?

MR. ERICSON: If the base numbers are correct.

MR. MARCHESE: But when you talk about interdiction and decontamination, you talk about other people getting involved making decisions other than the NRC. You have state and local officials and the government involved. Whether or not the CRAC code is really modeling what is actually going to happen is questionable, too.

MR. MINNERS: I would like to make one

clarification. I don't know whether you meant that, Mr. Ward.

The numbers, the dollars that he's showing up there do not include, directly, off-site property damage. Interdiction -- in any of those costs. He's taking basically the on-site costs for making these changes or whatever economic benefit you get from these changes and then he's multiplying man-rems, he's comparing that ratio to $1000 per man-rem. So nowhere in those numbers do you see dollar values for off-site interdiction, evacuation, those kind of costs.

MR. CRAMMOND: Off-site population dose and the on-site costs averted become a negative impact.

MR. MINNERS: That's the impact.

MR. EBERSOLE: Aren't off-site decontamination and any -- well, I find it a little troublesome to talk about interdiction. Aren't they fraught with all sorts of legal claims and a host of costs that are not envisioned in the current code?

MR. CRAMMOND: I'm sure that's true.

MR. EBERSOLE: It certainly is not going to be less than the CRAC code --

MR. CRAMMOND: I can't speak with any authority on the CRAC code.

MR. MINNERS: But you are not using the CRAC

code estimate. You are using $1000 per man-rem. You are using that as a surrogate for health costs and property damage and all of that kind of stuff.

MR. ERICSON: Except in the original -- in the CRAC2 estimate, we are computing the dose which cranks in areas set out for interdiction, area decontaminated.

MR. WARD: Okay. So there really isn't any expense of decontamination factored into this; you are just crediting what could be done as far as reducing off-site dose.

MR. CRAMMOND: Just keep the people out of there for a certain amount of time.

MR. WARD: There's certainly an economic penalty associated with that.

MR. ERICSON: You can go back to the CRAC code and get those numbers out, if you choose that output. It will give you the modeling they have done.

MR. CRAMMOND: We were asked just to use this one measure, the population dose out to 50 miles as our measure.

MR. WARD: Okay. So even this -- this isn't really a fair display of the real cost/benefit of interdiction then, either, because this isn't explicitly showing the economic penalty associated with decontamination or interdiction.

MR. CRAMMOND: That's true.

MR. MINNERS: The criterion that's used in the CRAC code, if you get a 30-year dose of 25 rem or greater, you get interdiction or whatever -- that's somewhere near the optimum for economics, if you value life more in the $100,000 range rather than in the $1 million, like $1000 per man-rem.

MR. EBERSOLE: I would think you would find numerous productive enterprises that have to be shut down which would bring about additional costs.

MR. CRAMMOND: There certainly are other measures. If one wanted a full impact or economic impact you'd have to consider the property damage.

MR. MINNERS: You can go look at the report and that will give you those kind of calculated off-site costs, okay? If you are interested in that. These numbers do not explicitly include those costs, only indirectly through the $1000 man-rem surrogate are those costs included. If you want to know what those costs are, go look at the strip calculation for Point Beach. I don't remember what the numbers are. I'll give you the current estimate --

MR. EBERSOLE: It would be very much site-dependent, wouldn't it?

MR. CRAMMOND: Yes. Very much. We wouldn't contend that this is a complete analysis. It's what we

were asked to do as a measure, and there are many measures you can use.

MR. DAVIS: It seems, though, like the NRC has got to make some kind of decision on whether modifications to the plant are warranted. It's not clear to me on what basis that decision is going to be made.

MR. MINNERS: It's not clear to anybody else, either.

MR. DAVIS: I guess that answers the question.

MR. EBERSOLE: If the plant is in the middle of nowhere and the employees can run off and leave it --

MR. WARD: You are suggesting, for starters, you think a more comprehensive look at off-site costs might be appropriate? Is that what you are saying?

MR. DAVIS: It seems to me that the picture is incomplete on off-site cost and on the cost/benefit evaluations that need to be made.

MR. WARD: Apparently those data, at least insofar -- I don't know what CRAC calculates. Warren is saying there are more numbers available from the CRAC output.

MR. CRAMMOND: Yes.

MR. MINNERS: If you take those numbers, Mr. Ward, if you took the CRAC code and used the off-site costs that they calculate -- okay? -- you'll get lower

dollar values than multiplying the dose by $1000 per man-rem, by a factor of 10 or more.

MR. WARD: Well, not if you just add it to what you are doing.

MR. MINNERS: Then that's double-counting, because the $1000 per man-rem is supposed to take that into account. You can either do it with the $1000 per man-rem surrogate, or you can actually go and make the calculation of what the off-site costs are.

MR. WARD: How many hours do you put on man-rem then?

MR. MINNERS: You don't. People don't. They go out --

MR. WARD: There's some health penalty associated with substantial doses --

MR. MINNERS: They calculate hospitalization cost, they calculate cost of death and stuff like that. But if you look at those health costs, I'm telling you, they are in the $100,000 per death range.

MR. WARD: You are saying that $1000 per man-rem is truly exaggerated?

MR. MINNERS: $1000 per man-rem is valuing life at millions of dollars per death.

MR. WARD: One other thing I guess I'm surprised at is the off-site benefits in the inclusion of the averted

on-site costs are not larger.

What is included in averted on-site costs? Replacement power, for example?

MR. CRAMMOND: Replacement power, cleanup and decontamination and replacing the equipment.

MR. MARCHESE: Capital investment.

MR. CRAMMOND: Yes. Capital investment. And, as I recall, probably the man-rems, occupational man-rems to the personnel in the cleanup.

MR. WARD: Okay. How did the assumptions there, that are used there, compare with the experience of TMI-2?

MR. ERICSON: Some of the generic numbers for on-site costs come out of that experience. We estimate $1.2 billion on-site? That's the rule of thumb is on-site cleanup, $1.22 billion.

MR. WARD: Okay. That's what I was trying to get at.

MR. ERICSON: Those kinds of numbers are in there.

MR. WARD: In table 9.6, the fourth column over, total averted dose ratio, where the bottom number is .94.

MR. CRAMMOND: Yes?

MR. WARD: I'm not sure how that is defined. What does .94 mean?

MR. ERICSON: You avert 94 percent of what you

would have had, had you had the accident, without the add-on being there.

MR. WARD: Oh, just those accidents that are -- I mean the 40 percent or something?

MR. ERICSON: Yes. Of our numbers. 94 percent of the dose that would have occurred under our analysis is averted by putting the add-on on.

MR. WARD: Okay. That includes the spectrum of accidents, which you said earlier might be about half. It includes everything but ATWS, LOCA and --

MR. ERICSON: That's what we looked at, so it could be larger. You can't eliminate more than all of it. You might not affect ATWS. You might affect ATWS.

MR. WARD: If it doesn't affect all those then it's really half of that or something.

MR. CRAMMOND: That concludes my presentation, if there's no further questions.

MR. WARD: One more. Some of the results here are substantially changed from the draft report in May.

MR. CRAMMOND: That's true.

MR. WARD: Some of those are because of, I don't know, additions or something that the Staff suggested. I don't mean to be critical with this question, but, I mean, any analysis, as we proceed in time, we sort of approach what might be a true result as an asymptote of that.

How close are you to that? If you had another year to spend on this, would you expect the results to change substantially? Or do you think it's a mature analysis now? What's your judgment on that?

MR. CRAMMOND: My personal judgment is that with all things, we did to respond to the NRC concerns, that we probably went from, maybe 70 percent accuracy to 90 percent, or something.

There's still some things that we haven't done that perhaps we should have done that might contribute, but that, unless you wanted to go to great detail, which may or may not buy you anything, like some of the PRAs are doing in the sense that they are looking at new territory, I don't think there would be at lot of changes. Just by going in and modeling things in more detail, I think we have skimmed off the cream already.

Whether or not you uncover some peculiar thing that you never would have noticed any other way is problematical. Maybe you would and maybe you wouldn't. I know there are some analyses where they found something very, very peculiar that you never would have found if you have hadn't gone into all the details, but I don't think any of those have been big.

So I would say that it would be diminishing returns at this point to do anything in more detail than

what we've done. Our goal now is trying to finish all the ones that we have done, to try to bring the whole project to some sort of a good conclusion and do what we are tasked to do: Help NRC make decisions. I think.

MR. WARD: Any more questions on Point Beach?

MR. DAVIS: I had a couple of quick ones.

In your report and also in your flyers there's two numbers noted for the core melt probability.

MR. CRAMMOND: That's right. I can explain that very easily. The first one is the estimate that we used when we were developing the alternatives, and which combinations of modifications we would have. So those were estimates.

The second number that you saw was the number that was computed using the sets code and a full quantification. So there is the difference.

MR. DAVIS: In your slides, in the fourth slide you have added another sequence, long-term station blackout, which doesn't occur on the second slide.

MR. CRAMMOND: That's right. Because -- I don't know why I didn't have it there. It wasn't one of the accident sequences that was performed by the computer. The long-term station blackout, we took cut sets from accident sequences and then manipulated them by virtue of what would happen in the case of a long-term station blackout where

the batteries depleted or the CST depleted. Then we came up with that, essentially by hand, because it was easy to do it by hand. So that's why it wasn't in the computer list, where it was done separately.

MR. DAVIS: One final question: Do you recall what you used for your auxiliary feedwater reliability number?

MR. CRAMMOND: No. And I can say that very clearly because we didn't come up with a number for aux feedwater. What we did is we had numbers for all the components in the aux feedwater system and the LOCA faults, test and maintenance, common mode, et cetera -- and on any given sequence, if the aux feedwater, whether it's success or failure, if it appeared in that sequence it was simply done in Boolean, so you never would know. In fact, we don't have system unavailabilities for any system. They were never run separately.

MR. DAVIS: I noticed that. I never noticed any of those.

In appendix B you defined the aux feedwater failure as failure of one of three trains.

MR. CRAMMOND: Yes.

MR. DAVIS: Does that mean that two out of three trains causes a core melt?

MR. CRAMMOND: Succession is one out of three so

you have to fail all three.

MR. DAVIS: Your definition then isn't correct. You say failure is one out of three trains in appendix B.

MR. CRAMMOND: That's a shortcut. Yes, that's a bit of jargon there. We say it's failure of success of one of three, is what that means.

MR. DAVIS: Okay.

MR. CRAMMOND: I say that's a bit of local jargon. I'm sorry about that.

MR. DAVIS: Thank you. That's all I have.

MR. WARD: Anyone else? Okay. Thank you, Wally.

Our next -- we've run a little ahead of time. I propose that we not take our lunch break but we go to the next speaker, Mr. Hatch.

(Slide.)

MR. HATCH: I'm Steve Hatch and I'll be talking about the Quad Cities results. Primarily I was in charge of the BWR analyses for the program.

(Slide.)

I'll just mention a couple of things about the BWR analyses, and point out some of the differences between the BWR and PWR stuff. Primarily all the techniques that Wally discussed were applied on the BWR work. There were some differences, and, again, I'll point those out as I go along.

This is the Quad Cities transient event tree.

I'm not going to show you the small LOCA event tree although it's in your packet. It's essentially the same type of tree.

First of all, this tree is consistent with the event trees developed in the risk methods and integration program, RMIEP program, the full scope on La Salle being done at Sandia. Not as full as the RMIEP, but it's consistent with those trees.

I have both an early emergency coolant injection and a late emergency coolant injection event. This is to take into account failures of the front-lying ECCS systems, that could occur downstream after an initiating event, three or four hours into the transient.

In the PWR analyses they looked at the station blackout question as a separate issue. Outside of the event tree and fault tree analyses, looked at that issue. For the BWRs, I have modeled those sequences implicitly in the fault tree and event tree analyses.

So, the early ECI failure is essentially those where all of your systems fail, at time zero or within about 30 minutes into the accident.

The late ECI is where you initially succeed emergency coolant injection. You have water going into the vessel but at some point downstream, in two or three hours, you fail due to a number of causes. Not only station

blackout, but it could be things like room cooling failures that cause equipment to fail downstream, battery depletion -- say you are in an AC blackout and the batteries deplete after about three or four hours -- those type of things are incorporated in this late term failure.

MR. EBERSOLE: May I ask, does this include the lifting of this -- the SARs, as they call them? And the interruption of water from a variety of sources?

MR. HATCH: Could you expand on that, Jesse?

MR. EBERSOLE: If you lost the capacity to inject water at pressure, the line of recovery at the boiler is depressurized using the semi-automatic release, primarily automatically, and then accomplishing depressurization to quite low pressures and then inject water, let it heat up the water, subsequently, under duress, even to release it to atmosphere.

MR. HATCH: Is your question whether or not the late-term failure would be failure to --

MR. EBERSOLE: Does it include that mode of operation?

MR. HATCH: Venting the torus late term to allow for --

MR. EBERSOLE: Yes.

MR. HATCH: Yes.

MR. EBERSOLE: Then it automatically includes

the low feedwater introduction from even domestic waters? Low pressure introduction --

MR. HATCH: Let me qualify that. We did not model many of the secondary water sources in our fault trees, but we have considered those, where appropriate, as recovery actions. Those would be manual-type things the operator would have to perform, operations to establish late term in the accident.

MR. EBERSOLE: I think most boilers have a method of introduction of cooling, using open pool pieces which can permit condenser water straight from the river to be put into the core, once you reduce the pressure; and therefore, you have a recovery method which is extremely simple, simple open boiling to the containment atmosphere, subsequent translation through the, even -- and then even commonly said, a determination to open the containment.

MR. HATCH: We have given credit for those secondary water sources where appropriate. For Quad Cities the primary alternate shutdown method, it's called a safe shutdown pump, a single pump, like RCIC capacity, it's an AC pump, as an appendix R addition, and that has been the primary secondary coolant source that we have looked at. Although you are correct that most plants do have a service water tie-in of some sort.

MR. EBERSOLE: Right. The Quad Cities includes

this terminal method of cooling?

MR. HATCH: Yes.

MR. EBERSOLE: Okay.

MR. HATCH: And many of the accident sequences that were dominant, though, you didn't have electrical power, so even some of these secondary sources which don't have a dedicated power supply --

MR. EBERSOLE: The fire water, was that used?

MR. HATCH: Pardon?

MR. EBERSOLE: The fire water?

MR. HATCH: They didn't have a tie-in from the diesel-driven firewater pump to the service, although that was in the planning stages. They are planning to put that in upstream somewhere.

MR. EBERSOLE: I see. So that will eliminate the AC problem.

MR. HATCH: It should help it.

MR. EBERSOLE: To a degree.

MR. HATCH: Yes.

I'm going to skip over the next couple of viewgraphs. I'm not going to show you the small LOCA tree or the event tree definitions.

(Slide.)

I'll quickly go over some of the reasons why we selected Quad Cities as a plant to study. Two main reasons:

One, Commonwealth Edison was one of the utilities that expressed an interest in allowing us to do a study on one of their plants; and then, as you might remember, we went through a lengthy screening procedure to try to select those older plants with potential vulnerabilities to study.

This is why you don't see many of the new plants popping up in our analyses, because those plants, for the most part, conform to newer requirements and kind of dropped out of our screening. The older plants, with -- which did not -- do not conform to some of the newer requirements, surfaced and were the subject of our particular plant studies.

These are some of the insights of that initial screening that kind of pointed us into Quad Cities' direction. These insights that could affect the decay heat removal capability and focused us towards Quad Cities. Some were important in the final analysis, some were not.

I'll point out the ones that were more important. The fact they did not have an integrated shutdown panel was important in the fire analysis. It's a two-unit plant, and right now they only have one 125 and one 250-volt batteries for each unit and they have cross ties between the two divisions. But essentially it's only one DC train per unit. That was a very important plant aspect to the study.

The cable separation was fairly important in the

fire analysis.

Vent stack collapse was something I talked to you about back in March, I believe. That looked like it was going to be an important wind problem; they have this big 350-foot stack that was thought to be a problem dropping over on the turbine hall. That finally went away. The probability of that event occurring, initiating event probability was such that that was not important in our final analysis.

MR. EBERSOLE: The very first line seems to me to have a substantial safety impact; you can't close the safety relief valve when you want to and you can't open it when you want to. Is that true?

MR. HATCH: That is something we did not pursue in detail.

MR. EBERSOLE: That's one of the most critical aspects of a boiler, can you depressurize it if you want to.

MR. HATCH: Is the point you are bringing up at what pressure it cannot open? The differential pressure?

MR. EBERSOLE: If I have no high pressure water, and the automatic aspect of safety relief does not function, I want to know if I can forcibly open the safety release valves.

MR. HATCH: I think this insight had to do with the ability to open up the SRBs, outside the control room.

And there were just limited sequences.

MR. EBERSOLE: Oh, that's only outside the control room.

MR. HATCH: Remote outside the control room.

MR. EBERSOLE: They didn't put that in the remote shut-in panel or anywhere else?

MR. HATCH: You can open them from the control room.

MR. EBERSOLE: It doesn't say that.

MR. HATCH: That's perhaps a little misleading.

MR. WARD: That's what "remote" means.

MR. EBERSOLE: Well, yes, but normally you refer to remote manual as even in the control room.

MR. HATCH: That's perhaps a little misleading.

(Slide.)

MR. MICHELSON: Could we stop for just a moment to pursue the events. Did you consider at all the possibility of loss of coolant accidents outside of containment?

MR. HATCH: We did not go through a plant-specific search of small breaks; no.

MR. MICHELSON: That's not quite what I said, identify the size. Did you consider, for instance, failure in the reactor water cleanup system? I don't know if it's even seismic at Quad Cities. I don't know if it's Q-8, at

Quad Cities. Full temperature and pressure constitutes a full blown, almost about a medium break rupture. You know, must isolate, there's further requirements and further probabilities of failure to isolate. You didn't consider any of that in your analysis? Is there some reason why that one was left out?

MR. HATCH: I wouldn't say it's left out.

MR. MICHELSON: You said you didn't include it.

MR. HATCH: We did not specifically look at particular break locations. I think part of that is done because of time and resources. That's a very lengthy type of analysis, going and looking at particular places where a break could occur. We also didn't have --

MR. MICHELSON: A pretty big system, though. This is not a few feet of pipe. It's a large system at very high energy. It's reactor coolant. It's a loss of coolant accident until isolated. Is there some reason why these aren't included?

MR. HATCH: At the beginning of the program, medium and large LOCAs were excluded from the scope of our study. It might fall in that category. But even the small LOCAs, we did not go and -- whether or not it falls in that range, we did not go and look for a particular break location. We tried to generically come up with, using past risk assessment results, what the frequencies might have

been. And, indeed --

MR. MICHELSON: Let me ask, has anybody else who looked at it, used as a basis to say, well, it looks so low as to use as a basis not to consider it?

I have yet to see the first analysis of reactor cleanup -- first reasonable analysis. Is there one existing that can be used as a basis to say it's a "no, never mind"?

MR. DAVIS: There is one done for Millstone Unit 1 recently released by the utility.

MR. MICHELSON: What did it show?

MR. DAVIS: The conclusion is it's not a dominant contributor, but one of the reasons is the system has flow limitor in the line which are passed, and ends up being a small break which can be handled in the normal way.

MR. MICHELSON: I'd have to see the analysis, see how they chase the water and steam --

MR. DAVIS: It's presumably qualified.

MR. EBERSOLE: More often than not those conclusions are reached on the basis of the dose level obtained by this leaking system. And it does not include the degenerate aspects of continued discharge of fluids into sensitive equipment areas.

Boilers have three lines which ought to be looked at explicitly: the steam line supply to the RCIC;

the steam line supply, if one, to the HPCI, most of which are at full pressure right up to the throttle valve; and then the line Carl was talking about.

These presumably have a competence to distribute almost plant-wide a discharge of steam which may or may not be curtailed by valves which have little if any record of testing under duress. I think these critical three break areas should be explicitly pulled out and looked at, irrespective of all those inside the containment.

MR. HATCH: I would think those particular type of accidents are being assessed in the RMIEP assessment of La Salle, which is going into environmental questions, environmental failures of components, et cetera.

MR. EBERSOLE: They may be. I don't know.

MR. MINNERS: Now that you mention the RCIC system, Jesse -- we took your suggestion and redid the prioritization to redo the reactor water cleanup system so there has been an analysis.

MR. MICHELSON: It's in the generic issue to be resolved, but I was wondering, has the analysis been done yet?

MR. MINNERS: There are some numbers in there.

MR. MICHELSON: But you didn't begin to consider the problems of releasing the water and so forth and got to be very careful not to do one plant to do this whole

analysis and draw a conclusion. It depends on where the system has been put. You'll find it's in various locations in various plants.

MR. MINNERS: But that is a generic issue being resolved; presumably if we do it right we'll include all this.

MR. EBERSOLE: Why will you not use the classic valve reliabilities when you examine it? They are not worth anything because they are not obtained from valves operating in duress?

MR. MINNERS: I don't know what we'll use.

MR. EBERSOLE: I don't know what you'll use either.

MR. MICHELSON: I guess what you are saying is you'll go back and do some kind of comparable study to this for the BWRs as a part of the solution of that generic issue? Is that what you are saying?

MR. MINNERS: Yes.

MR. MICHELSON: A PRA on that system would kind of take care of it.

MR. MINNERS: I would presume people working through the issue, at the end they'll have to work out the impact analysis with a PRA in it which is going to make some sort of estimate of the risk.

MR. MICHELSON: The solution is so far to keep

the valves closed, but of course that doesn't work for reactor water coolant.

MR. MINNERS: But that's a good comment to bring up at the meetings, are you including the environmental qualification effects in these analysis.

MR. CHELLIAH: I would like to add, including Limerick PRA review, you brought up this point, Limerick as well as Shoreham, in the PRA context, at least those two plants we looked into that, the full range of frequency resulting from that particular safety concern is somewhere around the minus 5 range, E minus 5 range.

MR. MICHELSON: You really have to go back and look hard, though, go back and check and see if they really chased the water releases and so forth and see what assumptions they made concerning how long before they would be able to obtain secondary isolation and so forth.

I find the things terminate a little too soon and don't really chase the environment. They do a fair job of chasing the steam because it happens to have a blowout panel for the steam, but the water doesn't go out the blowout panel. It goes down to the floor and down to the lower entrance of the ceilings.

MR. CHELLIAH: The frequencies are dependent on the plan -- in Limerick it wasn't significant, but I think in Shoreham it was significant.

MR. MICHELSON: In Limerick it shouldn't have been significant because they took a lot of special precautions to vent both the water and steam out the building. In Shoreham I do not see such provisions at all, and in the basement it's a very bad arrangement. I have yet to see the analysis that will show what it looks like at Shoreham.

MR. EBERSOLE: Was the Quad Cities plant vulnerable to floods other than the dam failure?

MR. HATCH: Floods both internal and external were not found to be insignificant contributors.

MR. EBERSOLE: In the external area you mentioned the dam failure, which is the sudden flood, but what about the long-term flood problem? Did it have one of those? I was under the impression it did.

MR. HATCH: I mentioned Cooper a little bit earlier as having actually a dominant upstream dam failure contributor.

MR. EBERSOLE: I'm not talking about that kind. I'm talking about water that comes up slow enough to take --

MR. HATCH: That's what happened at Quad Cities and that's why it was not deemed to be a problem. Our contractors looked at that long-term flood based on the Army Corps of Engineer data in that area; and for the worst-case flood where it rains upstream or whatever,

there's like a seven-day period where the waters slowly come up, and the maximum is still lower than the top of the doors of the reactor building.

But Quad Cities has a very interesting procedure to handle that. What they do when they know that flood is coming, essentially they shut down the plant. They shut down all the equipment on the lower levels, rack it all out, they take the top of the vessel off, potentially get natural circulation cooling going and they open up the front doors and let the flood come in. They essentially shut down the plant to a degree where flooding in the lower elevation of the plant --

MR. EBERSOLE: Do they then use evaporate cooling with just feedwater into the plant?

MR. HATCH: I believe they set up small pumps and upper elevations and get the water in and just evaporate cooling.

MR. EBERSOLE: This is the first example of open evaporation to the environment.

MR. HATCH: I'm not sure if it was the first or not. But one of the problems was that the outer walls of the reactor building were deemed to not be strong enough to withstand, you know -- they could probably sandbag it so it wouldn't get in, but then the wall loading would be such they couldn't guarantee they wouldn't have structural

failures on the walls.

MR. EBERSOLE: Does that culminate in open pool boiling to atmosphere?

MR. HATCH: I believe so. I'm not sure it goes all the way to the atmosphere. I'm not sure where they are eventually venting it off, whether it goes to the gas system treatment or not, but I would guess it eventually does. Some retention period and eventually released.

MR. MICHELSON: Just for the completeness of your story, what did they do to prevent the torus from lifting when they flooded the building with water?

MR. HATCH: They have flooded the torus.

MR. MICHELSON: They weren't using open pool boiling of the torus, they were just opening up the vessel and letting the rest of it fill.

MR. EBERSOLE: Did they drain the oil tanks to prevent displacement and subsequent fires?

MR. HATCH: I'm not sure what steps they took in that direction. It was a rather lengthy preparatory list, but they claimed they could do it in a day or two, once they had the planning.

While we implement going from the first drafts to the more finished drafts, I'll mention a couple of things plus some peculiar to Quad Cities.

We add pump and valve common mode failures. I

might add, that wasn't quite as important on the PWR as it was for BWR. We have more pumps, we don't have as many redundant pumps in the same place, we don't have as many valve combinations associated with common mode failures, so that really didn't add as much to the BWR analysis as it did to the PWR analysis.

We increased the control circuit failure a little bit.

We added support system initiating event. Rather a limited look at the support system initiates, one DC and one AC bus failures as initiates. We felt from past experience those were the most important of those types. We reevaluated other data such as diesel LOCA faults, et cetera.

One of the particular ones for Quad Cities was -- one of the post-TMI modifications being made at BWRs, is to adjust the ADS logic, such that if you have a transient with a stuck open relieve valve or many other transients, you will get automatic blowdown, even though you don't have high drywall pressure.

In the initial version of Quad Cities, we did not give them any credit for that. That is something they are doing. Either they have begun in this last outage or will be doing in the next outage. So it was decided, since we were going back and addressing other things, to go ahead

and give them credit for that post-TMI modification.

MR. EBERSOLE: So they put water on the core if it gets low no matter what other conditions exist.

MR. HATCH: Essentially low water level; yes.

MR. EBERSOLE: That long has been evident that that should be done.

MR. DAVIS: Just a second on that one. In the Millstone PRA, the argument is made that that fix could create problems because for some transients the water level goes below the low load level and these transients would normally would be recovered at high pressure. If this modification is changed then you would blow the system down and cause lots of problems and turn it into an accident more serious than it would otherwise be. And they are resisting this modification change. I don't know whether that's going to cause any reconsideration at Quad Cities or not.

MR. HATCH: That's one of the reasons they had the high drywall pressure signal in there. They want to make sure you don't get an inadvertent blowdown. There is a 30-second or two-minute -- there's a couple-of-minute timer involved with this which gives the operator an opportunity to assess the situation and determine whether it really is a case where we want to blow down. So they haven't taken out all the safety precautions to try to

avoid a preliminary blowdown.

MR. EBERSOLE: But you can have a main steam leak LOCA through the main steam valves and you are looking at a vacuum through the reactor core which will suck it dry in no time and you haven't got any containment pressure at all in that case. You know, failure of the main steam isolation valves are closed and subsequently looking into bypass and other blowdown vessels.

MR. HATCH: The bottom line to changes, there was a depletion in the core melt probability by about a factor of 2. So it wasn't a real dramatic change. I think probably the biggest thing was the support system initiates. That was probably the bulk of the increase.

(Slide.)

MR. EBERSOLE: Did you look at common mode failures in the dump mode design? Did you look at the reactor control system?

MR. HATCH: No. And most ATWS systems were deemed out of the scope of the analysis. We did not look at that particular system.

Real briefly, the overall results.

(Slide.)

We had 21 internal event sequences that were dominant prior to application of recovery factors. "Dominant" in this case is with probabilities greater than

10 to the minus 7.

We had 16 sequences dominant after recovery. And, in general, the application of recovery actions was like a factor of 4. Internal event core melt probability went down by a factor of 4 after recovery was given.

Seismic events and fires dominated the special emergencies, and I'll talk more about them in a minute.

(Slide.)

There were three types of accidents that we really looked at. We looked at accidents where you have immediate emergency coolant injection failure, where the ECCS systems fail, 1, 2, 3, right within 30 minutes.

The second type of accidents involved situations where emergency coolant injections succeeded internally but then within about four hours failed due to a variety of reasons, room cooling, battery depletion during an AC blackout, temperature shock ongoing from the condensate shock to a hot pool -- a whole variety of things were looked at in terms what could fail the system long term.

The third type of accidents were transients where you had a cooling for the bulk of the time and -- but you don't have any cooling to the pool. And this is the case where the suppression pool slowly heats up and in about 30 hours was estimated to fail structurally and which would lead to failure of ECCS. So we have kind of a

30-minute sequence, about a four-hour sequence, and this long-term 40-hour sequence.

MR. EBERSOLE: Those numbers at the right are probabilities of core melt as a result of these?

MR. HATCH: Yes. I'm going to explain these. The ones on your handouts are the total core melt probability, of the things we've looked at, internal and external, which follow in the three categories. So this number includes the seismic-related accidents that led to this type of scenario, and so forth. The fire-related events that led to this type of scenario.

The numbers that I have above here are strictly the internal event results which fall into each of the three categories. So you can see that internal events really dominated this first category, and those of that is station blackout-related and electrical power-related. And you can see that, in general, internal events dominated that whole accident category. That accident category made up about 60 percent of the total core melt probability.

Internal events only made up about half of the transients, where you immediately fail ECCS; and special emergencies, such as seismic and fire made up the other half. Most of the special emergencies fell in this category in terms of their contribution to the core melt probability. Most of them, if you have a fire, it's going

to probably get you immediately rather than -- you are probably not going to get to the four-hour and 30-hour case.

Then you can see the relative contribution from internal events, and then total for the long term PW, going back to the WASH-1400 terminology, those sequences only contributed about 6 percent to the core melt probability.

I might note this number. This is the internal event results for that long-term suppression pool heatup accident.

This agrees very well with the NSAC study, DHR study on Brunswick. I believe they only looked at internal events and they only looked at this class of accidents, where essentially it's RHR failing, long term. And that's their results of the whole study. I think their number was 40 to the minus six or something like that, for that type of accident.

So, I think for a comparison of what NSAC looked at and what we've got, it was very close, with less than a factor of 2 difference.

MR. EBERSOLE: Which of these in both these methods of depressurization and low pressure coolant injection that you mentioned -- all of them?

MR. HATCH: No. Primarily this one. We did not any credit for that mode of cooling for the real quick accidents. For this set of events you have cooling for the

bulk of 30 hours. It's primarily where your systems fail, initially succeed but fail down line somewhere, you have time to get the people down, manned at the stations and aligned and spool pieces in if necessary. So most of that particular recovery action was that four-hour time sequence.

MR. EBERSOLE: Even though this was a diverse system you still didn't get a substantial -- 1, 2, 3, 4 --

MR. HATCH: This is the base case, internal. We haven't looked at modifications yet.

MR. EBERSOLE: Oh, you haven't?

MR. HATCH: The total core melt probability of this class, which includes -- the difference between this number and this number is not the application of a modification. It's -- this is internal, this is internal plus seismic and fire and flood and all the others.

MR. EBERSOLE: I see.

MR. HATCH: So we have internal event, probability, and then the total probabilities for each of these types of accidents.

This slide is a little bit mislabeled.

MR. MICHELSON: Could you refresh my memory again as to what LOCAs you actually did even look at in this whole business? I notice there, there's only a 66 percent -- there's practically nothing in your third item. So you better clarify for me what you mean by "LOCAs"?

MR. HATCH: In general, LOCAs were not important at the depth we looked at them. Again, we did not look at specific break location LOCAs. We essentially, we looked at small LOCAs, less than, oh -- less than a square foot, easily. I'm not sure. We didn't really have a set range.

MR. MICHELSON: Inside a containment or outside a containment?

MR. HATCH: We didn't distinguish between inside and outside.

MR. MICHELSON: So a small LOCA in the RCIC steam line, for example -- well, it should be a "no, never mind" if properly isolated but there is a finite probability of failure to isolate, but I guess you just came out and ignored them?

MR. HATCH: I wouldn't say we went to the depth where, we didn't look at particular depth locations --

MR. MICHELSON: I don't know how you look at LOCAs if you don't look at what is breaking.

MR. HATCH: We looked at it in terms of how it would change the success criteria of the front line systems. We looked at some of General Electric's break calculations, which did include steam breaks, and looked at how the front line systems had to respond to those range of breaks. Some were small, some were a little bit bigger. And based on our analysis and success criteria on some of those General

Electric calculations.

Essentially what G.E. has said is you have to get a pretty big break in order to get a change in what equipment needs to respond to a small break, including the steam breaks. Essentially those requirements are the same as a stuck open valve or even accidents without any loss of coolant at all. The transient criteria --

MR. MICHELSON: Except when the breaks are in an area where there's some question about the environmental qualification of this equipment. If you read LERs, you'll see this equipment doesn't really seem to handle steam and water too well in the basement, because there have been small leaks in the basement and lo and behold, the RCIC doesn't want to work or whatever.

I have a great deal of difficulty grasping these numbers and then looking at reality, although mine are apparently data points and not a big picture. But I just don't have a feeling of confidence that we could just ignore these kinds of LOCAs because they are down in the trash.

MR. HATCH: I wouldn't say we are ignoring them. At this stage it's difficult --

MR. MICHELSON: People focus on your slide and say we better worry about the transients. Don't worry about the small LOCAs down in the basement because that's

50 percent of our showing.

MR. CHELLIAH: The third role does not include the frequency contribution from LOCAs outside the containment.

MR. MICHELSON: It's only inside the containment LOCAs? Okay. That's my answer. I thought I got both, both inside and outside, that you didn't differentiate, but I must have misunderstood.

MR. HATCH: It's LOCAs primarily inside containment, but we didn't make a decision about where the break was.

MR. MICHELSON: As long as it's inside the containment you simply have to say this doesn't deal with stuff outside the containment, and if you want to know about stuff like that, we'll have to look. We don't know.

MR. HATCH: That's one of the reasons we didn't go into more detail. That is a very difficult topic and one which, for a variety of reasons, we have excluded from the scope of this study.

MR. EBERSOLE: What do you think would have happened if they had firewater injections, which requires only diesels to maintain a feedwater flow at low pressure? I'm talking about, you know, a fairly simple modification.

MR. HATCH: One that was easily started up within a short time period?

MR. EBERSOLE: Sure.

MR. HATCH: It would primarily affect this. Well, I guess it would have affected both these numbers. By how much, I don't know.

MR. ERICSON: But it's simply a recovery action. It's not part of the automatic action.

MR. HATCH: If it was made part of the normal EOPs, or emergency op's --

MR. ERICSON: But it's still a recovery action, not the plant in its normal operating mode, which is what is depicted here. No recovery in these numbers, just what the plant normally is in its normal operation mode.

MR. HATCH: There is --

MR. EBERSOLE: I thought this included a recovery where you bumped water from the SRBs and water from wherever you had it, but you need electric power to do that so you didn't incorporate the LaSalle availability on the power system.

MR. HATCH: If Quad Cities had diesel-driven fire pump that had good connections and they said they knew how to do it and showed us how to do it, as they do at Cooper. We have given some credit. Given the fact that we haven't done a detailed human factors analysis, we don't know a whole lot about some of the other mechanisms involved -- we haven't necessarily given a lot of credit

for those systems, but we have given some credit where appropriate. And if Quad Cities had had that type of setup outside of this safe shutdown pump, the numbers here would have been somewhat different.

MR. EBERSOLE: It's like the credit you give to the fire department for coming to put out a house fire. Better than that, I hope.

MR. HATCH: I'll just briefly go over the internal event sequences.

(Slide.)

The first couple, the YZ sequences are those long-term sequences where the torus heats up. You can see those probabilities were pretty low. These are the sequences that match up pretty well with what happened at Brunswick. The YZE sequences are the dominant ones, this is the dominant one here, which is primarily an AC blackout-related sequence.

These TD sequences are the case where you feel immediately. And the ones down here, the TAC and TDC sequences are the support system initiates, and they contributed about 20 percent to the overall internal event frequency of core melt.

MR. DAVIS: Excuse me. One of the conclusions of the Brunswick study was that service water failure was quite important and they had a probability over 10 to the

minus 5 for service water failure contribution.

Did you find a similar problem in Quad Cities?

MR. HATCH: Yes.

MR. DAVIS: Is it on the list there?

MR. HATCH: Well, service water failures, secondary cooling of the RHR heat exchangers, those type of failures were important. They are not drawn out explicitly but they are inherent in these YZC sequences. They are part of those sequences. We did not go out and pull out individual contributors in terms of system contribution or component contributions, but I think we would agree that it's the support systems, and in particular, cooling water, that drive a lot of it.

MR. MICHELSON: Does your answer mean that you started out with the assumption that you suddenly lost all service water and went through -- you didn't go through that so you don't know the answer in terms of service water losses and initiating an event and how important it is.

MR. HATCH: We didn't look at service water as an initiating event, but as a subsequent random event after another initiator, we have included it. We thought about including the surface water initiator but decided not to for a couple of reasons: One, those events are much more difficult to find in the course of the plant study. The couple we picked out were the AC and DC bus initiates.

Those, from past studies were found to be over, again and again, dominant contributors. They are very easy to identify. It's usually just a couple of buses you have to look at.

The service water-type failures, again, are difficult to find, and they are always -- usually long term in developing. You lose some component in service water, things slowly heat up. It builds up over a period of hours, usually. And that was another reason we decided not to pursue that support system initiator because you have a lot of time. There's more possibility for an operator to recover from that type of failure than, say, a bus failure. And from past PRA experience, it's the bus failures that should dominate.

MR. EBERSOLE: But what about the probability? Bus failure probability is very low and service water probability, do you find that to be low as well? You find it drawn out, I guess.

MR. HATCH: It depends on the type of failure you are talking about. In the ANO study, one of the initiates was a valve failure, that was a 10 to the minus 3 event. And they are talking here in the 10 to the minus 3, 4 or 5 times 10 to the minus 3 probability of initiating event that we use. It's not that small. You have an initiating event and you have half of your systems gone at

the first instant. So even though it's a very small initiating event probability, what you start out with is much less than the other initiates.

MR. EBERSOLE: Tell me, considering all these, isn't the lesson to be learned here the main problem is loss of feedwater supply due to loss of electric power?

MR. HATCH: It's primarily electric power. Diesel and diesel support systems.

MR. EBERSOLE: So then one looks for a source of water wherever he can find it or not driven to the electrical network.

MR. HATCH: Or looking for another network sometimes.

MR. EBERSOLE: Well, that's the patchwork approach. Looking for some way to get power.

(Slide.)

Most of the internal event vulnerabilities, again, are related to electrical power. The first vulnerability was LOCA faults of two diesels. Quad Cities is a three-unit plant and they have two diesels for each unit, so each unit has a diesel and a half available. There's a swing diesel that can flip out.

There's local faults dedicated to diesels and then the swing diesel is important. Failure of the field flashing was found important.

The diesel cooling water failure was interesting. Each has a one-pump standby system dedicated to provide cooling, but also they take cooling out of one of the pumps; one of the diesel pumps supplies room cooling for the whole plant -- whole unit. So these cooling water failures, not only diesel but room cooling that's associated with this. That was kind of an interesting system-type failure. And then DC control power failure to the -- some of the pump breakers and valve breakers and to the ECCS logic was another vulnerability identified.

MR. EBERSOLE: Do you tell me now that one of the diesels supplies cooling work to the room coolers. You have said for the whole plant, does that mean both diesel room?

MR. HATCH: No. Each diesel has a one-train system that supplies cooling water to the diesel and room cooling for that diesel. But off one of those diesel cooling lines it goes to the RCIC rooms, the basement corner rooms, the RHR lube oil pumps --

MR. EBERSOLE: And there's no cross-tie to the other diesel?

MR. HATCH: There's a way to manually cross-tie between one plan, Wally, one diesel to the other.

MR. EBERSOLE: But it's a low rising problem.

MR. HATCH: We did if it's appropriate. We went

down and gave credit for operators going down and opening valves --

MR. EBERSOLE: This suggests there's a single line that runs to all these cooling pumps that is somewhere off in the building; is that correct?

MR. HATCH: Some pumps, some have self-cooling abilities such as core spray. But in general, you are right, and the RCIC --

MR. EBERSOLE: How does that meet the single piping failures criteria?

MR. HATCH: I'm not sure exactly what the criteria is for this type of system, but indeed this is one of the things we expected at some of the older plants, and we want to evaluate the plants for DHR vulnerabilities.

MR. EBERSOLE: If I have trouble with this cooling line, would it?

MR. HATCH: Not immediate. There are four hours.

MR. EBERSOLE: There's some patch-up time.

MR. HATCH: Yes.

MR. MICHELSON: The water is hot --

MR. HATCH: Core spray has internal lube oil cooling, but it still has some cooling --

MR. MICHELSON: It has to all be from some external water source, obviously. I'm a little surprised there's only a single pass system supplying cooling for all

the pumps, which is what you are saying?

MR. HATCH: Yes. That's exactly right. With some manual intertying to the other --

MR. MICHELSON: I guess, although you didn't -- this is one of the deficiencies in this analysis, as I questioned earlier for the others, I assume you didn't just go through and take such pipe breaks as a part of your analysis?

MR. HATCH: These systems are -- it's a standby system so it's not normally operating.

MR. MICHELSON: No. But the pipe break may lead to a need for operation, depending on where in the building the pipe break is located.

MR. HATCH: That's certainly true of many pipes. I wouldn't necessarily pick on this pipe.

MR. MICHELSON: You don't even go into that kind of analysis.

MR. EBERSOLE: So it's normally not in operation, it's called up in emergency? This?

MR. HATCH: Yes. Room cooling to the corner rooms is not needed until you get a situation where the torus is heating up and you need the pumps.

MR. EBERSOLE: Is it designed to eliminate water hammer when it starts, on emergency?

MR. MICHELSON: I think you'll find it's

designed to start on shutdown. You have to take that motor heat out of the compartments or areas.

MR. HATCH: It's not the motor heat so much.

MR. MICHELSON: It's a heck of a lot of motor heat from a 600 horsepower motor.

MR. HATCH: The RHR rooms at Quad Cities are pretty much wide open and extend up about three stories. Talking about Oak Ridge on what the room cooling requirements are, were they felt the only time room cooling requirements would be needed for the corner rooms is where you don't have suppression cooling and you have radiated heat coming into those rooms, and that's where we modeled it. For those cases where you have suppression pool cooling, that torus doesn't get hot enough to require room cooling, and so it's only special cases where we decided room cooling was needed, and this was based on some discussion with Oak Ridge personnel. We're taking a good look at that.

MR. EBERSOLE: Those pumps, as I recall, are 2000 horsepower. A percentage of that is raw heat into the room and the rooms are pretty big.

MR. HATCH: The rooms are fairly spacious as compared to some other plants and, again, they have quite a bit of thermal mass in the concrete, but they also have this extended -- this stairway goes up; essentially you can

look up three stories. There's quite a bit of volume for the heat to go into, and it's only in that particular case where the cooling fails where it was felt to be critical. Except for RCIC. It's often a different beats, often a little room with a very small cooler. We modeled RCIC as needing cooling all times, when it's running, anyway. So RCIC is the special case for room cooling.

(Slide.)

MR. HATCH: The internal event modifications tried to address the vulnerabilities we identified. The first one is to add a fourth diesel. And let me remind you, you have three diesels for two plants, so really we are coming up to two diesels for Unit 1, two dedicated diesels for our unit.

We looked at adding a dedicated battery on one of the diesels. It was felt that you didn't really need to add dedicated batteries to both in order to get a good core melt reduction, and we were trying to minimize the cost wherever we could and so we only looked at, put a battery on one of the diesels.

We looked at installing an additional DG cooling water pump, which would supply water to the diesels and this room cooling line we spoke of; and we also looked at automatic transfer of critical DC loads of one bus to another in the event you lose a battery or bus or et cetera.

MR. EBERSOLE: That last item is extremely controversial in that it invites cascade failures if you connect into a load which is in fact on a failure? Do you do that on a supervised basis, and what do you think about this? I thought that had been virtually disallowed as a generic approach for diesel, the transfer to a bus and thus inviting the cascade failure of both sources? Has this been worked up in some detail? Is that under consideration now? Is the electrical department of the Staff here in agreement with this general proposition to transfer DC loads?

MR. MINNERS: Jesse, if I may be a little impertinent, I think you've gone beyond the scope of our presentation. We are just trying to tell you what we did and you are trying to get us to say whether we agree or disagree and this is what we are going to do or not. We are a long, long way from deciding what we are going to do.

MR. EBERSOLE: Well, okay. I'll just say that's a proposition fraught with a lot of argument.

MR. HATCH: At Quad Cities they already had automatic transfers of RCIC DC loads. They had some of these equipment in already. We were just proposing to put similar equipment in in a similar fashion.

MR. EBERSOLE: It's always a controversy. Never escape it. I think the question is: Did you examine the

down side when you did this? Did you get a probability --

MR. WARD: For any of the fixes. It's really a methodology question.

MR. MICHELSON: I'm going to watch this closely and start talking about five times the SSC, because this is probably really enforcement, too. It gets real touchy worrying about the for the SSEC.

MR. HATCH: I'm sure the contractor used the best engineering they could to avoid getting yourself into a worse case with the fix than not having the fix. But I don't think we can rule out possibilities of that nature.

MR. WARD: Okay. But there wasn't any explicit reevaluation of a risk with this system, for introduction of new risks perhaps?

MR. HATCH: No. We did not interject negative performance in our modification.

I'll quickly go through the fire analysis. There were two vulnerabilities identified in the fire analysis. Essentially what they did was went around and looked at single locations where, if you had a fire, of a certain magnitude, could take out enough systems to get the plant in serious trouble. And, of course I think the common ones that have been found in other studies: Control room fires and then the main cable spreading room, which is shared by both units.

MR. EBERSOLE: Are they in compliance with appendix R at this time?

MR. HATCH: I believe they have initiated their safe shutdown pump modification the way they intended it to be. I don't know what the result is.

MR. EBERSOLE: It's kind of a catch-all, isn't it?

MR. HATCH: I believe so.

So we had about a 10 to the minus 5 per reactor year vulnerability to fire. The modification is -- involves the safe shutdown pump. Essentially, the people who did the fire analysis determined that there was a significant probability that the safe shutdown pump would not be aligned to the proper unit, or when the unit that needed it had that need. And they felt that adjustments to the operating procedures for that pump could alleviate the vulnerability to or reduce the vulnerability to fire.

So essentially what the modification was was to modify the procedure for the safe shutdown pump operation to assure that this pump gets aligned to the proper unit when it's needed, and the results were, oh, a factor of -- whatever. Factor of 4 reduction.

MR. EBERSOLE: This is the pump now that provides low pressure feedwater in the open SRV motor coolant; right?

MR. HATCH: I'm not sure it's low pressure. I'm trying to remember what the discharge is. It might be higher than a LPSC.

MR. EBERSOLE: Well, if it's high pressure it can also be low pressure.

MR. HATCH: About RCIC.

MR. EBERSOLE: Well, did the Staff then temper their requirements of appendix R?

MR. HATCH: Pardon?

MR. EBERSOLE: Once this was agreed to as a countermeasure, it presumably would permit a good deal of tempering of requirements on fire protection elsewhere.

MR. HATCH: I'm not sure what the results were on that.

MR. ERICSON: We are not in the appendix R business.

MR. MINNERS: Yet.

MR. DAVIS: One thing appendix R can do is increase the problem of pump room cooling if you have to install three-hour fire walls around all the pumps, that can, you know, change the convection cooling availability to the pump and change the requirements of pump room cooling.

MR. EBERSOLE: That's where the shutdown pump might be a better source.

(Slide.)

MR. HATCH: What I'd like to point out about the seismic analysis is Quad Cities does have a fairly significant shutdown earthquake. It's about twice that of Point Beach. That has some interesting results, I think. If you were to look at the frequencies of earthquakes for the different ranges of multipliers of the SSE, you see that most of the frequency, initiating event frequency does fall in the range that the plant was designed for. In fact, we found -- we felt that Quad Cities was well designed for the SSE. And, you know, if you looked at this number you'd say, yes, that is what you should design for. It was kind of of interesting the way the core melt frequencies panned out, though.

MR. EBERSOLE: Pardon me, before you go away from there, you have T-1 and T-2. Isn't T-2 automatically a consequence of T-1?

MR. HATCH: Yes, that's true. There's not a whole lot of distinction between the two; although if you know you have lost power, that affects other systems beside feedwater.

MR. EBERSOLE: Okay.

(Slide.)

MR. HATCH: The interesting thing then, if you look at the seismic core melt probabilities, most of the

seismic contribution falls in ranges above the SSE. So, while the plant is well designed for the SSE, we did find a fairly hefty seismic contribution to core melt. And the reason is, is that much of the contribution falls above where the plant was designed. And the total seismic contribution being about 8.3 E to the minus 5.

MR. EBERSOLE: Is the safety shutdown pump going to offer any recourse?

MR. HATCH: The safe shutdown pump was looked at as a recovery action. For some of the sequences --

MR. EBERSOLE: Is it seismic?

MR. HATCH: I don't believe it's seismic. Strictly appendix R. It wasn't a whole lot --

MR. EBERSOLE: It won't then accommodate loss of DC power?

MR. HATCH: No. It's dependent on diesel or off-site power, which, quite likely, won't be available.

MR. EBERSOLE: Okay.

MR. DAVIS: On this seismic issue, maybe you can clarify something for me. On page 10, section 10, you make the statement that "Although the core melt probability was found to be significant, it was determined that the plant was well designed for such events."

What does that mean, exactly?

MR. HATCH: I think we determined that the plant

is well designed for what it was supposed to be designed, a safe shutdown earthquake. And we were not able to find a whole lot of individual fixes or modifications that would really do much to reduce that probability. What you would have to do at that stage goes beyond patches or whatever. It gets into a place where you'd have to replace whole components of valves or breakers or whatever -- modifications that we weren't prepared to take a look at; but just from the systems, the physical systems, and to the degree we looked at it, there wasn't a whole lot we could do, and I'll get to the couple of modifications we did come up within a minute.

MR. DAVIS: I understand it now, but it is confusing the way it's written. It looks like it's "well designed for core melts."

Anyway, the second sentence is "The reason for the large core melt probability is the result of the high SSE level."

I have trouble with that, too. You mean if they had design of an SSE level they would have had lower core melt --

MR. HATCH: The other way around.

MR. ERICSON: There SSE is a quarter of a G. That's high. So when you get to two times that, you are getting up there and you are really starting to shake

things pretty hard. That's the intent of the comment. In other words, they are designed to a quarter of a G, so if you go to two times that you are up to a half a G or more.

MR. DAVIS: Probability should fall off rapidly for accelerations that high.

MR. ERICSON: If we go to twice the SSE we are really shaking the equipment hard, and so we get a contribution. That's what we are trying to say.

We obviously did not communicate our thought correctly.

MR. WARD: Pete, they've a different hazards curve; right?

MR. DAVIS: Yes.

MR. HATCH: This is Quad Cities.

MR. DAVIS: But it says the reason the core melt is high is because the SSE design basis is high.

MR. CATTON: They need to rewrite the paragraph.

MR. ERICSON: We didn't communicate what we meant to say.

MR. DAVIS: That means if you redesign to a high level the core melt would be higher.

MR. ERICSON: If you designed a half a G and 2 SSE would be really a G, you'd really be tearing stuff up.

MR. DAVIS: But the probability has to fall all the way down for a G.

MR. WARD: If you are at a site where you have to design to half a G, then what they've said follows.

MR. ERICSON: You arc right, Pete. What we said was poorly worded and we need to take a hard look at that with the seismic guys. We did not communicate the intent.

MR. HATCH: And the frequency of seismic events is dominant in the SSE range. But if you look at the core melt probability, it is falling in the later -- higher ranges, so you might argue that the plant is well designed for earthquakes that -- of the SSE -- in the SSE range. It's not designed for these higher ones, and unfortunately, that's where some of the core melt contribution is falling, in the higher ranges.

MR. DAVIS: That's always been found to be the case for seismic analysis.

MR. HATCH: If the SSE had been lower, these numbers would not have been as high. More of it would have been shifted down here.

MR. DAVIS: Right, and the total CMP would have been higher for seismic.

MR. EBERSOLE: You said the safe shutdown pump was not seismic?

MR. HATCH: I don't believe it's seismic.

MR. EBERSOLE: If that's the case, why was it preferred to put in a safe shutdown pump rather than a

cross-tie into the five system?

MR. HATCH: That's an appendix R modification. I don't think they had seismic in mind when they put that in.

MR. EBERSOLE: So it's simply a quick fix for that, for fire? And doesn't incorporate the generic quickness of electric power failure?

MR. HATCH: Don't think they were addressing electric power --

MR. EBERSOLE: The cross-tie to the fire system would not have been that.

MR. HATCH: The two vulnerabilities that we did come up with outside of global modifications, their DC battery racks were wooden. Those were felt to be fairly fragile, so we did look at installing metal battery racks to beef up those battery supports. And the plant also has a number of vital buses sitting out in this big main turbine hall for both units at main levels, and they are not anchored. They are vertical cabinets and they are not anchored at the top, and the seismic people found that some of the vibration could come up and get those things wobbling, and they were found to fail under low accelerations.

MR. EBERSOLE: Were they vulnerable to turbine explosion?

MR. HATCH: I think they were shielded from the turbine, but I didn't do that.

MR. EBERSOLE: You said they were in the turbire hall.

MR. HATCH: There are some walls, not full walls but -- between them and the turbine. I don't think we went into great detail on missiles.

MR. MICHELSON: Are these safety-related cabinets and they are in the turbine hall?

MR. HATCH: Yes. Which is controlled.

MR. MICHELSON: What do you mean, "which is controlled." From a seismic viewpoint, is the turbine hall seismically qualified?

MR. ERICSON: We don't know the answer to that question. Our people analyzed what those would do.

MR. HATCH: The seismic people don't care what's seismically qualified and isn't. They go in and look at what the the component looks like and whether it's bolted down; they look at what it is, rather than what it's supposed to be.

MR. MICHELSON: I assume they also looked at the building.

MR. ERICSON: We did not look at walls falling down in an earthquake.

MR. MICHELSON: So you don't know what the

source of vulnerabilities might be, be it the crane falling down or the walls coming down --

MR. ERICSON: We looked at component fragilities and how the component would fail. The building falling down on it, we didn't examine.

MR. MICHELSON: I think it's a little less of a concern in most cases, but other components falling on it would be potentially a source of major concern. So you have to look around.

MR. ERICSON: I think they did that. Pieces, the ability for something to fall on it was looked at, but the building itself falling down on it was not looked at.

MR. HATCH: Okay.

(Slide.)

And then the seismic modification was just to anchor the tops of these cabinets.

I might mention that these were found to be very cheap, inexpensive modifications. All of the -- in general the special emergency modifications tended to be very cheap compared to some of the internal event modifications. Usually it's tie down something or putting in some new racks, which, in terms of labor and materials, is pretty cheap.

MR. EBERSOLE: You mean all these years they have just had wooden shelves for batteries?

MR. HATCH: Well, they have sides on them and all that like a big crib, but, yes, they are made out of wood. I think they have committed to change that in the next year or two.

MR. MINNERS: They corrode a lot more slowly.

MR. MICHELSON: From the acid --

MR. HATCH: Real quickly, this table shows how the core melt frequencies changed.

(Slide.)

After the application of both these modifications. We go from 8 E to the minus 5 to about 3 E to the minus 5.

(Slide.)

Now, discussed all the individual modifications and will now discuss how these were grouped into alternatives.

Again, what we tried to do was take all the individual modifications and somehow put them togethe. in packages with two things in mind. I think we were looking at trying to get a variety of costs and a variety of benefit, and try to somehow spread the range and pick some things that seem to be reasonable.

The first alternative that was selected was adding the extra diesel, which brings Unit 1 up to two dedicated diesels, and then transferring the DC loads from

a failed bus to a good bus.

The second one was adding a dedicated battery to diesel 1 for a fuel flashing and startup; adding a third cooling water pump, which would give you more redundancy in diesel cooling, and the room cooling issue and also the DC transfer.

So, 1 and 2 were strictly internal event alternatives.

Alternative 3 takes alternative 1 and adds the fire and seismic modifications.

MR. EBERSOLE: May I ask you to consider looking at the fire pump transfer?

MR. HATCH: Pardon?

MR. EBERSOLE: The fire pump transfer in lieu of the new shutdown.

I want to do it because it may encapsulate a defense against a number of things rather than just a single point patch which it is now for -- what was it, fire? It may, you know, cover a number of other options. If you'll make it -- well -- just have a hard look at it.

MR. HATCH: We can take a look at it. As of now they don't have the ability to patch it in. But as I mentioned, that's something they are going to be implementing over the next few years. I don't think they had it planned to do yet, but --

MR. EBERSOLE: You know, that's not a lot of money in a diesel-driven fire pump. Generally they are diesel-driven pumps, truck pumps of some sort, modest source power, probably competent to withstand earthquake, if you can put them on a foundation it can stand that.

MR. CATTON: Quite cheap.

MR. HATCH: They already have a diesel pump on-site. It's a matter of getting it tied-in and deciding where you want to put the piping --

MR. EBERSOLE: I would guess it would have the versatility to cope with a lot of things.

MR. MINNERS: I hope you didn't hear Mr. Hatch say that he would look into that.

MR. EBERSOLE: I thought I did.

MR. MINNERS: I think the Staff would have to say I don't know whether it's worthwhile --

MR. EBERSOLE: I would like to hear the Staff respond to that request.

MR. MINNERS: I guess we'd like to have you think about this, Jesse --

MR. EBERSOLE: Sure. I would not want to have you do this unthinkingly. It ought to take one minute.

MR. MINNERS: We can do more studies. The purpose of these studies is to address whether we need a dedicated heat removal system and not whether to evaluate

whether there are some things that could be done to plants --

MR. EBERSOLE: In a way you are right, Warren, it's a patch. I would rather go along without it.

MR. MINNERS: I couldn't promise we'd do that study for you.

MR. CATTON: On the other hand, your other approach, the cost, $84 million or something, that almost precludes it out of hand. Whereas the fire pump approach would be quite cheap and would accomplish the same thing.

MR. MINNERS: I think you can draw that conclusion without doing the study that Mr. Ebersole suggests.

MR. EBERSOLE: Well, it borders on an approach to what the GSA R-2 is going to use, called the -- what is it -- UPPS system.

MR. MINNERS: I don't think that Sandia is asserting that these fixes that they have are the best possible fixes that you can have for this. We are doing, basically, an example of what you can do in patch fixes versus what you can do with a dedicated system, to illustrate, more on a generic basis, we are going to extrapolate this to a generic situation. Doing more and more studies I'm sure you can fix up these plants, but that's not the point of the studies.

MR. EBERSOLE: The boiler has a unique advantage,

if you open the valves it's just a pot with fuel and water in it. It's just a pot and all you have to do is keep it full, and I think one ought to take advantage of that simple concept.

MR. MINNERS: That might be true, but I would say that there's probably enough information now to make the decision of whether we would go ahead and require dedicated heat removal system or whether we will make people go back and do more reliability, value impact studies and get rid of the vulnerabilities, whatever they are, in the best, the cheapest way.

If the licensee thinks that the fire pump is a better way of doing it than what we suggested, that would be a study that would come on the implementation phase. I think to do that kind of stuff now is just going to drag this thing on and on.

MR. EBERSOLE: Sure. It's just a good patch.

MR. MARCHESE: Before we --

MR. MINNERS: We'll note that as a repair it's a good patch.

MR. MARCHESE: Someone made the comment you could achieve the same thing by adding a diesel-driven fire pump as you can by adding a dedicated system. I'd have to strongly disagree with you.

MR. EBERSOLE: I agree with you. I would, too.

It's just a good patch.

MR. MARCHESE: There's a whole host of things that come up that's difficult to quantify that the dedicated system prevents and mitigates.

MR. EBERSOLE: You are talking about boilers? The boiler is just a pot full of fuel.

MR. CATTON: Andy, I didn't mean to imply you use the same pump, but a diesel-driven fire pump is cheap. Put one in that's dedicated to this other purpose rather than the system you have here for $84 million.

MR. EBERSOLE: Andy, to no stretch of the imagination should you put PWRs and boiler in the same box. This looks entirely different if you try to do it with a PWR.

MR. HATCH: Okay. Alternative 4.

(Slide.)

This was essentially the same as alternative 2 which was the diesel cooling water pump and dedicated diesel and DC transfer. Again, now plus the special emergency modifications.

Alternative 5 was the add-on system. I'll say a couple of words about how this system differs somewhat than the PWR one and its intent.

We decided early in the program to use NUREG 2883, decay heat removal study done at Sandia a few years

ago, use the designs from that study as our baseline DHR system. For the PWR this included a dedicated injection and secondary cooling water trains.

In that report, though, for the BWR, they ended up with something less than "independent" for their add-on system for the boiler.

Essentially what we have is a low pressure injection system with heat removal capability but a system that is dependent on RCIC operation for about two hours.

What happened was the contractor who did the cost estimate decided, along with Sandia, that, one, putting in a high pressure system to take care of accidents where you remain at high pressure was very, very expensive. So they decided to go to a low pressure system with automatic blowdown to get to your low pressure pump.

When they decided -- after they decided on that, they found that to size the pump and heat exchanger and the diesel for that system, that you could have -- those things would have to be huge. You'd have to have a heat exchanger 300 feet tall or something, very big system, in order to allow a pressure system to successfully remove decay heat at the time of an event --

MR. EBERSOLE: That's the ancient isolation condenser, isn't it?

MR. HATCH: It isn't what it looks like, but

perhaps it would serve the same purpose. Based on this, the fact that they'd have to have a very big diesel, pump and heat exchanger to remove decay heat at time zero, they decided to go with a system that would initially depend on RCIC operation for two years. RCIC would come on, get the pressure and temperature down a little ways, and then at two hours, they could then design a much smaller system, a system that would be more easily -- more easily fit into the plant that they were looking at, and they went that route.

MR. EBERSOLE: So this is not open cycle boiling to atmosphere? This is closed?

MR. HATCH: This is closed.

Since we went with NUREG 2883 as our baseline design we have this dependency in our alternative 5, add-on for Quad Cities.

MR. EBERSOLE: May I ask, was the basis for having that the basis that you had core damage prior to invoking this mode of operation? It must have been, because there's no radioactivity in the primary coolant to begin with.

MR. HATCH: They were specifically asked to look at add-on systems of a totally independent nature.

MR. EBERSOLE: Without going to any root examination of why?

MR. HATCH: I'm not familiar with --

MR. EBERSOLE: The primary coolant in the boiler is clean to begin with, and if you keep it that way, you don't need to confine it.

MR. HATCH: I'm not sure why they didn't address a different type of system.

MR. EBERSOLE: This bothers me, not to have the whys, to see the blind, ferocious approach to a design. I don't understand that.

MR. ERICSON: The rationale of the original was closed cycle cooling. Very simple.

MR. EBERSOLE: Somebody handed it to you and you had to go.

MR. ERICSON: Nobody has told me yet that I can open the pot to the atmosphere and let it boil.

MR. EBERSOLE: Along at GSA R-2.

MR. ERICSON: I know what they are proposing. I don't see anything in the regulations that let me do that today.

MR. EBERSOLE: You can because that's been invoked on Limerick, Grand Gulf, on a host of other plants as a terminal operation prior to cooldown.

MR. MARCHESE: Well, I think we've pointed out in the past that there's several -- we've looked at this concept and there's several flaws associated with it that I

don't think the Staff has finally blessed one way or another. As you know blowing down into a saturated suppression pool has some pool dynamics associated with it that have not been thoroughly examined.

In addition, there is environmental conditions generating containment, and it's questionable for the older plants, at least, whether or not the valves that you are going to be venting containment with can operate in that environment.

And, third we have the problem, is the Staff going to allow containment venting for decay heat removal, in which case you would be venting containment considerably below the ultimate failure pressure of containment. Event containment to prevent catastrophic failure is one thing, but for decay heat removal I think it's much lower in pressure, and it's questionable whether or not the Staff is going to allow that.

MR. EBERSOLE: I think what needs to be done is get the Staff to integrate on the matter of Grand Gulf, Limerick, and about four or five others in their big PWRs that haven't have this in their procedures.

MR. MARCHESE: Its failure to prevent ultimate failure of containment -- but for decay heat is another matter.

MR. WARD: Do you want to resort to this --

MR. EBERSOLE: Prior to core damage?

MR. WARD: Not prior to core damage. In a more probable situation.

MR. EBERSOLE: It's not chosen, it's a terminal method to avoid core damage. It's the last stage. But the question is, what price do you pay? And it turns out it's not much, apparently. Anyway, I think there's a considerable integration problem in the Staff to come to grips with it.

MR. MARCHESE: There's probably not a price penalty for the newer plants, but to backfit this to the older plants I think there would be. In terms of what it buys you in reduction of core melt frequency and risk, we are not sure.

MR. EBERSOLE: That's right. I agree. But I just suggest it is worth some inquiry.

MR. WARD: Steve, I lost track now of the definition of what you mean by the add-on system. Is that a system that picks up at two hours?

MR. HATCH: Yes.

MR. WARD: That size system.

MR. HATCH: When you are looking at some of the tables in the back, alternative 5 is an add-on, two-hour add-on with a RCIC. In section 10, I believe, and some of the final summary tables, we talk about alternative 6,

which is the add-on, completely independent add-on, which does not have that RCIC dependency. And we've given some numbers to try and see how much an independent system would buy you as opposed to what is in our base case.

MR. WARD: Question?

MR. MICHELSON: This add-on system is really dependent on a system which already is somewhat vulnerable to fire, flood, et cetera? We haven't done a thing to the vulnerability of RCIC, and without RCIC you don't have an add-on system. It won't work because it may catch up with you too fast.

(Discussion off the record.)

MR. MICHELSON: This is probably not the best time. Let's have a break for lunch, come back at 1:10 please.

(Whereupon, at 12:10 p.m., the meeting was recessed, to reconvene at 1:10 p.m., this same day.)

AFTERNOON SESSION (1:10 p.m.)

MR. WARD: Mr. Hatch, we interrupted you in mid-syllable, so if you would just pick up where you left off.

MR. HATCH: I believe I had just finished defining what went into the alternatives for Quad Cities.

(Slide.)

This is essentially the same type of figure that Wally had.

MR. WARD: Except you put the Xs in --

MR. HATCH: Yes. It shows how the alternatives address the vulnerabilities. The internal vulnerabilities, again, were the diesel local faults, diesel fuel flashing, diesel cooling water pumps, and/or DC loads, circuit breaker loads and DC CS -- BC to the ECCS logic, fire, and then seismic was the battery racks and the AC cabinets were found to be vulnerable.

As you see, the first couple of modifications were strictly internal event-oriented; 3 and 4 we have both internal and special emergency modifications; and 5 is the add-on. Although it's really not quite correct.

As I discussed, the add-on has this two-hour RCIC dependency, which limits -- that's what I needed to do, I needed to talk more about the dependency -- the baseline add-on that we looked at has a two-hour RCIC dependency.

Therefore, the add-on as we have analyzed it, really does not affect fire.

All the fire scenarios occur immediately so that, really, while an add-on has potential to address the fire vulnerability and some of the seismic ones, in our base case we have that extra, really should not be there. And in some of the seismic sequences, the add-on also has not effective.

We'll see this lack of effectiveness for a dependent add-on in one of my later slides.

In some of the tables in the back and in the report we talk about an alternative 6. All that is is the add-on without this RCIC dependency. We have included some sensitivity calculations to see what it buys you to get rid of this RCIC dependency, and I believe it's a factor of 30 or 50 percent change in some of the cost/benefit information when you remove that two our dependency.

MR. WARD: Change in the cost/benefit information? You mean the cost goes up by 50 percent?

MR. HATCH: No. The alternative looks 50 percent better if that dependency is removed. The dose -- dollars per man-rem goes down by a factor of about half or so.

MR. WARD: I see. It's in the table. I have it.

(Slide.)

MR. HATCH: The next slide gives you a broad brush of the results. It splits out the core melt frequencies for the internal and special emergencies, for the base case and then what occurs for each of the alternatives, 1 through 5.

For the internal floods and external floods, lightning and wind, those special emergencies were not found to be large enough or of a nature which warranted modification, at least in our analysis. So essentially for most of them the base case number is essentially the same number, all the way through except for some of the alternative 5 -- the add-on system does affect some of the special emergencies, those where you do not melt immediately.

One of you mentioned earlier that with this dependency, the add-on, the effectiveness of the add-on would be reduced, and that is entirely correct. For those sequences where you don't have RCIC for the two-hour period the add-on is not effective at all.

For sequences where you do not -- you initially have core cooling successful and you have that RCIC, or perhaps another system to initially depressurize or remove heat, then the add-on is effective. And you can see the core melt frequencies after applications of the modifications, we've gotten some reduction but we've never

been able to get below -- we have not, with these modifications, gotten below the 10 to the minus 4 barrier. I think perhaps one of the reasons for this is that we are working with an older plant and some of the modifications kind of bring it up to the same level as some of the plants, some of the newer plants.

We are getting to the point with some of the modifications that we have two diesels for the unit, more reliability on the DC electrical side, giving them -- looking at things that some of the newer plants already have. That's perhaps one of the reasons why the core melt frequencies don't change more than that.

MR. MARCHESE: Steve, you should probably point out that if you were to put alternative 6 results up there, for example, the total you show on number 5, 1.1 times 10 to the minus 4, if you were to show the same total for alternate 6, the number goes to 2 times 10 to the minus 5. That gets you below the 10 to the minus 4 barrier.

The total for alternative 6 is 2 times 10 to the minus 5.

MR. HATCH: Yes. So for that case we can get an order of magnitude reduction, just about.

MR. WARD: Is this -- the Point Beach numbers that we were told this is not total core melt but it was only about half of it. Is that approximately the same

story for Quad Cities?

MR. HATCH: I don't know what the percentage is but certainly, leaving out ATWS -- ATWS would probably be a 20 or 30 percent increase -- increase this by 20 or 30 percent. Certainly some of the other things we have excluded from this analysis would up these numbers.

MR. DAVIS: Excuse me, Mr. Hatch, I don't want to be picky, but one of your conclusions is that the plant has decay heat removal vulnerabilities, and that these vulnerabilities can be counted. Now, the reduction in core melt probability doesn't seem to justify that conclusion. You haven't been able to counter them below the proposed safety goal level and none of the al ernatives do more than about a factor of 2 to 2-1/2 reduction in the core melt probability, which is well within the error bounds of the original number.

I would suggest you take another look at that conclusion.

MR. HATCH: The other way to look at this, and we'll get to it, is in the cost/benefit framework. Indeed, there we had marginal cost-effectiveness -- marginal, if not cost-effectiveness for most of the alternatives, although for one case we did get down below the $1000 per man-rem.

It depends on how you want to look at it.

Certainly if you start looking at uncertainty ranges that can fuzz up a lot of this, which we have not done to a lot of extent.

MR. MARCHESE: You have to remember the baseline core melt frequencies are very high. If you had a delta of 1 times 10 to the minus 4 core melt frequency, that is very significant. Even though the number is still high, a delta of 1.4 times 10 to the minus 4 core melt frequency is very significant.

MR. DAVIS: Perhaps. Your uncertainty is plus or minus a factor of 5. None of these alternatives even approach that amount of uncertainty.

MR. MINNERS: I don't like that way of looking at uncertainties. That's saying that when you get out, if it's a factor of 5 higher or a factor of 5 lower, the probability that the answer down there is the same as the central estimate, which is not true. There is a wide uncertainty, I agree. I understand what you are saying, but I mean, we all have to play with uncertainties.

I think the way the game is best played is to go along with the estimates, always recognizing in the back of your mind that there are large uncertainties associated with it. You can't go on making your decision saying hey, we'll take the high side of the uncertainty, because you are more likely to be wrong there than you are with the

central estimate.

MR. EBERSOLE: Yesterday we had a lecture of the potential contribution of common mode failure as a discrete feature in its own right. Did these studies have the benefit of that, which we heard was as much as a factor of 10?

MR. HATCH: We did include common pumps and common valves, and in the initial study we had diesel common modes and battery common modes --

MR. EBERSOLE: When you get to these plants in essence they are composed of pumps and valves and that's about it, and something to make the water move. The valves, we don't have any reliability for how the valves operate under duress, and what sort of adjustment factor do you put into the valve reliability to counter this, if anything?

MR. HATCH: We have a valve common mode number.

MR. EBERSOLE: Not necessarily common mode, but the intrinsic weakness of valve, and the fact that they are never tested in their full duress load condition and then over the life of the plant they are swung back and forth on zero load and said to be still operable when, in fact, you don't know whether they are or not.

MR. HATCH: We don't have any mechanism to incorporate that in the data at this point.

MR. EBERSOLE: The degrading torque output of

the motor or gear train is not accommodated in the lifetime test of 20 to 30 years. Nobody ever knows if the valve will do what it was supposed to do, even if it ever did originally, in the context of closing against a dynamic load.

The new valves may.

MR. MICHELSON: There's a lot more to common mode than just whether the valve was designed to do the job. The next question is, is it maintained to do the job, is it properly adjusted and so forth. That's part of common mode. I don't know how you incorporate it.

MR. HATCH: I guess we try to incorporate that by -- we have a test and maintenance number developed.

MR. MICHELSON: Where did you get the data? I have never talked to anybody that's developed the data base yet so I don't know how you get your numbers. Have you developed a data base to incorporate things like torque switch, and switch adjustments --

MR. ERICSON: One more time: We are using IREP and ASEP data; we didn't generate any on our own, Mr. Michelson, at all.

MR. MICHELSON: They didn't address this issue.

MR. ERICSON: We are using the generic data.

MR. MICHELSON: So the probability of some of these valves may be unity under load on conditions -- you

just don't know.

MR. HATCH: As with the PWR, we had our contractor, United Engineers and Constructors, take a look at these alternatives and come up with preliminary designs and estimates of the costs to install.

(Slide.)

This is the results for the five alternatives. They range from about $6 million to over $80 million for the add-on. These are one-time costs for the installation.

We then also have an associated yearly operations and maintenance cost which would be incurred yearly throughout the lifetime of the plant, and then occupational exposure, we also cranked in at the $1000 per man-rem, evaluated it as $1000 per man-rem. And many of the alternatives did not have any occupational exposure at all. They are done outside the reactor building or in areas that aren't any type of radiation field.

MR. WARD: Could I ask you a question, Steve? I guess it probably won't make much difference, but it seems to me a little strange. You use $1000 per man-rem for occupational dose, but on the other hand, for off-site consequences, we've heard that $1000 per man-rem is kind of an extravagant surrogate for all sorts of things that might happen off-site. It seems extremely inconsistent.

MR. MINNERS: It's probably a low number for

occupational exposure. I think most utilities will tell you that occupational exposure to them is about $2000 or $3000 per man-rem.

MR. WARD: So they take economic penalties to avoid at about that rate, you say?

MR. MINNERS: It's all economics.

MR. HATCH: I will mention that the occupational exposure for the add-on is something that limits the overall effectiveness. The value -- in the value impact realm, costs are impacts. The costs of the modifications or alternatives are positive impacts. The cost of occupational dose is a positive impact.

Averted costs such as averted power replacement, clean up, investment, averted costs are treated as negative impacts and are subtracted down the load, which I'll get to.

Values are equated with dose, and averted doses. I'll try to explain that a little more in my upcoming slides.

MR. CATTON: Your alternative 5 seems to be awfully expensive.

MR. HATCH: Yes. It's kind of interesting. One of the interesting results out of that analysis is what that cost --

MR. CATTON: What did?

MR. HATCH: Primarily it's not the amount of

pumps or valves. It's the amount of piping that has to be laid and how close you can situate this dedicated building to the unit it's going to serve, tended to drive the cost.

For Quad Cities, the building had to be offset from the plant site somewhat -- I don't know how many hundreds of feet of piping it was, but that more than anything drove the cost up.

To kind of compare it, for the Cooper plant, which is a very similar type of BWR as Quad Cities, they were able to locate the add-on building much closer, and even though they added an extra high pressure pump to do away with this RCIC dependency, the add-on cost for Cooper was about $60 million.

MR. CATTON: Even $60 million seems awfully high. Is this safety grade?

MR. HATCH: Yes.

MR. CATTON: Why?

MR. HATCH: Seismic 1 building and a lot of the cost is land -- labor of laying that pipe and digging, putting the pipe runs underground or whatever they are going to do. That's a major expense. Perhaps when Frank talks later on this afternoon -- I think one of our UEC guys is going to be here -- he can elaborate on that. But it's not so much the components that go into the system, it's how much piping has to be routed around. That seemed to be

the major sensitive feature to the cost.

MR. CATTON: It still seems awfully high.

(Slide.)

MR. ERICSON: I might point out, Ivan, that that number is consistent with everything we heard in Belgium, Germany, Netherlands; an add-on of any kind is going to cost you anywhere from $750,000 to $100 million. That's been their experience also.

MR. MICHELSON: Does that include the loss of the down time and so forth?

MR. ERICSON: In our case it does. As Steve has pointed out, in most instances, United was able to do the engineering such that they could do it in normal outages, double shifting, that sort of thing.

MR. HATCH: It was assumed modifications wouldn't be mandated to be done at a certain time so they could spread it over several outages.

I'll summarize the impacts, then. The total impact is really, essentially the engineering cost plus the present worth of the operations and maintenance costs. So present worth over all the years that you'd be maintaining this modification, present worth back in today's dollars.

The averted costs are essentially the present worth of the averted power replacement, loss of investment, and cleanup costs. The costs that you would avert by

installing a particular alternative.

Present worth, again, from the time of the accident back into today's dollars.

The net impact, then, is the total impact minus these averted costs, and both the total impact and net impact are then used in our cost/benefit calculations. I'll show you those in a minute.

(Slide.)

This table gives a summary of values. All the numbers I'll be presenting on here are central estimates. I believe in the back of your packet you have some tables that give the variation based on source term, et cetera.

The averted on-site dose is based on about a 50,000 person-rem exposure to those people on-site. That dose is multiplied by the probability of having a core melt and then averaged over the lifetime of the plant.

The averted on-site dose are the values calculated out of the CRAC code and then weighted by probability, et cetera, to come up with the -- this is the dose over the lifetime, now. Wally was showing earlier on one of his slides the dose per reactor year. This is the dose times the remaining plant lifetime. You can then sum those doses and come up with a present worth of total averted dose, and this is present worth and based on $1000 per man-rem.

MR. WARD: What's your discount factor?

MR. HATCH: 5 percent.

MR. MINNERS: I would just like to make a comment about the present worthing of doses. Usually we avoid that by just taking a ratio in person-rem which is not discounted over the dollars. When you monetize it, I notice sometimes people present worth it. That's got some philosophical questions which I don't know whether it's good, bad or indifferent but we tend to avoid it.

MR. WARD: Well, I think avoiding it doesn't do away with the philosophical question. You've got a philosophical question if you avoid it.

MR. MINNERS: It's a question that -- it's not accepted that you present worth health effects.

MR. WARD: I guess I'm still troubled by this, the $1000 and $3000 or something that was the occupational dose for the cost of installation. I think Mr. Minners said there's a number -- oh, you are using $1000 for that.

MR. HATCH: All the doses are valid at $1000 per man-rem. This is dose, now, not dollars.

MR. WARD: I'm going back a little ways. My complaint was about the $1000 you were using to cost occupational dose.

MR. HATCH: Both occupational dose and off-site dose is valid at the same amount.

MR. WARD: My complaint was that the off-site dose, $15000 used for that is intended to be a surrogate for other off-site costs. So I thought you were extravagant for using $1000 for occupational dose. And Mr. Minners has pointed out that in practice the utilities actually spend more than that to avoid occupational dose. But I have a philosophical problem there. If that's utility practice, that might be of their own choice, but there's some question about whether the NRC should credit such a large number.

I mean, if the CRAC code uses, I don't know -- what does it use for fatality? A couple of 100,000 dollars for fatality?

MR. HATCH: I CRAC code I don't think puts a value on the fatalities. But if you look at the strip report it's $100,000 per latent fatality and $1 million for early fatality.

MR. WARD: Why shouldn't you cost these doses at the same rate? Workers aren't any more tender than neighbors.

MR. CAVE: Cave, C-a-v-e, UCLA. Traditionally the figure $1000 per man-rem has been used by NRC for occupational exposure. The extension to statistical deaths, as it were, arising from accident conditions, is, as Mr. Minners has said, a convenient surrogate. But where

you can see the dose delivered to a specific person you should, perhaps, differentiate between that and the statistical chance of a very small dose spread over a large population where you'll never be able to say whether a particular person has or has not received that dose.

MR. WARD: Well, Lesley, I find that a little hard to -- I mean if you are using the central estimate and you really believe the numbers you are making -- you brought up two points. There probably is some de minimus level, but in the off-site dose that's taken into account to some extent by having a 50-mile or some radius. I don't know to what extent de minimis is taken into account for the occupational dose. I suspect it isn't.

The other thing is you are saying a delivered dose is worse than a speculative dose. I don't know. Maybe you can discount it due to uncertainty or something, but we are talking about probabilistic risk assessments that are given as purported central estimates. So a speculative dose can be pretty real, also.

MR. CAVE: If we go back to a sort of basic situation, we are saying, if we put a price of $1000 per man-rem, that we are prepared to spend $10 million to avert a latent cancer. That, I think, is high compared with the sort of compensation that would be awarded for cause, if a person were involved in a radiation accident.

If you go back to the case of those in Nevada exposed to weapons testing, for example, they had to settle for rather less than that. But if you have got a work force that you know you are going to expose, then as a good employer, maybe you give a much bigger margin. That's the way I would look at it.

MR. WARD: Well, I guess you could make the argument that it's just the cost of doing business, that in order to keep the work force you have to compensate at a rate of $3000 per man-rem, or something equivalent to that. Maybe that's hard to do.

MR. MINNERS: I don't understand what your question is, John. What was your original question? That you shouldn't treat occupational exposure the same as public exposure?

MR. WARD: No. I guess I'm suggesting that you should treat it. For public exposure you are saying that the total cost related to off-site damage is expressed by charging $1000 per man-rem on off-site exposure and that covers putting farms out of business, and this and that. You are using that same number for occupational exposure where you are not putting any farms out of business.

MR. MINNERS: When you look at an off-site exposure to the public and off-site property damage, and -- you will see if you monetize public exposure at $1000 per

man-rem, that off-site property damage for large, high-risk accidents is usually a small fraction -- I forget the numbers, 10 percent or something like that.

When you get to low-risk accidents which are usually more probable accidents but with much lower -- smaller releases and therefore much less exposure per accident, in those cases then the off-site property damages will become, or can become approximately equal to the public exposure times $1000 per man-rem. But in most cases the risk is driven by the low probability/high exposure accidents, in which off-site property damage is a small fraction of what the $1000 man-rem exposure would be.

So, surrogate, you could leave out off-site property damage and not change the number very much.

MR. WARD: That doesn't really deal with the question but --

MR. MINNERS: I'm trying to say that we are equating public exposure at about $1000 per man-rem, $990 per man-rem and we are doing on-site exposure at $1000 per man-rem. That's no difference.

MR. WARD: I haven't gotten my point across but it's one of several inconsistencies that we aren't going to be able to --

MR. MINNERS: I don't understand your point.

MR. WARD: Let's go ahead and not take any more

time.

MR. MARCHESE: Let me mention, when you pull this all together for value exact analysis I think the results are going to be presented in such a format that one can play with the numbers to do his or her own sensitivity studies. If you wanted to use a higher or lower number, the results will be in such a form that you can do that and draw your own conclusions.

MR. WARD: Thank you.

MR. HATCH: This summarizes the value-impact analysis for Quad Cities.

(Slide.)

The information is the change in core melt frequency for each alternative, the net benefit of the alternative based on off-site costs and dose alone, and then the dollars per man-rem based on just off-site cost, then the net benefit based on off-site plus on-site factors, and then the dollars per man-rem based on that total.

The net benefit for off-site costs is the present worth of the averted dose minus the total impact of the alternative. The total impact is the impact that doesn't include the averted on-site costs such as cleanup and power replacement.

The net benefit for the total cost is the present worth of the averted dose minus the net impact,

where we have included those avertable on-site costs.

I will just point out that for all of the modifications, and here we are showing alternative 6, which is that add-on system without the RCIC dependency. In all of the cases the net benefit to the total costs is negative, which essentially means the -- you are going to be paying more in that you have the potential to avert in costs by implementing the modification.

However, if you look at the dollars per man-rem, we did find one of the modifications to fall below the nominal $1000 per man-rem criteria, so it really depends on what combinations of measures you want to look at. If it's only $1000 per man-rem then this says maybe there are things out there that you can do that are cost-effective, if you don't look at other measures such as the net benefit.

In general, the modifications that seem to do well and kind of make sense, the ones that don't add big ticket fixes, the ones which don't include any diesels or pumps, et cetera -- we found for Quad Cities and some of the other studies, if you have fixes that are fairly labor -- not labor-intensive and don't include big stretches of piping and pumps, in some of these cases you can get down to fairly low values based on the $1000 per man-rem.

MR. WARD: It's interesting that 6 actually gives you a lower number than 5 does.

MR. HATCH: Remember, here we have -- we do not have the RCIC dependency, so, in terms of -- we drop about a factor of 2 in the dollars per man-rem so that's what you'd expect. It gets better.

MR. WARD: Did you give us the total cost to that system?

MR. HATCH: I'm not sure if I have it on a slide. It wasn't very much. In alternative 6 all we've done is added a high pressure pump so the system is available at time equals zero, it's essentially a RCIC pump, AC RCIC pump that's powered by the dedicated diesel to the system which can provide high pressure water from time zero.

As I talked about earlier, the addition of one pump or valve or other components, I think it was about $1.5 million between and 6 for the installation plant, it isn't really a whole lot of money in terms of adding out or adding more piping or putting the building a little further away. It wasn't very much an incremental addition.

MR. WARD: Why have you downplayed 6, then?

MR. HATCH: I haven't meant to downplay it. It's just that in our baseline case we were taken in our baseline what was defined in NUREG 2883, one of the heat decay studies done at Sandia a few years ago. In that baseline they used a RCIC dependent add-on system and we realized in the study that's perhaps not the optimum way to

go. If you are adding an add-on it's probably better to have a totally independent system.

MR. ERICSON: Mr. Ward, when we started this study we agreed we would not spend a lot of money redesigning such, particularly the add-on systems; we would use what was out there. And it was when we got into the analysis that we realized buried in the fine print of this 2883 was this two-hour dependency that we did not cost earlier on.

MR. WARD: I thought you said the opposite, 2883 included the nondependent system?

MR. ERICSON: No, it's not.

MR. WARD: I understand.

MR. HATCH: Certainly from the cost perspective it's not very much more costly to go ahead and add that high pressure capability and the other BWR analysis we have been doing, we have done that. We have included that high pressure pump in the baseline case.

MR. EBERSOLE: If you had looked at an old plant with an isolation condenser before the MBAs had gotten a hold of the business, how would it have looked as you analyzed it for this condition?

MR. HATCH: I'm not really sure how it would, Jesse. They had advantages in one area but disadvantages in others.

(Slide.)

As with the PWR, we took a look at an alternate approach to the consequence calculations where we ran the CRAC code without interdiction or decontamination, essentially. There's an evacuation of the people around the plant but everybody is sort of left where they are.

These are raw populations, dose conditional on an accident occurring so they do not have the probability of core melt cranked in at this point so their dose is given in an accident. You can see the second lines are the cases without interdiction. I have given it for the upper bound, central and lower bound estimate and you have an idea of what kind of increases we are talking about. Factors of 20 or more for some of the dose increases.

(Slide.)

This slides shows how it translates into the cost/benefit. If you carry that assumption through you can note very quickly that your net benefit for doing some of this modification is now positive. You'd be gaining more than you'd be putting in by doing some of these modifications. Even for the add-on, if you have the totally independent add-on, we are still showing a total positive net benefit. And with -- also, the dollars per man-rem is very favorable when you compare it to the $1000 per man-rem criteria and essentially it's because the dose

goes up by a factor of 20. The averted dose goes up.

(Slide.)

I'll quickly summarize some of the results from Quad Cities.

AC blackout was the most important sequence, with the batteries giving out in about four hours. It contributed about 60 percent to the overall probability of core melt.

On the whole, we found Quad Cities to have a pretty good physical redundancy of DHR systems. They have a lot of pumps and methods of getting water in. It just tends to be the electrical things that get you into trouble. The fact that you only have three diesels for two units, you have only two diesel trains for two units -- those type of considerations dominated the internal event analyses and the overall results.

Seismic events dominated the special emergencies, and I would like to mention a couple of things about the special emergencies.

Again, I think I said that on the whole the special emergency modifications were pretty cheap. We found that adding an anchor here or support there or wrapping some cables to be pretty cheap modifications, as opposed to some of the internal event modifications.

I also point out that the special emergencies

were really of a different accident class than the internal events. The internal event sequences were dominated by station blackout, again, where you initially succeed with some equipment and you fail four or five hours down the line. Much of the special emergencies tend to be of a nature where everything fails right at once and within 30 minutes or so you are having core melting.

So, the special emergencies really were of a different class of accidents than the internal events.

MR. EBERSOLE: I notice a line there that says "effective venting containment minimal." I would like to examine that. It's minimal because your makeup system is still electrical power dependent. You have a heat sink here that you can't use because you don't have a water source, won't do you any good. So each of these lines is interdependent on what you do somewhere else and the statement doesn't convey that information to you. Containment venting would be valuable if you had source feedwater.

MR. HATCH: I was going to caveat that. Most of the credit for that was given for the long, 30-hour sequences where you have time to do lots of other things. For the earlier time sequences you need both venting and a water supply to take care of you and if you don't have one, the other doesn't help you.

MR. DAVIS: I have another problem with that conclusion. In section 10 you say containment venting was found to have very little effect on core melt probability or risk. But in that same paragraph you said that, you say that you don't consider the possibility of venting after coal melting because of the uncertainties of radio nuclide scrubbing in the suppression pool. My understanding is, is after melting, after core melt has occurred to prevent the gross releases from arising between the failure. You said you didn't consider that scenario but you do conclude it does affect risk. Am I missing something in that conclusion?

MR. HATCH: I guess we were hampered somewhat, and I guess maybe we should change some of those statements. At the time we did Quad Cities they had not submitted their procedural guideline package for General Electric's EPGs, essentially how they are going to implement venting at their plant, which entails a number of the specific things you need to know in order to assess what venting can or cannot do for you, and, in particular, what pressure are you going to vent at.

In the beginning it seemed all the plants were going to vent at twice designed. Now I think minimum RCIC is going to vent at lower than twice designed for a variety of reasons. We didn't have the specific information for

Quad Cities to really determine how venting may or may not help you, and so our interpretation of how venting can help you perhaps is limited. Perhaps some of those statements in section 10 are a little strong.

MR. DAVIS: I will agree with you it may not affect core melt, but I think I won't agree that it may not affect risk. There are now some good data on suppression cool scrubbing, even down to the temperature. I notice that that conclusion doesn't appear on all handouts so I was hoping maybe you had picked it up and changed your mind.

MR. EBERSOLE: I disagree, it does affect core melt because it offers the critical thing we need, a heat sink, which is the thing we have. It gives us an exit for thermal release. All I have to add for that is a source of water to that to make up our loss, in which case I'm done.

MR. HATCH: That's the problem we face because in the earlier sequences you don't have that source of water.

MR. EBERSOLE: Right. But it's easy to get.

MR. HATCH: The last thing I would like to mention, I didn't go into detail in this talk but I do have a discussion in the report, is Quad Cities as a two-unit plan. While we did not look at Unit 2 specifically, we did have to model parts of Unit 2, such as the second DG train and the swing diesel which can supply either unit. One

observation we came up with is that there are a lot of scenarios, that we have only looked at how it's affecting Unit 1, but in actuality both units could be in dire jeopardy given those combinations of failures. Ideally it would have been nice to look at both units simultaneously and assess the plant site core melt frequency given some of the accidents we've gone through. I found that to be kind of an insight. For the earlier plants that really have those shared dependencies between units I think it's something that should be kept in mind.

MR. EBERSOLE: When you looked at a multi-unit plant like that, did you conclude that if one unit went to a full degraded state, the management could stay and work the other one?

MR. HATCH: Yes. That's a good question.

MR. EBERSOLE: On what basis? The control room may have been designed on that basis, just the leakage and direct radiation exposure has not been designed on a full integrated condition.

MR. HATCH: It's a good question but we didn't look into it.

MR. EBERSOLE: Some of those gases will reside in the auxiliary building in which they will accumulate rather than being dispersed, and the people will be exposed who have to stay rather than leaving the house.

MR. HERNAN: That's what is supposed to be a TMI fix, Jesse.

MR. EBERSOLE: Did they do it for the concept -- the loading up the aux building before releasing it to atmosphere? You know the products of core melt?

MR. HERNAN: Probably not but I don't really know that much about it.

MR. HATCH: Are there any other questions? Thank you.

MR. HERNAN: I wanted to say that the procedures in place are for containment -- for gross containment failure, which I think is a little different than what Jesse said.

MR. EBERSOLE: They are not based on core melt at the moment?

MR. HERNAN: At the moment. That's correct.

MR. MICHELSON: They'd have to reach high pressures before you'd consider venting?

MR. HERNAN: 200 to 250 times.

MR. MICHELSON: Can they even open the vent valves before they reach those kind of containment pressures?

MR. HERNAN: I don't know.

MR. MICHELSON: How can you get enough torque to open the vent valves?

MR. EBERSOLE: Can I get a documented defense of that position? Because I need it in DSAR 2.

MR. HERNAN: We can provide you with the BWR owner's group emergency procedures guide.

MR. WARD: Jesse, let me remind you that -- was it last month we designated a subcommittee to look into containment venting procedures?

MR. EBERSOLE: I had forgotten that. That's correct.

MR. WARD: Now that you remember that -- as far as I know the subcommittee hasn't met and gotten organized.

MR. EBERSOLE: I can't believe this will persist as a position.

MR. WARD: But that's the place to look at it.

I'm informed we are honored by having Mr. Mulligan rather than Mr. Cook as a speaker.

MR. MULLIGAN: I'll make a few introductory remarks and then get Frank up here. I'm Jack Mulligan and I'm the project manager for the work that United Engineers is doing in support of Sandia's work in the A-45 area.

Our primary role is to take the modifications that are being proposed or identified by Sandia, going out into the field and walking those systems down to find ways of installing them in the plants, bringing that data back to United, and then providing cost estimates plus a design

description of each one of the modifications, so that for all those things that Steve and Wally and those people have been presenting here, there is a design document that backs up each one of those modifications and a detailed cost estimate. And to answer the question we had here before with regard to the cost estimates, let me just take a minute here, if I might, Dave, to explain what the basis for those costs are.

(Slide.)

United Engineers maintains a data base for DOE, we call it the energy economic data base. Some of you may be familiar with it. It is considerably -- a large base of data on new construction plants. We maintain them for all kinds of technologies, including nuclear. Of course, because of the rise in the cost of nuclear plants over the years, we have been tasked by DOE to make many studies of the products in the field, particularly the productivity problem, and we have a data base associated with just the individual units of production in the field for things like piping and concrete and rebar, in quite a bit of detail.

That's the very -- the base for these estimates. We are using what we call the median plant, which is the average -- average plant in the United States. So it is real data that we have collected from all the plants in the United States. We are using the average plant as the basis

for new construction type of work.

If you were to take the add-on system, for example, the add-on system, the building is built outside the security fence and is more like new construction work than anything else, any of the other modifications. That portion of it is costed just like new cons.ruction for the average plant in the United States.

The remainder of it, where we have to go in, within the security fence and into the plant and actually make tie-ins, we use an approach which is our standard approach in our backfit work that we do, which is to take the base rates and based on health restrictions, radiation levels, congestion, accessibility, and the data that we have collected in the field -- and we have done this, as I say, by sending our engineers and cost estimators to the field, walking down the systems, taking Polaroid photographs and recording any data that was necessary, talking to the people in the plant, and come back and we do the estimate and we mark up those base numbers, new construction numbers, with a series of enactors depending on the complexity of the paiticular job.

If we are tying into the primary system inside the containment in a high radiation area, you may find the base productivity numbers marked up by a number up to a factor of 6 over new construction. And that tags right

along with actual experience in the field.

After we complete the estimates for each plant, what we do is we go -- these are detailed estimates. We will roll up the costs into commodities. For example, all piping less than 2.5 inches, all piping greater than 2.5 inches, safety class, nonsafety class and what have you. And we go back and check those with roll-ups for the same kinds of commodities in other data bases for other plants that we have in-house, just to make sure that the final numbers that we come up with, that we can rationalize those with respect to what is actually happening out there in plants in the field on backfit work.

MR. EBERSOLE: Can I ask a question? You say the multiplier is something like 6?

MR. MULLIGAN: It could be anywhere from a factor of 1 up to 6, depending on the complexity of the particular area. You don't take the whole estimate. We go through line by line. In a particular piping installation in a particular area where you have got a high radiation area, it's hard to get the pipe down into that space and people have to do a lot of welding in odd positions, things like that, you could find up to a factor of 6. But it could be down, you know -- for example, on these add-on buildings, most of the cost is in the new construction portion of it which is outside the fence. So most of it is

marked up at new construction rates.

MR. EBERSOLE: Do you have a corresponding multiplier for backfit construction where you have to rip out what was there and put in something different?

MR. MULLIGAN: What we put into the cost estimate was line items for rip-out.

In addition, when you go back and look at the cost estimate there's a section associated with rip-out and then another section associated with all the installation, so that's included in it.

MR. EBERSOLE: I figured this would be a factor of about 30 to rip out and replace with something similar; is that about right?

MR. MULLIGAN: I haven't handled them but we don't handle rip-out by factoring up the new construction cost. We actually put the rip-out cost in there and then mark up the new construction numbers.

MR. CATTON: How do those new construction numbers compare with, say, fossil fuel numbers?

MR. MULLIGAN: Much higher.

MR. CATTON: Like what? 2? 3? 4?

MR. MULLIGAN: The productivities? I don't know offhand. I'd rather not say. I don't do much work in the fossil end and I'd rather not compare.

MR. EBERSOLE: Is that due to the QA record

keeping constraints and so forth?

MR. MULLIGAN: Yes. And the fact that safety class work is harder to do. You need to re people. There's a lot of problems where you've got to go back and rip out something that you've already done and replace it.

As I say, these are actual numbers based on the average plant in the United States, and looking at it in a very fine basis, you know? For various -- for rebar, for pipe under 2.5 inches, pipe graded 2.5 inches, safety glass, not safety glass, category 1 concrete, non-category 1 concrete, pumps, valves --

MR. EBERSOLE: If you could diminish these requirements by an adequate heat removal system would you expect an overall cost reduction? Significant?

MR. MULLIGAN: On new plant?

MR. EBERSOLE: Yes.

MR. MULLIGAN: My own opinion is if you could get everything massed inside containment you'd reduce the plant costs considerably. I think that's still to be proven but there are certainly a lot of people out there working on modular systems.

MR. EBERSOLE: We are working on high quality equipment all over the place rather than a recovery system that will tolerate a degree of practice less critical than we presently use.

MR. CATTON: How much would the cost be reduced if this system was built just to good industrial quality rather than safety grade?

MR. MULLIGAN: You are really asking me the same question another way. I really don't know the answer.

MR. CATTON: That's right.

MR. MULLIGAN: If you would like I can get you that information.

MR. CATTON: I would like to have that information.

MR. MULLIGAN: I'll send some of that information down to Dave.

MR. EBERSOLE: It 'omes up -- would the heat removal pay its way by savings in design?

MR. MULLIGAN: It's ' matter of opinion but I personally think, maybe if we concentrated on more of that stuff instead of putting all that stuff outside containment instead, with all its seismic supports and all that sort of stuff, we'd probably have done better, but that's still to be proven. That's just my own personal opinion. I wouldn't want to make that the company's opinion or anybody else's.

MR. WARD: Do the costs for this program include financing costs?

MR. MULLIGAN: The total evaluated cost numbers

that you saw include the direct cost, field cost, plus the engineering, the field supervision, the quality assurance, a 25 percent contingency, 10 percent owner's cost, and then I think we considered it was to be about an 18-month construction schedule and there was an escalation and allowance of funds used during construction on top of that also.

If you look at new plants today, I think they are running about equal, the financing cost about equals the base capital cost on new construction plants. I'm not sure -- do you remember any of the percentages, Frank? What those are, from direct to evaluated?

Once again, those numbers are numbers based on what's actually happening out there based on a median plant experience. There's a vast array. There's some fairly cheap plants and some extremely expensive plants. We didn't feel it was fair to take either end so we used the median and also our backfit experience in the areas that were truly backfit type of work.

Okay. I think I've covered the first bullet, there.

One of -- just from a terminology standpoint I introduce this add-on decay heat removal system which you have all been talking about, the add-on system, the bunkered system which other people have been talking about

before which is a single frame with a feed and water, primary break-up size for a LOCA, dedicated power and water supplies, and all in a dedicated building.

MR. MICHELSON: Excuse me, the word bunkered isn't necessarily synonymous with dedicated.

MR. MULLIGAN: Did I use bunkered? I'm sorry, I didn't intend to. It is not bunkered.

MR. ERICSON: He didn't mean to.

MR. MICHELSON: This is not bunkered?

MR. MULLIGAN: No, it's just a seismic category 1 building.

MR. MICHELSON: Thank you.

MR. MULLIGAN: The other thing we have been asked to do in this program is evaluate other credible approaches to resolving A-45, and really that's why I'm here today. Mr. Glen Reed has proposed what he's chosen to call a primary blowdown decay heat removal system, and we were asked to take a very quick look at how that might be done and give some rough idea of what that would cost.

We felt that we ought to look at an alternative system to that also, which is a high pressure RHR system.

We went and developed a conceptual cost estimate for both of them. The cost estimating techniques and data base and everything else that is being used in the base program were used to put these together, although we

obviously haven't had enough time to put as much engineering effort into these designs as we have in some of the other work.

The idea here was to compare this primary blowdown decay heat removal system, the high pressure RHR, and then this baseline ADHR.

We also, through another alternative that we are looking at, in the base program, which is the add-on ADHR, with RHR capability so you can come to cold shutdown using that system that's out in the add-on building.

What we tried to do here, once again, was to pick some numbers that seemed reasonable, look at the costs, look at what problems there were associated with the designs. We have not had the time to optimize them. I'm sure we are going to want to get into some discussion about that but they certainly are not optimum systems, but we are trying to get some idea of where these systems would lie with respect to where others systems lie in the base program.

Mr. Frank Cook will present some basis designs and I also have with me the manager of our fluid analysis group, in case we get into any real tough questions.

MR. REED: I might point out the high pressure RHR system as an alternative has certain drawbacks and doesn't have features of coverage that blowdown does. In

other words, it can't depressurize. And right away it is not as versatile in the total decay heat removal activity.

MR. MULLIGAN: We'll get into that. We just thought it was worthwhile. We are not recommending any particular system. I think there's a lot that has to be done in terms of the risk analysis and what have you, before any decision would be made to go one way or the other.

We were asked to develop the systems and provide some costs associated with them and that's it.

MR. MICHELSON: Is this being developed from the viewpoint of a new plant addition or is it from the viewpoint of alteration of present plant?

MR. MULLIGAN: Backfit.

MR. MICHELSON: Thank you.

MR. WARD: Let's see, when comparing it to the ADHR, maybe we ought to go back to Wally, I guess. Did that have -- does what you were calling the ADHR have small break LOCA capability? It does have?

MR. ERICSON: Yes.

MR. WARD: Okay. Because as I recall, most of the European systems don't really have a small break LOCA capability. They have capability to make up -- compensate for shrinkage but not really small break LOCA. So this is really maybe a little bit more.

MR. MARCHESE: That's right. They are designed to N plus 2 criteria, so they have three trains of high pressure makeup.

MR. COOK: As Jack mentioned, we did develop some conceptual designs for the various options, and in order to make sure we were consistent we started out and established a set of design criteria which we would use for all alternatives. We started with the Point Beach plan and the baseline at ADHR system that was used and evaluated earlier.

(Slide.)

For the purposes of size of the system we took the heat load at one hour after shutdown. We said we would cool to low pressure, RHR intro conditions in three hours following initiation, total four hours after shutdown.

We put an arbitrary service water temperature rise limit of 20 degrees on. I can't emphasize enough that that is arbitrary. When we get further into it you'll see that has a major impact on cost, and it's possible with optimumization, with specific sites, with different arrangements we could certainly let this temperature rise much higher from a technical point of view and reap due costs.

And, of course, in keeping with the add-on facility we wanted a minimum dependence on or interface

with the existing facilities.

MR. REED: I certainly agree with you on that 20 degrees, that's really a crazy temperature rise limit. It also seems to me the three hours is rather fast. I would think that you'd be using something more like five to eight hours.

MR. COOK: We just did this, Glen, for the purposes of the evaluation, and they are constant all the way through.

MR. MULLIGAN: You can get on low pressure RHR at that point in time and that's really why we did it.

MR. EBERSOLE: Did you by any chance look at service water evaporation as an alternate rather than just cooling it?

MR. COOK: Not in this study, no.

MR. MICHELSON: In this study you are going to use these criteria for looking at this high pressure RHR system as well, I guess?

MR. COOK: Yes.

MR. MICHELSON: In the case of what Glen is proposing there's less question in my mind, at least, about fire, sabotage, et cetera, some of the things that are presumably taken care of. Where are your criteria now as to what kind of events you are going to take care of? Is this going to be free of fire in any other part of the

building? Floods, et cetera?

MR. COOK: Yes, as is the base case.

MR. MICHELSON: This added DHR, for instance, would be functional, irrespective of where the other fires were located?

MR. ERICSON: As long as you are still tied to the systems inside containment.

MR. MICHELSON: Oh. I understand, yes.

MR. COOK: We developed these with independent power source, water supplies --

MR. MICHELSON: So the pipe chasers and everything are somehow protected against external instances?

MR. COOK: The chases coming in from the facility are underground, concrete.

MR. MICHELSCN: Thank you. I just wanted to make sure I understood what your objectives are.

MR. EBERSOLE: May I ask Glen a question? Glen, was there a strict -- well, was the matter of the reduction of AC power and service water, volume need and so forth, considered to come to the conclusion you wanted a 20 degree rise rather than just straight evaporation to atmosphere?

MR. REED: In the thing John and I worked to we were talking about an 80 or 100 degree rise on service water.

MR. EBERSOLE: Was the aspect of simply boiling

secondary water to atmosphere considered? You know the grade reduction in water flow requirements, house power, electric power and everything --

MR. COOK: Yes, sir. It was not considered and it does have a great impact on the total dollars we are looking at here.

MR. EBERSOLE: It might be tougher to get to a lower temperature that quick.

MR. COOK: Yes.

(Slide.)

This is essentially the primary blowdown system as Glen proposed it. We did make some minor changes which I'll discuss as we go through it, but essentially we were going to blow down from the high point of each hot leg, to a flash tank, cooling the bottoms and reinjecting into the cold leg. The flash tank will be vented back to containment.

One of the changes we made, just as an afterthought almost, was to take that vent line back to reactor coolant drain tank. If in fact it's operable, you don't mess up the containment, and if it's not oprable or blows out the safety desk you haven't lost anything anyway.

At this valve on the flash tank which is another change from, I believe, the way Glen originally intended; rather than taking the drop back here we felt we could

control it better here and minimize water and steam hammer in the piping between containment and the facility.

As you see later when I put up the plot plan that was used to develop these costs this run of pipe here in the pipe tunnel is very significant, and in fact in some plants it's much longer than it is here. But we would take the pressure drop here at the valve. We had a transfer pump here for makeup tied to a dedicated water source for small LOCA cooling, the 20 degree rise. You'll see the result of that is over 20,000 gpm, in 24-inch pipe.

MR. EBERSOLE: This is what would drive you to evaporator cooling.

MR. COOK: It would drive most people crazy to put something in this bi . I agree -- with the two heat exchangers here.

When we get into the facilities themselves, of course to power all this we have a dedicated diesel with its own starting air, batteries, dedicated ventilation systems, et cetera, in the facility. And we put all those components in with the flash tank and make up pumps, whereas on Glen's original sketch he had them in the service water pump-out. The reason we did that, the baseline plant, that's where they were located and the service water pump house for the BWRs was strictly a pump house, so to keep it apples and apples we put everything up

in the one facility.

MR. REED: The reason I separated was, was part can be radioactive and part will not be. And I thought part seems to be close to the source of water and the other part needs to be close to the container. So, separated seemed to be important.

MR. COCK: I'm not trying to make any technical judgments on it. We did it simply from a cost basis to make life simpler for us on a cost --

MR. MULLIGAN: And we were using, the base design, one of the ground rules was that work had been done on the add-on decay heat removal system before and we were going to use the same design philosophy here as was used on the ADHR. Just so we had an apples and apples basis for the design. That's all.

MR. EBERSOLE: Earlier on, in talking about the venting system for the boiler, it was said that Staff would not invoke that until you had experienced core melt which, as far as I'm concerned, negates the value of it.

In this case you would do it before core melt or after core melt -- either? Right? Certainly you would do it before core melt? Which gives it a far higher value than if you wait until afterwards.

MR. MULLIGAN: It's sized for a steam generator dryout.

MR. COOK: This is meant to be as soon as you discover you have no aux feedwater you may start using this.

I think those are the real major changes we made just for the purpose of this evaluation. To size the flows and heads, et cetera, we took the basic criteria and just followed through with it to come up with the flows and equipment sizing.

MR. WARD: Are your costs going to be based on it being seismic design?

MR. COOK: Yes, sir. As Jack -- the add-on facility is a separate seismic category 1 reinforced concrete structure.

MR. WARD: What about the single failure criteria?

MR. COOK: Okay. Single failure criteria was not applied on this system except to isolate the primary coolant pressure vent.

MR. WARD: Okay.

MR. COOK: That's consistent with the baseline add-on facility that we evaluated earlier, which was a single train, and we've kept that approach here.

MR. WARD: Right.

MR. EBERSOLE: Since you have a water throughput here, you are going to be flashing highly borated water. What will happen?

MR. COOK: We are going to probably concentrate it in the flash tank.

MR. EBERSOLE: How are you going to get rid of that problem?

MR. REED: Goes back with the pumping.

MR. COOK: We do have dilution capability here and it continues to recircle. It will be taken to the condensor box and hopefully not venting too much steam back to containment, although there will be some.

MR. EBERSOLE: Is the flashing process compatible with borated water?

MR. COOK: I would think so. I didn't really look at that.

MR. EBERSOLE: Would the wells load up?

MR. REED: I'd say there would be no problem, completely soluble at these temperatures and concentrations and you'd be pumping the borated bottoms with very little change.

MR. MULLIGAN: You have 65 percent of the mass of the water is coming back through the flash tank, even though, like, you know, 85 percent of the energy goes through the seem through the condenser, that's only 35 percent of the mass. So you've got a lot of water coming back through the flash tank.

MR. REED: I might note that one change that you

have made which in subsequent issues of our document, which I'll give to Mr. Marchese and Dr. Ericson today, the latest version, you have added a pressurizer spray injection. We just add pressurizer blowdown for blowing down from the top of the pressurizer as well as the hot legs, and there's a debate going on as to whether there should be a blowdown off the reactor vessel head. I don't think so, but --

MR. COOK: That's right. We did put a spray in to help take down the steam space.

So then essentially we followed the same criteria to develop a closed loop high pressure RHR.

(Slide.)

This facility here, essentially, is based on the same kind of temperature change, approximately the same sized flows. The reason for the two heat exchangers in parallel is this little program we used to optimize and take a rough cut at heat exchanger sizes indicated that because it's such a large surface water flow compared to a small primary side flow we need to put two in parallel. We sort of run out of time trying to optimize time, but again if we relieve that 20 degree delta T --

MR. EBERSOLE: Does requirement -- large motors, valves, pipes all over the place -- doesn't this sort of drive you to an automatic consideration of open boiling on the secondary as an alternate?

MR. WARD: Hasn't he already answered that, Jesse?

MR. EBERSOLE: Well, I know. I don't know really what we are talking about. In pump horsepower or whatever, can you give me kind of a qualitative number as to the nature of the support system that goes with it.

MR. COOK: I'll get into that but this is a relatively low head. You don't drop pressure. You are just making up line losses here.

MR. MULLIGAN: But in the other system it is a big pump, 12 stages.

MR. COOK: I have a slide here to compare the various equipment.

MR. EBERSOLE: Okay. Fine.

MR. MICHELSON: As I understand it, this is for a solid operation. There's no possibility of this working with two-phase, is there?

MR. COOK: It was sized with that in mind to keep it solid.

MR. MICHELSON: If you should be losing liquid during this event for whatever reason, losing inventory, sooner or later this would cease to be functional.

MR. COOK: Or we'd have to take injection from the alternate tank.

MR. MULLIGAN: If you have noncondensables

coming out of solution you'll have to vent them.

MR. MICHELSON: You may have two-phase coming off. The other system looks like it worked equally well, whether you were blowing down steam off the hot legs or two-phase or liquid. This one doesn't work so well if it's two-phase, or steam. At least unless you design very carefully for steam.

MR. COOK: Oh, these are conceptual designs, please, I can't emphasize that enough either.

MR. REED: I wish to repeat again that this system has limited application compared to the blowdown system. It can deal with very small breaks where pressure can be kept up, but it can't deal with such things as equalizing pressure on tube rupture and many other situations.

I also should point out that this was the system used on the original PWR, S1-W, the Navy version. And closed heat exchanger, high pressure systems for decay heat removal had their problems in those days and I predict they will have the same -- similar problems today.

MR. MULLIGAN: The Navy still uses them on all their plants.

MR. REED: Well, I hope they are better than they were in the early days when they didn't work whatsoever at all. And they do involve lots of thermal

shock problems. It's hard to make heat exchangers that will stand up to this kind of 80 degree standby situation and then you are going to hit them.

MR. EBERSOLE: This is a system which eliminates -- a system, I think, which could eliminate lots of times, the component cooling interface loop direct side to side. It would have to be stainless because in the primary loop chemistry, on the secondary side undoubtedly the water is going to be loaded with borides. It has to be laid up or somewhere or other you have to argue that you can both test it and preserve it against stress cracking. How are you going to do that?

MR. COOK: At this stage in the design we haven't come up with any real details on something like that. We could come up with a bypass around the heat exchangers, induce an artificial pressure water drop, test the operability and then put a flooding wet lay-up type of system in there -- flood water --

MR. EBERSOLE: Yes, just sterile water.

MR. COOK: As you noted, the heat exchangers are stainless and they were priced that way as well.

MR. EBERSOLE: Right.

MR. COOK: The next step after we came up with the conceptual system here was to put it in the facility and come up with the design.

(Slide.)

Just as a matter of history here, I'll back up a little bit, this is the baseline add-on facility with a single train aux feedwater and high pressure makeup which we have up in this particular plant. The building is about 85 by 55. We've got a diesel with all its auxiliaries for starting, fuel oil supply, the high pressure makeup pump, the aux feedwater pump, electrical capabilities, its own separate dedicated ventilation facility; and it is, as I mentioned, reinforced concrete seismic category 1.

In back of that, again you'll see later on the plot plan, is the facility that houses the two separate dedicated storage tanks, the condensate storage tank for aux feedwater and borated water -- again, reinforced concrete, seismic category 1. This is the building that we evaluated for cost in Point Beach.

So, what we did to evaluate the other facilities is start with this and massage it to try to get the same components in, as best we could.

What you'll notice in the previous section or in the following sections, and drawings, plans, is I'm only showing two floors. What essentially we've done is taken this upper Plenumsome area and turned it into a ventilation floor and put the ventilation up on top. The cost, even though the dimensions of the plant haven't changed, has

risen because the height has risen. But to simplify things here we didn't bother to make that third plan.

I'll start here. This is that same facility, then, as we modified it to house aux feedwater, primary makeup, and RHR, to get to a cold shutdown.

(Slide.)

The lower elevation now is strictly equipment with the fluid equipment being separated from the electrical equipment, everything draining back into the pipe chase. Your grade elevation here would then be your diesel and auxiliaries, the control room and offices. As I mentioned the third floor, again, would be ventilation. And this building stayed about the same size.

Now, we have made a little effort here to optimize and come up with some good arrangements here without changing building size.

For the last two that we just undertook, recently, we went and did a very quick layout that we really couldn't take the time to fully optimize.

(Slide.)

We felt the components weren't fully optimized either. This being the primary flow down, flash, pumps at the lower level, with the diesel, control room, and offices on top. Again, the building size didn't change, but for the purposes of cost we felt we didn't really look at this

as close as we could have. There's extra volume up here. There's volume here that's not really used. So from the standpoint of cost we figured that we could reduce the cost of the facility by 25 percent. Another, you are looking at one building size here, the cost numbers actually reflect a 20 percent reduction, to try to be fair to these other systems here that came on a little later in the game.

MR. EBERSOLE: The diesel generator, I presume, runs the service water pump system?

MR. COOK: Yes, sir. It powers everything in this building plus the pump house.

MR. EBERSOLE: So you still have the pump house as a service system?

MR. COOK: Yes, sir. There's a pump house. When I get to the plan --

MR. REED: You mean the pump house as an intake point, but the pump house pumps -- service water pumps in the pump house?

MR. COOK: Yes. We put the pumps out there. We put the service water pumps out there, cooling, service water pumps.

MR. REED: Out in the normal --

MR. COOK: Not the normal, an additional, separate service water pump house.

MR. REED: Along the concept I had proposed in a

separate pillbox?

MR. COOK: Right.

MR. REED: But rather than putting the diesel out there you put it here?

MR. COOK: Yes. But like you said, too, Glen, it's very site-dependent.

MR. MULLIGAN: From an arrangement standpoint you have to understand there was a certain design philosophy done to put the auxiliary decay heat removal design together. We couldn't go back and redesign that, and we felt in order to make a fair comparison we'd make some changes on what you proposed to make an equal design basis.

MR. REED: So you really haven't optimized at all the primary concept? You just fitted it in to do the cost analysis?

MR. MULLIGAN: We figured whatever we could do to your system we could probably go back and do the same things to the other systems anyway. There are some fundamental technical differences where you can't do those kinds of things, we agree, but we haven't done a lot of engineering work to try to optimize each one of these systems or try to get order of magnitude cost.

MR. EBERSOLE: So there are some long large pipes as well as another building in this picture?

MR. MULLIGAN: Yes.

MR. COOK: Yes. Right here, I'm sorry, I'm just looking really at the base add-on facility. There are three facilities involved: There's the base, the tank facility, and the pump house.

MR. EBERSOLE: Yes.

MR. COOK: And the tank facility here would be half of what the baseline is because you don't need condensate storage tank. You are just talking about borated water. But you still have a pump house and tunnels from the pump house to these facilities, and from these facilities into the plant. This is constant for all designs, as we evaluated here.

(Slide.)

And then we did a similar thing with the high pressure RHR.

MR. MICHELSON: Where did you intend to discharge the water that you had to pump into the facility?

MR. COOK: Back out through combination intake discharge structure.

MR. MICHELSON: That's a combination structure? You'll discharge at roughly the same point where you intake?

MR. COOK: Yes.

MR. MICHELSON: Thank you, sir.

MR. COOK: Again, this is the high pressure

facility which we felt would shrink some. And then in the cost estimates, again, we have shrunken it another 20 percent from the standpoint of cost. But both halves are independent facilities.

(Slide.)

Everything fits together as we started out, at Point Beach, where we had the main facility with the pumps, the diesels, ventilation equipment. This is the baseline tank facility with both condensate and borated water storage.

Then the baseline plant doesn't have a pump house, and we tunnel here and enter it into the aux building and into the containment.

As we grew and changed equipment facility, we still kept the location the same here. The tank facility, now, for blowdown or high pressure RHR, is half of this, because we've -- we don't need the condensate. But now we have the pump house that will be located up here in its own facility.

All facilities, reinforced concrete, seismic category 1. All tunnels are below-grade concrete enclosed until we get into here where we have to step up and get into the building, at which point we come above-grade, again in a seismic category 1 structure.

All piping and components are supported in here,

costed out on the basis of a seismic category 1 support and analysis system.

As Steve alluded to earlier, and as we found in visiting the various plants during the baseline of the study, is that the location of these facilities relative to the existing facilities is a substantial cost factor.

These tunnels are worth a lot of money when you go to put them in, between the excavation, the concrete work, and hanging the pipe.

MR. EBERSOLE: Is this a shared facility?

MR. COOK: This is just for one unit.

MR. EBERSOLE: Then you could on a per unit basis split the costs.

MR. COOK: You could realize some cost savings. We did all these -- all these estimates were based on a single unit, of a twin unit site.

MR. MICHELSON: Is that tunnel necessary as opposed to burying it in the ground?

MR. COOK: It depends, I guess, on design criteria that would be imposed on the piping. Whether it's the criteria of today --

MR. MICHELSON: There's no requirement even there, is there, that it be in a tunnel?

MR. MULLIGAN: No, it doesn't have to be.

MR. COOK: Not specifically.

MR. MICHELSON: I wonder why it's in a tunnel.

MR. MULLIGAN: Because that's the way the original design was done. It's not the concrete that costs the money. It's the pipe.

MR. MICHELSON: I thought you meant the tunnel cost a bundle.

MR. MULLIGAN: It's the long runs of safety class pipe.

MR. COOK: You'd still have the excavation and piping.

MR. MULLIGAN: It's going to be a design decision based on the particular site, what the groundwater conditions are and all those kind of things, how well you can protect the pipe, what the seismic loads are and whether you can handle them in the underground scenario as opposed to the tunnel. All those things come into play. This is what the base design was and that's what we used.

MR. EBERSOLE: May I ask the Staff a question? What is the current position, if any, on a multi-unit plant degrading to the stage and having to look at, for example, all AC powered units? All three units or two units in this case? Is there any --

MR. MINNERS: Are you talking about A-44?

MR. EBERSOLE: When you look at more than one unit at a time, now.

MR. MINNERS: I don't know what our position is. I guess the A-44 position is that the plants should be able to survive loss of all AC power for two to four hours.

MR. EBERSOLE: There's no particular credit given to self-help from the other auxiliary units, those other units? Contiguous units?

MR. MARCHESE: I think they are treated on an individual basis.

MR. MINNERS: I guess the reason I pause is if somebody came in and credited the second unit as providing power, I guess we would listen to them.

MR. EBERSOLE: But there's no orderly consideration of this at the time?

MR. MINNERS: I think there is an orderly consideration because the A-44 solution is going to require people to go out and make a demonstration, which is they'd have to make some kind of engineering study with maybe some PRA attached to it which shows that, yes, for a certain length of time they can provide without an AC --

MR. EBERSOLE: The reason I ask this is I was wondering why you put it at this station.

MR. MICHELSON: In the old designs they have done a great deal of designing a control room and single spreading units and that sort of thing to the point where I expect you have to have separate decay heat removal for

each unit because they could be in a two unit situation. New units you could do it.

MR. MARCHESE: I would just like to make a comment on the separation aspect.

You can correct me if I'm wrong but I think those European countries who have decided to backfit a dedicated facility have purposely insisted on criterion that calls for separation of that facility from the rest of the plant structures, because it's the separation in itself that buys you added protection against such events as aircraft crash, gas cloud explosions and third party intervention.

If you have the dedicated facility separated from the other structures, one of those events cannot disable all means to cool the plant down.

So the separation is expensive but it does buy you added protection.

MR. EBERSOLE: Is it not a German practice to cross feed aux feedwater when you have two contiguous units? I know one plant that does it.

MR. WARD: I don't know what the newest plants do.

MR. MARCHESE: The plants that we looked at were single units.

MR. WARD: For what it's worth, the French, with

their very standard design, the latest plants have gone to having each unit entirely separate from the others, except for, at Palo Alto, for example, it's four units, entirely separate except for a common intake structure.

MR. EBERSOLE: No cross feeds?

MR. WARD: Where earlier plants had some cross --

MR. EBERSOLE: It's a neverending argument.

MR. MICHELSON: In doing the design for this system, of course one must be assured, now, that the primary loop is in a proper condition to be cooled, if, for instance, this is a high pressure decay heat removal.

What are you going to do now on the design of the balance of the rest of the plant now in terms of being assured that you are not blowing down the reactor at the same time due to the fire or whatever? Since this is in there, in part, I think, for fire protection -- as an answer to fires. How are you preventing the reactor from being blown down during the fire so that your high pressure decay heat removal may not work?

MR. COOK: The basic philosophy behind the add-on system is to take total control of the plant.

MR. MICHELSON: That's right. How are you going to assure taking total control? Where are the disconnects that prevent the relief valves from opening? That sort of thing.

MR. COOK: I believe they are within the existing facility.

MR. MICHELSON: Well, no, the fire is there.

MR. EBERSOLE: They have not been asked to go into that detail yet. That's detail design --

MR. MICHELSON: I was asking what the philosophy was. In other words, I think your answer was going to be -- what is your answer? How are you going to handle it? Are you going to go back now and review -- would you go back and review the design and make some provision to assure that for a postulated fire at any location that you can disconnect the relief valves and certain other critical items? Is that the approach?

MR. MINNERS: I don't think we are going to go back and do that. That's not the purpose of the study. The purpose was trying to get a scoping study of how much it might cost to put in a primary blowdown system or high pressure system. Okay?

You have got to realize it's a scoping study and it may need some other pieces of equipment. No, I don't think that we intended at this point to take the scoping --

MR. MICHELSON: I only meant to ask what it is going to cost to do this other part. It has to be a part of this scoping study, if it were significant.

Maybe it's an insignificant cost, to take care

of this question. If it is, then you don't need it in your estimate. Otherwise you need it in your estimate because your system doesn't work without a proper isolation from the event that you are worried about.

MR. WARD: Wait a minute. Maybe it's not an insignificant cost but it would be common for each of the four proposals here, wouldn't it?

MR. MICHELSON: It may be considerably more for the high pressure heat removal, which I think depends on single phase removal, than for Glen's case which I don't think it makes a difference. I don't know. He may be able to tolerate a blowdown going on and it will, if anything, it may help. I haven't thought it through but it may help. In the case of high pressure decay heat removal I think it has to be prevented.

MR. WARD: That will have a small break LOCA capability.

MR. MICHELSON: Yes. But not big break, not the size of several relief valves opening, depending on the number on the system. That's generally one or two relief valves. In each of 10 --

MR. REED: I agree with what Carl is saying. I'm more concerned about -- there's so much difference between an auxiliary feed add-on on a primary blowdown system and an a high pressure heat removal system from the

primary. There is so much difference in those systems that it bothers me.

I understand the scope of your work and the fact that you are trying to add something in at a very low cost. I believe th y are so unique and different that even their layouts, that is in the area, will be lots different.

For instance, a primary blowdown system should be snuggled real close, and then you use a buried service water pipe. You don't have to have tunnels. The burying would be wrapped in buried pipe and the cost differences from these aspects can change radically, based on which of the three you choose.

I believe you have to go more to optimization to decide on costs.

Now, I understand this is a rough shot, a rough shot. The other thing that Carl is talking about --

MR. WARD: A rough shot. It's the only shot we have. We have been hearing about these systems. We are trying to begin to get some kind of engineering comparison. We are getting it. I suggest we hear the rest of it.

Would you go on?

MR. COOK: Well, basically the basis for the cost, we sized the major components and the piping structures.

(Slide.)

The facilities, the structures with the base case only having the primary 2, the equipment building and tank facility, and if you add RHR, then you have to go to a pump house; and with primary blowdown and high pressure RHR, you end up with all three as well: service water, tanks, and the equipment, although your equipment facilities are slightly reduced and so is your tank building.

Tanks being another major item. The base RHR had 220,000 tanks. When you add RHR you have added on any tanks. Of course primary blowdown we had the RWST, BWST, which of course we reduce because we had the inventory at the time and then you have the base case with the high pressure RHR again.

As far as pumps with the base ADHR, you have your aux feedwater pump and primary injection pump, which -- and then, go to RHR we add the low pressure RHR pump. The primary blowdown, the 1 -- let's see -- the makeup pump. This is the primary injection pump. There is another small makeup pump but we didn't add one on this table. And then the service water pumps at which you start with your normal RHR and flow, goes up considerably. But the primary blowdown and the high pressure RHR. (Indicating.) Again, primary because of the that arbitrary limit. But any cost penalties here would be constant between the two.

MR. MULLIGAN: The other thing is the heat load

for that RHR is much lower because that comes on much lower in the game.

MR. COOK: Oh, yes. The diesels, you can see the main injection pump is the primary driver in the overall diesel sizing, which affects the primary blowdown a little more than some of the other options, the smallest one still being the baseline case and the high pressure RHR. And then with the addition of low pressure RHR, or the primarily blowdown.

Heat exchangers, the base case has none since we are using secondary side evaporation. The RHR heat exchange here is sized about 2000 for the condensor and bottoms cooler for the blowndown. We have two, for a total of about 5400 square feet and 3000 square feet for high pressure RHR.

The big difference in the costs, as we'll see in a minute, comes down here in the piping.

Whereas, with the base case and the base case RHR, all the piping is 3, 6, 8-inch schedule 40 lightweight wall standard pipe, service water was 18 inches.

When we get into these two -- and one of these, by the way, is the change that we made and put control to flash tank which makes all your piping high energy piping, heavy wall pipe. It's sized about the same size for both systems.

If we can resolve it and design to take the control back into containment, we'd see some additional here. The service water piping, we are paying the penalty here again because of the high flows. These two later systems do have the higher, larger pipe sizes.

(Slide.)

As a result, if we take the direct costs, break them out into some of these major categories, the structures -- it changes a little bit but if you look at structures and piping together, piping is the overwhelming driver. You know, it's anywhere between 25, 30 -- when we get into these high energy systems, we are up to almost 50 percent of cost, over 50 percent in some cases. The problem there being the heat treatment. It's not only welding its heat treatment. When you are back on the standard wall piping it's just basic welding. That is a significant driver. Instrumentation conduit, cable are small drivers, but they do change slightly.

MR. EBERSOLE: Would you elaborate on what you mean by "heat treatment"?

MR. COOK: When wall thickness gets up in this range, schedule 1630, 180 pipe got to pre-weld and post-weld heat treatment to relieve stresses and that, in addition to time, takes a lot of man-hours.

If we could drop the pressure down earlier and

sooner, and minimize those pipe runs or minimize the design pressure, get back to a schedule 80 pipe, anything below a half-inch wall --

MR. EBERSOLE: You mean right back at the reactor piping someplace?

MR. COOK: If we could do it somehow. With the limited time we couldn't agree on how to do it there.

MR. MULLIGAN: You have some serious problems in that you are running 65 percent liquid and 35 percent steam, and you are blowing big slugs of liquid down that line.

MR. EBERSOLE: Couldn't you do it with some good ball valves right on the pipe?

MR. COOK: The piping down on the stream is the problem.

MR. EBERSOLE: I mean at the primary piping with some good ball valves --

MR. MULLIGAN: You still run into the problem where you are throwing big slugs of water down the pipes, and restraining those pipes and keeping them together during this whole thing is a major design problem if you can do it at all.

MR. MICHELSON: You don't know what the upstream fluid condition is, necessarily, either, in the case of Glen's proposal. When you are blowing down you don't know what you are blowing down. It could be any one of either

phase or mixed.

MR. EBERSOLE: Well, let me get shot out of the saddle here by saying you depress the primary coolant down in the reactor and then you are carrying steam out.

MR. MULLIGAN: Well --

MR. COOK: Yes. We sized this to take over at one hour.

MR. MULLIGAN: That's in the core, isn't it?

MR. EBERSOLE: No, it's above the core. We've got some new devices now that will tell us where we are.

MR. MULLIGAN: I understand.

MR. EBERSOLE: Not ambiguous, shall I say.

MR. REED: To clarify in the concept I was dealing with, you would flash inside containment and you would have water and steam and we recognized that. We recognized there would have to be lots of restraints and the flash tank, that little half moon you have in there is quite an impact structure into flash tank.

That's why I didn't -- somebody suggested why don't you go underwater to discharge. No way could you ever hold that. You are going to have to come into the top of the flash tank, above water and hit an impact plate. I really think that we should be able to design that kind of a blowdown and that makes your high pressure line situation go down.

MR. MULLIGAN: The other thing it gives you now is you've got some pretty big pipe that you have to figure out how to get out of containment. If you have to put in additional penetrations of that size, what did we figure, 20-inch?

MR. COOK: I don't think it was that. 10, 12 --

MR. MULLIGAN: You have to be able to find the penetrations to do it. If you don't find the penetrations to do it -- because if you can't you are in a major problem; putting another penetration in the replacement power costs far exceed anything we have on this.

MR. REED: I recognize that and I know what some of the spares are and the sizes are. I recognize that. Maybe you are going to be just outside or just inside. I'm not sure.

MR. COOK: Essentially all the costs do is sum up from the baseline facility. These last two at this stage of design probably should get a little more work before they are used anywhere to confirm this pipe. Because the piping has such a heavy burden on the overall direct.

MR. MULLIGAN: I think the only thing you can conclude is that, you know, the primary blowdown and the high pressure RHR are considerably more expensive than the add-on decay heat removal system.

You know, I think there's enough uncertainty in what we've done to date that you can't say whether one or the other is more expensive. From the overall control standpoint the high pressure RHR looks like it is quite a bit simpler than the primary blowdown. You are dealing with, you know, for the most cases that we were considering, single phase or the other issue of multiple phase that was brought here.

But you are talking about a couple of pumps and valves and you don't have the problem with trying to balance this whole system. We still haven't really come up with a control system that we thought would work on the primary blowdown. After looking at several different kinds of control systems we are still up in the air as to what it would really look like in order to be able to control the whole operation, to balance the whole operation without slamming down the pressurizer or draining the pressurizer during the process. And then the delicate balance of bringing the thing down to RHR conditions, to put it on RHR.

There's a lot -- it's a lot more complex to control the whole operation. As I say, to this point we haven't figured out how we would control it.

MR. WARD: But it may offer advantages, as Glen points out, in dealing with a wider spectrum of accident conditions.

MR. MULLIGAN: We are not in a position to say anything about that. I think that really has to be analyzed in the context of the PRA, or whatever, to decide whether that really is worth the extra money.

MR. WARD: Right.

MR. CATTON: Did you look at the loft blowdown tank when you were thinking of this design?

MR. MULLIGAN: No.

MR. COOK: No.

MR. CATTON: It might be helpful.

MR. WARD: How that's designed, you mean?

MR. CATTON: Yes. They have been running it for a long time, for large break LOCA studies.

MR. REED: We didn't, but we will.

(Slide.)

MR. COOK: As a matter of comparison we have developed what we call the total evaluated cost, the number that Steve was showing, discussing with the direct costs, the indirect costs such as construction management, engineering, owners' costs -- I'm sorry -- construction, management, on-site materials, temporary facilities, to come up with a total. Then we do have a 25 percent contingency in here as well. It's clear, across the board, 10 percent owners' costs, escalation and AFUDC, based on an 18-month to two-year period to come up with a total number.

At this point the directs are just as good as looking at everything else here.

Questions?

MR. ERICSON: My comment -- Mr. Reed made the comment earlier, that their original thoughts were that the flash tank, that sort of thing was "snuggled up" I think was your comment, to the containment. We might come back and mention some of the concerns we had about trying to do construction right adjacent to or as part of containment.

MR. MULLIGAN: Yes. There is considerable concern trying to dig a hole right next to the containment, and if you have any problems at all that shut you down it's going to cost you a quarter of a million dollars a day. You very rapidly -- you are going to shorten up some of that more expensive pipe.

Out of that $20 million, even though you said it's big, it's maybe $2 million worth of pipe you could save. You could very rapidly lose all that advantage by doing the construction right next to the containment and running into operational problems as a result of the construction.

Now, you can say well, that's hypothetical, but I think it's a real concern. I think on the concern of the Point Beach people they wouldn't think of building anything in right snuggled up to the containment. They want it

right out there where they could put it outside the fence, build that whole thing and tie it in when they could tie it in.

As I say, it's worth -- you are right. But you know you've got to balance off, you are losing something by reducing the length of those -- that piping, but on the other hand you could very well wind up -- for example, if you looked at this, you put this thing down here you wind up making the service water piping longer. So you don't get the full advantage of doing that, you are kind of moving a building in between some expensive piping and not quite so expensive piping, and you don't get the full benefit of it and you could very rapidly lose that advantage if you run into operational problems while you are working close to the containment.

MR. REED: Recognizing that, my definition of snuggling is different from yours. My snuggling is at 65 years of age, and yours is somewhat less.

MR. EBERSOLE: I thought you were going to say at 65 feet.

MR. REED: Okay. I want to drive home again if I can, and I certainly ask Dr. Ericson and company to reread the final papers on this idea. Because the primary blowdown system and the closed system has been around for years and it has its pressurized therm 3458 shock problems

and all that kind of thing -- I would like to find out that this system of primary blowdown does a multitude of things and helps in a lot of areas.

Small break LOCA; pressurized thermal shock; steam generator tube rupture; steam generator overfill; loss of AC, outside AC; loss of primary natural circulation; and that can't be discounted.

Secondary system: rupture problems, auxiliary feed, lack of diversity.

The other thing is, keep in mind when you build on the auxiliary feed system you still must move the heat through the steam generators.

MR. MULLIGAN: You look at the high pressure RHR, okay? It should handle everything except a large break as long as you can vent the high points in the system.

For example, on the B&W plants they are venting and can decay over to the head and venting the head. As long as you can restore -- vent the high points in the system you should be able to make that --

MR. REED: How do you deal with high pressure thermal shock and tube rupture and steam generator overfill? How does it help those cases, I mean?

MR. MULLIGAN: I haven't looked at those cases. Were those listed on his list?

MR. COOK: I'm trying to remember.

MR. REED: Primary blowdown helps many of the problems that we've had and we have been patching for years.

MR. MICHELSON: What pressure did you have in mind for the high pressure RHR?

MR. MULLIGAN: It operated at normal system pressure.

MR. COOK: Normal pressure. 2250.

MR. MICHELSON: 2200 pounds? That's a relief. Thank you.

MR. WARD: Any other questions?

Well, thank you. It has been a very interesting look and useful comparison of the concepts.

Let's see, next on our agenda -- I guess we are back to item G? Let's take a break for -- about a 15 minute break and come back.

(Recess.)

MR. WARD: Let's reconvene and our next speaker is Mr. Marchese on the CE/PORV issue.

MR. MARCHESE: One of your favorite topics. You specifically asked us for a discussion on how information developed in the A-45 program will support development of a staff position on the Combustion Engineering PORV issue, which, as you know, has been a longstanding item.

(Slide.)

This slide lists the A-45 input that we feel

will assist us in reaching a decision on this issue.

I believe -- I think I alluded to this when we had the meeting last month on the Palo Verde Unit 2 licensing.

In the A-45 program, all 5 PWRs, including the Saint Lucie, which is a Combustion Engineering unit, are being analyzed with and without bleed and feed capability, therefore we can calculate the change in core melt frequency and also risk of adding bleed and feed capability.

MR. MICHELSON: Excuse me, is there going to be a hand-out on this?

MR. BOEHNERT: You have it. It's in the initial one Andy put out. First packet.

MR. MARCHESE: It's the fifth slide in the first packet.

In addition to changing core melt frequency and risk as associated with adding bleed and feed capability, we are also going to determine the cost and impacts of adding said capability.

The bleed and feed capability is one, as you know, of several alternatives being examined in the A-45 program. Based on the value impact analyses of all of these alternatives, a bleed and feed will be compared and we feel that this will provide the kind of input we need to determine whether or not we select bleed and feed, versus

some other alternative.

The next slide, which you really, I think, have seen in the past, but just to give you a feel of the other alternatives that are being looked at in the program, and they include such things as improved procedures, just adding PORVs, going to dedicated bleed and feed systems such as the one Mr. Reed has proposed, high pressure RHR, and the other ones that are listed there. In other words, we will examine this in value impact space, and make a recommendation.

Now, in terms of specifically what we are doing on bleed and feed -- again this has been presented several times in the past, specifically at the meeting we had on Palo Verde -- we are doing a lot of work on bleed and feed, not only looking at system concepts that were proposed -- that were discussed here earlier, but we are also doing a lot of work in the thermal hydraulics area to assess the viability of bleed and feed. We are doing this for a range of PWRs.

(Slide.)

We are extending this to other plant types, getting a handle on the key parameters such as valve size, RCIC pump shut-off head, operator action time to bleed and feed, and, again, assessing the impacts associated with adding such capability.

MR. REED: You talked to the alternative systems and high pressure and primary blowdown system.

As far as I'm concerned, and I have always felt this way, bleed and feed is really a primary blowdown activity.

Now, the extent to which you polish that and make it better and less challenging to inside container equipment gets you, perhaps, to the Cadillac, and the Cadillac in the system is a primary blowdown or a bleed and feed to a flash tank outside which keeps from messing up the inside of the containment.

So, you can go it one of three ways.

Bleed and feed dirty, messing up the inside of the containment, or you can have what we are calling a containment-supported primary blowdown of bleed and feed, or you can go to the Cadillac.

You are costing out the -- what we'll call the messy; that is assured, but it is not very expensive.

MR. MARCHESE: I think we'll have cost information on all three different ways of doing it.

Okay. And then finally as I mentioned, we are going to compare all of these alternatives in a value impact analysis and make some recommendations.

Now, Brian Sharon is not here, but he asked me to remind you that when we did the CE/PORV study, it was NRR

management's position that adding PORVs to those Combustion Engineering plants that didn't have them, that that was a minimum requirement, that it was determined that it was necessary. It was the Staff's opinion that those values did buy you a reduction in risk and was worth implementing, but it was decided to hold off on that pending a decision on A-45. Once this study is completed that decision will be made.

MR. WARD: That decision will be confirmed or reversed. But I think you said, rightly, that there really was a decision made to require PORVs. But then it was agreed it would be -- implementation would be held in abeyance until after A-45.

MR. MARCHESE: Okay. That's all I have on the combustion.

MR. REED: Well, you've got me all excited here. Where do you think we are coming out with requiring PORVs, or bleed and feed, or the dirty primary blowdown?

MR. MARCHESE: I think with respect to those Combustion Engineering plants that don't have PORVs, it's NRR's position that that ought to be a minimum requirement that comes out of A-45. A-45 may come out with something more comprehensive than just adding PORVs.

For example, we may recommend a dedicated bleed and feed capability which is more extensive than just

adding PORVs.

MR. REED: But there's something along the PORV line that's going to happen; is that what you are predicting?

MR. MARCHESE: That was NRR's position. That was prior to going to CRGR, but --

MR. MICHELSON: What is roughly the schedule for getting the resolution?

MR. MARCHESE: That was my final viewgraph which I was going to come back to later on to wrap things up with.

MR. EBERSOLE: Andy, at the risk of intercepting what could be a better dedicated decay heat removal system and to introduce my own best patch, I think you better look at a low pressure, low flow, 2- to 300 pumping system at about 200 psi, with diverse pumping water systems to the boiler, and then along at open rating with blocked open PORSs and boiling to atmosphere on a pre-core melt basis, not with this, as I regard assinine position of the owner's group to wait until the core is melting and then do it. I think that is absolutely without logical foundation. I'd just like that to go on the record.

Any comments?

MR. MARCHESE: With respect to the boilers, we are -- we have taken a cursory look at that system.

MR. EBERSOLE: I know. You said that. We've

got to do more than cursory.

MR. MARCHESE: I think it will be ranked along with these others as best we can. But as Warren pointed out, we've got to get on, in terms of getting a resolution put together. You know, we keep doing studies and studies.

MR. EBERSOLE: I invite you to consider in the course of doing this, as I always say, we should do the relative complications of this versus this thing that we just looked at in terms of cost and complications and liability. It's like an order of 1 to 50; in complexity and cost.

MR. MINNERS: Are you suggesting, Jesse, that when we finally get out with a proposed resolution, that we specify a particular system that licensees should install?

MR. EBERSOLE: Yes. It's prescriptive, in caps.

FROM THE FLOOR: That's against the --

MR. EBERSOLE: I understand that and that's one of my major problems with this regulatory process.

MR. MINNERS: Okay. That's clear.

MR. MARCHESE: Okay. We are now clear to discuss the sabotage analysis. Do you want me to do that now?

MR. MINNERS: Why don't you do that in the open session, get rid of it in the open session?

MR. WARD: All right. Good.

MR. MINNERS: So we are not hiding anything.

MR. MARCHESE: Maybe some people want to go home. Should I do it now?

MR. WARD: Go ahead.

MR. MARCHESE: Okay. Schedule.

(Slide.)

The main ingredient of the schedule right now is to complete the plant analysis, the seven-plant analysis.

Dave Ericson talked about the plant analysis status. Basically, I think what he said is we can expect four plants to be complete by Christmas, and the following three to be done in about the February-March time frame. So that's driving -- that's one of the things driving the schedule.

Now, in terms of the main -- the critical milestones.

(Slide.)

This is my best estimate on what it is going to take to complete those. We are estimating that we can produce a summary report on all seven plants in about the May -- springtime frame. In addition, a regulatory analysis will proceed in parallel with that effort.

As you know the two main documents we need to go forward to CRGR are a technical findings report and a regulatory analysis. We are anticipating that we can get

those out for Staff comments next summer.

Then that starts the internal process of bringing this through the approval chain, and the milestones are shown here, including getting division concurrence, going to the director of NRR and getting his concurrence, and then finally submitting that to the CRGR, and they'll do their review and provide their comments to us.

That comes back. We resolve the comments and then it goes out for public comment, and we are projecting that this thing would go out for public comment about February of '87.

That's all I have on scheduling. Any questions?

MR. WARD: Is the schedule constrained by limitations on resources within the Staff -- your ability to contract resources?

MR. MARCHESE: The schedule problems that we have been having are partly attributed to, once we provide the documentation to other parts of the Staff, we kind of lose control in terms of the time it takes for them to do their thing. That has been a continuing problem with this program.

Our contractor resources right now we feel are adequate. The funding that we have available, we feel, is consistent with doing this job. But once it leaves our

hands and goes into other divisions within NRR, it has been a problem in terms of getting a timely review because they are busy with other things.

MR. WARD: But yet that review seems to have been very important, a lot of important input.

MR. MARCHESE: I think it is very important.

MR. WARD: Okay.

MR. DAVIS: Excuse me, Andy, I had a quick question. This third item from the bottom, the package to CRGR, is that going to include your recommendations on which plants need to be fixed and how they should be fixed? Or is this just the complete analysis of the plants?

MR. MARCHESE: No. We'll have to have some specific recommendations.

MR. DAVIS: Okay.

MR. MARCHESE: Just what the resolution is going to be, we haven't developed that yet. It could be a number of different things.

MR. WARD: But rather than what plants have to be fixed, it might be a set of criteria against which plants will have to judge themselves or something like that, I guess.

MR. MARCHESE: Right. Right.

MR. DAVIS: That's what I was trying to decide, is what exactly would be in it in terms of recommendations.

MR. MINNERS: I don't think we know that, Pete. I guess there's lots of questions in what form of resolution. Jesse says it can't be in the general form of do good, that's not going to be enough for him. He says put high pressure system on plant A, and --

MR. DAVIS: The source problem will not be resolved by that time in all likelihood and neither will the safety goals, likely. I just wonder what criteria you are going to use to make the decision. But I guess we'll just have to wait and see.

MR. MINNERS: The safety goal rule isn't that big a problem. Maybe I speak out of turn but I think people are generally accepting the proposed safety goal criteria that were laid down.

All day today we talked about $1000 per man-rem, and things like that. I think there's kind of a consensus in the technical part of the Staff. That's what people compare things to all the time, But it's not that simple.

There are lots of other factors to be considered than just the number crunching of cost/benefit analysis, and the next session on sabotage is probably one of the bigger issues that has to be considered.

All of the things that Glen brought up, this system can fix a multiplicity of problems, and maybe we should include that defense in depth. Should we prevent

core melts as well as prevent public risks. I guess that's the process the Staff has to go through. That's what the Cooper package is going to provide. It's going to give some kind of technical resolution, the form of which I don't see what that is at the moment, and then it's going to give a value impact analysis which is more than just number crunching. It is going to give the rationale of why we think that resolution is the proper resolution for the Commission to adopt.

It's going to try to weight all of the quantitative factors, all the qualitative factors. It's not an easy process. We have to figure out how to handle occupation exposure versus public exposure and all those kind of things.

MR. EBERSOLE: Warren, would it make sense to do a study based on some fluctuations in the source term as we anticipate they might come?

MR. MINNERS: We already presented some of those results. 1.3 in RSS, okay?

MR. EBERSOLE: If it goes down by a factor of 10, things get a lot better, don't they?

MR. MINNERS: Well, yes, as the numbers show.

MR. DAVIS: Your sensitivity study shows they are sensitive. Now we have to decide what we are going to use.

MR. MINNERS: Public risk is directly proportional to the source term.

MR. DAVIS: It's even more than directly proportional.

MR. MINNERS: Actually not, because of the 25 rem interdiction criteria. You won't see that big a difference in criteria on the public risk because people are now being moved out when they get 25 rem, and with the new source term they are going to get out when they get 25 rem. If the source term is so small that nobody gets 25 rem, then you'll see some difference. But it really isn't that sensitive to source term. I misspoke when I said proportionate. With the interdiction it is not. With the full potential it would be almost directly proportional. What it will affect on the noble gases --

MR. EBERSOLE: I hope there will be a lot of work done on the relative aspects of using these systems in the context of mitigating an entire core melt versus what I regard the better use of them, to prevent a core melt, and then have them in reverse for use subsequent to core melt if you have to.

MR. MINNERS: Well, there's economics in there. That to me is largely an economic decision, whether you want to prevent core melts or whether you want to mitigate them.

MR. EBERSOLE: I guess I can't quite get rid of the economic picture.

MR. MINNERS: That should be considered but that kind of stuff is handled -- if you include on-site damages you automatically include whether you should prevent or mitigate. If the numbers say it's cheaper to prevent, well, that's the way you go.

MR. EBERSOLE: That's where the big money is, building these facilities.

MR. MINNERS: That's right. If you have high core melt frequencies then the on-site costs become very significant.

MR. WARD: I see the United Engineers people are gone but I should have asked one more question. Those four designs, let's see, none of those had any redundant capability, as I recall.

MR. MARCHESE: No. But we are doing some variations of those systems that will give us a delta on costs of adding redundancy as designed to single failure criteria.

Bunkering has been brought up several times. There's been a lot of confusion on what a bunker really is. We also will have a delta in there, on what the cost is of going from a seismic category 1 structure to a bunkered structure.

As you know, bunkered structure is more extensive in terms of the amount of structural hardening than a seismic category 1 structure, so we'll be able to display the costs of doing that.

MR. WARD: But as far as single failure resistance and multiple trains, there'll be a delta cost available?

MR. MARCHESE: Yes.

MR. WARD: Do you have any idea what that is?

MR. COOK: I do, but it's not with me. We do have the numbers, but it's not with me.

MR. WARD: Unless there are any other questions, we'll go into the closed session for the meeting. Let's take a 5 minute break and clear the room. And we'll end the record right here.

(Whereupon, at 3:50 p.m., the meeting proceeded in closed session.)

CERTIFICATE OF OFFICIAL REPORTER

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

SUBCOMMITTEE ON DECAY HEAT REMOVAL SYSTEMS

DOCKET NO.:

PLACE: Washington, D. C.

DATE: Tuesday, December 3, 1985

were held as herein appears, and that this is the original transcript thereof for the file of the United States Nuclear Regulatory Commission.

(sigt) Joel Breitner

(TYPED)

Official Reporter

Reporter's Affiliation

TASK ACTION PLAN A-45 RESULTS FOR QUAD CITIES

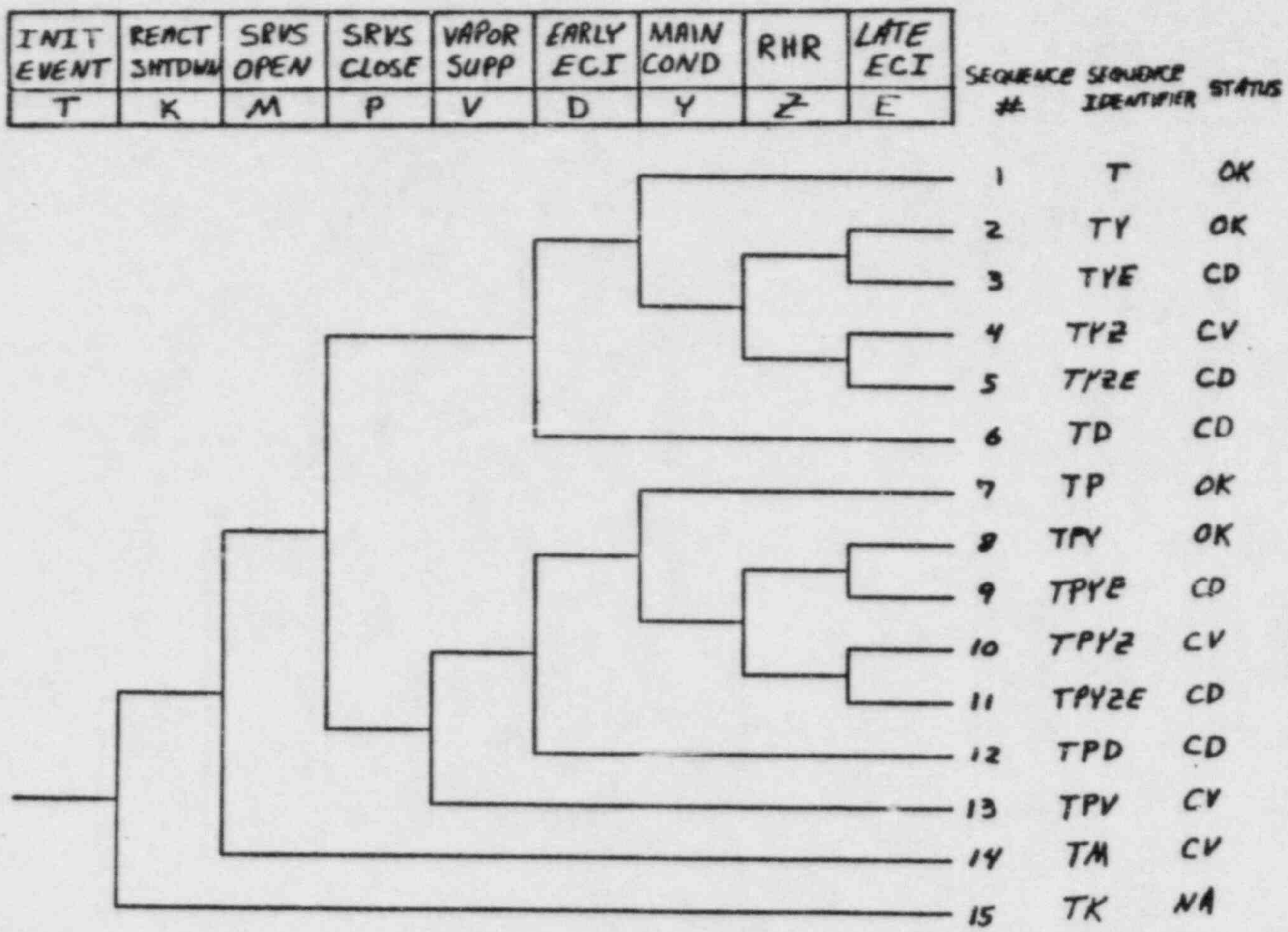
ACRS SUBCOMMITTEE MEETING

DECEMBER 3, 1985

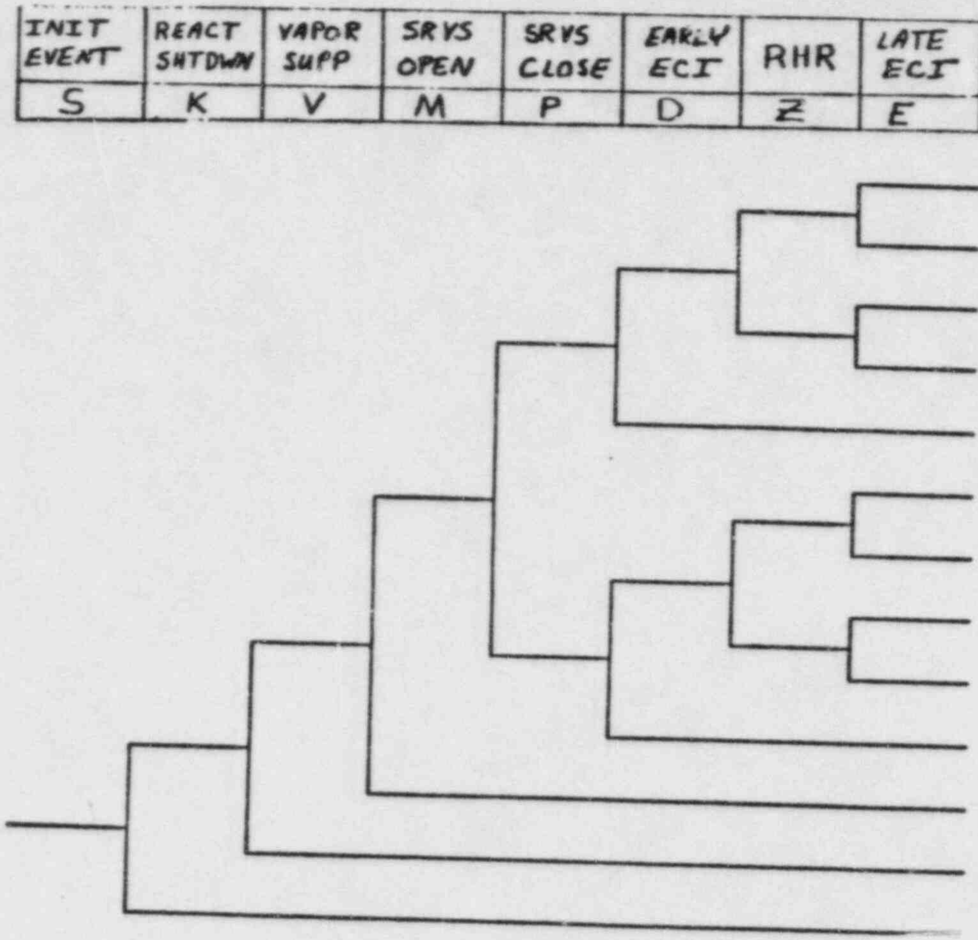
STEVEN W. HATCH

SANDIA NATIONAL LABORATORIES

QUAD CITIES TRANSIENT EVENT TREE



QUAD CITIES SMALL LOCA EVENT TREE



SEQUENCE #	SEQUENCE IDENTIFIER	STATUS
1	S	OK
2	SE	CD
3	SZ	CV
4	SZE	CD
5	SD	CD
6	SP	OK
7	SPE	CD
8	SPZ	CV
9	SPZE	CD
10	SPD	CD
11	SM	CV
12	SV	CV
13	SK	NA

QUAD CITIES EVENT TREE DEFINITIONS

T1 - LOSS OF OFFSITE POWER TRANSIENT
T2 - LOSS OF FEEDWATER TRANSIENT
T3 - TRANSIENT WITH FEEDWATER INITIALLY AVAILABLE
T-AC - AC BUS FAILURE INITIATOR
T-DC - DC BUS FAILURE INITIATOR
S - SMALL LOSS OF COOLANT ACCIDENT
K - REACTOR SHUTDOWN FAILURE
M - SAFETY/RELIEF VALVES FAIL TO OPEN
P - SAFETY/RELIEF VALVE FAILS TO RECLOSE
V - FAILURE OF VAPOR SUPPRESSION
D - FAILURE OF EARLY EMERGENCY COOLANT INJECTION
Y - FAILURE OF THE MAIN CONDENSER
Z - FAILURE OF THE RESIDUAL HEAT REMOVAL SYSTEM
E - FAILURE OF LATE EMERGENCY COOLANT INJECTION

CHANGES SINCE PRELIMINARY DRAFT

* ADDED PUMP AND VALVE COMMON MODE FAILURES
* INCREASED CONTROL CIRCUIT FAILURE
* ADDED SUPPORT SYSTEM INITIATING EVENTS
* REEVALUATED OTHER DATA

RESULTS

* CORE MELT PROBABILITY INCREASED BY A FACTOR OF 2

INITIAL QUAD CITIES INSIGHTS

NO REMOTE MANUAL CONTROL OF SAFETY/RELIEF VALVES

NO REMOTE CONTROL FOR RECIRCULATION PUMPS

NO INTEGRATED REMOTE SHUTDOWN PANEL

ONLY ONE 125 AND 250 VDC BATTERY PER UNIT

PLANT APPEARS TO BE VULNERABLE TO UPSTREAM DAM FAILURES

BOTH SAFETY DIVISIONS ROUTED THROUGH ONE CABLE SPREADING ROOM

BUILT WITH THREE FOOT VERTICAL CABLE SEPARATION

VENT STACK COLLAPSE COULD IMPACT 4160 VAC SWITCHGEAR

CONDENSATE STORAGE TANK IS NOT SEISMIC CATEGORY I

QUAD CITIES RESULTS

21 INTERNAL EVENT SEQUENCES DOMINANT PRIOR TO RECOVERY

16 INTERNAL EVENT SEQUENCES DOMINANT AFTER RECOVERY

SEISMIC EVENTS AND FIRES DOMINATE THE SPECIAL EMERGENCIES

INTERNAL EVENT SEQUENCES

	PROBABILITY
1. TRANSIENTS WITH LATE ECI FAILURE (STATION BLACKOUTS, TYZE)	1.6E-4 (57%)
2. TRANSIENTS WITH EARLY ECI FAILURE (TD)	1.0E-4 (36%)
3. TRANSIENTS AND LOCAS WITH NO POOL COOLING (SZ, TYZ)	1.8E-5 (6%)

DOMINANT QUAD CITIES ACCIDENT SEQUENCES

SEQUENCE IDENTIFIER	PROBABILITY WITH RECOVERY
T1YZ	1.3E-06
T2YZ	3.4E-06
T3YZ	4.1E-07
T1YZE	8.7E-05
T1PYZE	7.0E-07
T2YZE	1.6E-06
T3YZE	4.0E-06
T1D	4.3E-05
T1PD	3.5E-07
T2D	2.7E-07
T3D	1.6E-06
SZ	1.3E-07
T-AC-YZE	3.7E-05
T-AC-D	2.4E-06
T-DC-YZ	1.1E-07
T-DC-D	1.7E-07

Note: All probabilities are per reactor-year.

MOST SIGNIFICANT VULNERABILITIES - INTERNAL

1. LOCAL FAULTS OF TWO DIESELS
2. FAILURE OF DIESEL FIELD FLASHING
3. DIESEL COOLING WATER FAILURE
4. FAILURE OF DC CONTROL POWER TO BREAKERS AND ECCS LOGIC

INTERNAL EVENT MODIFICATIONS

1. ADDITION OF A FOURTH DIESEL
2. DEDICATED BATTERY FOR DIESEL 1
3. INSTALL ADDITIONAL DG COOLING WATER PUMP
4. PROVIDE AUTO TRANSFER OF DC LOADS

FIRE ANALYSIS

VULNERABILITIES

CONTROL ROOM FIRES	6.7E-6
CABLE SPREADING ROOM FIRES	5.8E-6
	1.3E-5 PER R-YR

MODIFICATION

REVISE PROCEDURE FOR SAFE SHUTDOWN PUMP OPERATION

CONTROL ROOM FIRES	1.5E-6
CABLE SPREADING ROOM FIRES	1.3E-6
	2.8E-5 PER R-YR

SEISMIC ANALYSIS

* SAFE SHUTDOWN EARTHQUAKE .24 G

* EARTHQUAKE FREQUENCIES

.5 - 1 SSE	1.0E-3
1 - 2 SSE	2.3E-4
2 - 3 SSE	1.4E-5
3 - 4 SSE	5.3E-6
4 - 5 SSE	1.5E-6

* SEISMIC INITIATED EVENTS

  S - SMALL LOCA
  T1 - LOSS OF OFFSITE POWER
  T2 - LOSS OF MAIN FEEDWATER

SEISMIC CORE MELT PROBABILITIES

LEVEL	S	T1	T2	TOTAL
.5 - 1 SSE	4.6E-9	2.6E-6	9.3E-7	3.5E-6
1 - 2 SSE	1.0E-5	4.1E-5	5.0E-7	5.2E-5
2 - 3 SSE	3.8E-6	1.5E-5	5.1E-7	1.9E-5
3 - 4 SSE	1.6E-6	3.6E-6	4.1E-9	5.2E-6
>4 SSE	1.9E-6	9.6E-7	1.1E-9	2.8E-6
			TOTAL	8.3E-5

SESIMIC-RELATED VULNERABILITIES

FAILURE OF BATTERY RACKS

FAILURE OF 4160 VAC BUS CABINETS

SEISMIC MODIFICATIONS

INSTALL METAL BATTERY RACKS

ANCHOR TOPS OF 4160 VAC BUS CABINETS

SEISMIC CORE MELT PROBABILITIES WITH MODS

LEVEL	S	T1	T2	TOTAL
.5 - 1 SSE	0	2.0E-7	6.2E-7	8.2E-7
1 - 2 SSE	2.9E-6	1.4E-5	0	1.7E-5
2 - 3 SSE	2.5E-6	3.1E-6	2.2E-8	5.6E-6
3 - 4 SSE	1.0E-6	1.4E-6	4.1E-9	2.4E-6
>4 SSE	1.4E-6	8.0E-7	0	2.2E-6
				2.8E-5

QUAD CITIES RESULTS FOR ALTERNATIVES

	Base Case	Alternative 1	2	3	4	5
Internal	1.8E-04	7.4E-05	1.3E-04	7.4E-05	1.3E-04	5.5E-05
Seismic	8.3E-05	8.3E-05	8.3E-05	2.8E-05	2.8E-05	4.3E-05
Fire	1.3E-05	1.3E-05	1.3E-05	2.8E-06	2.8E-06	1.3E-05
Internal Flood	negligible	-	-	-	-	-
External Flood	9.8E-08	9.8E-08	9.8E-08	9.8E-08	9.8E-08	9.8E-08
Extreme Wind	1.4E-07	1.4E-07	1.4E-07	1.4E-07	1.4E-07	1.4E-07
Lightning	1.7E-06	1.7E-06	1.7E-06	1.7E-06	1.7E-06	1.7E-06
	-------	-------	-------	-------	-------	-------
	2.8E-04	1.7E-04	2.3E-04	1.1E-04	1.6E-04	1.1E-04
Change in core melt		1.1E-04	5.4E-05	1.7E-04	1.2E-04	1.7E-04

Note: all values are per reactor-year of operation

DEFINITION OF DHR ALTERNATIVES

ALTERNATIVE 1

- FOURTH DIESEL GENERATOR
- AUTO TRANSFER DC LOADS

ALTERNATIVE 2

- DEDICATED BATTERY TO DG 1
- THIRD DG COOLING WATER PUMP
- AUTO TRANSFER DC LOADS

ALTERNATIVE 3

- SAME AS ALT 1 PLUS
- ENHANCE PROCS FOR SSP
- NEW BATTERY RACKS
- ANCHOR AC BUS CABINETS

DEFINITION OF DHR ALTERNATIVES

ALTERNATIVE 4

SAME AS ALT 2 PLUS
ENHANCE PROCS FOR SSP
NEW BATTERY RACKS
ANCHOR AC BUS CABINETS

ALTERNATIVE 5

ADD-ON DHR SYSTEM

QUAD CITIES DHR ALTERNATIVES

	ALTERNATIVES				
VULNERABILITY	1	2	3	4	5
INTERNAL 1	X		X		X
INTERNAL 2		X		X	X
INTERNAL 3		X		X	X
INTERNAL 4	X	X	X	X	X
FIRE			X	X	X
SEISMIC 1			X	X	X
SEISMIC 2			X	X	X

COST OF ALTERNATIVES

ALTERNATIVE	ENGR + INSTALL	O+M	OCC DOSE
1	$15.2E6	9.7E4	0
2	5.8E6	4.0E3	0
3	15.3E6	9.7E4	0
4	5.9E6	4.0E3	0
5	82.4E6	5.3E5	1200

SUMMARY OF IMPACTS (CENTRAL EST)

ALT	TOTAL IMPACT ($XE-6)	TOTAL AVERT COSTS ($XE-6)	NET IMPACT ($XE-6)
1	16.5	3.3	13.3
2	5.9	1.6	4.3
3	16.6	5.2	11.4
4	5.9	3.5	2.4
5	89.3	5.0	84.3

SUMMARY OF VALUES (CENTRAL EST)

ALT	AVERT ONSITE DOSE	AVERT OFFSITE DOSE	PW OF TOT AVERT DOSE ($XE-6)
1	123	3053	1.9
2	61	1486	0.9
3	196	4831	3.0
4	133	3263	2.0
5	190	4705	2.9

SUMMARY OF VALUE-IMPACT ANALYSIS

ALT	DELTA CORE MELT	NET BEN OFFSITE ($XE-6)	$ PER P-REM	NET BEN TOTAL ($XE-6)	$ PER P-REM
1	1.1E-4	-14.7	5400	-11.4	4200
2	5.4E-5	-5.0	4000	-3.3	2800
3	1.7E-4	-13.7	3400	-8.4	2300
4	1.2E-4	-4.0	1800	-0.4	700
5	1.7E-4	-86.5	2E4	-82.6	2E4
6	2.6E-4	-86.3	1E4	-82.4	1E4

ALTERNATE APPROACH TO CONSEQUENCE CALCS

50 MILE POPULATION DOSE

RELEASE CATEGORY	UPPER BOUND	CENTRAL ESTIMATE	LOWER BOUND
QC1	1.6E6	1.5E6	8.6E5
	*1.3E8	4.7E7	1.3E7
QC2	2.1E6	1.7E6	1.1E6
	*1.8E8	5.4E7	1.8E7
QC3	1.7E6	1.2E6	6.9E5
	*5.5E7	1.7E7	5.5E6
QC4	3.3E5	1.7E5	8.3E4
	*2.0E6	6.0E5	2.1E5

* CALCULATIONS WITH NO INTERDICTION

SUMMARY OF VALUE-IMPACT ANALYSIS (NO INTERDICTION)

ALT	DELTA CORE MELT	NET BEN OFFSITE ($XE-6)	$ PER P-REM	NET BEN TOTAL ($XE-6)	$ PER P-REM
1	1.1E-4	+20.4	270	+23.7	210
2	5.4E-5	+11.5	200	+13.2	150
3	1.7E-4	+41.1	170	+46.4	120
4	1.2E-4	+32.2	90	+35.8	40
5	1.7E-4	-32.5	940	-28.5	900
6	2.6E-4	-3.4	620	+3.5	570

SUMMARY OF QUAD CITIES RESULTS

STATION BLACKOUT SEQUENCES MOST IMPORTANT

QUAD CITIES HAS GOOD PHYSICAL REDUNDANCY IN DHR SYSTEMS

ELECTRICAL FAILURES DOMINATE INTERNAL EVENT ANALYSIS

SEISMIC EVENTS DOMINATE SPECIAL EMERGENCIES

MODS WERE FOUND WHICH MEET THE $1000/P-REM CRITERIA

MANY SCENARIOS WILL AFFECT BOTH UNITS

SHUTDOWN DECAY HEAT REMOVAL ANALYSIS

POINT BEACH CASE STUDY

ACRS SUBCOMMITTEE MEETING

DECEMBER 3, 1985

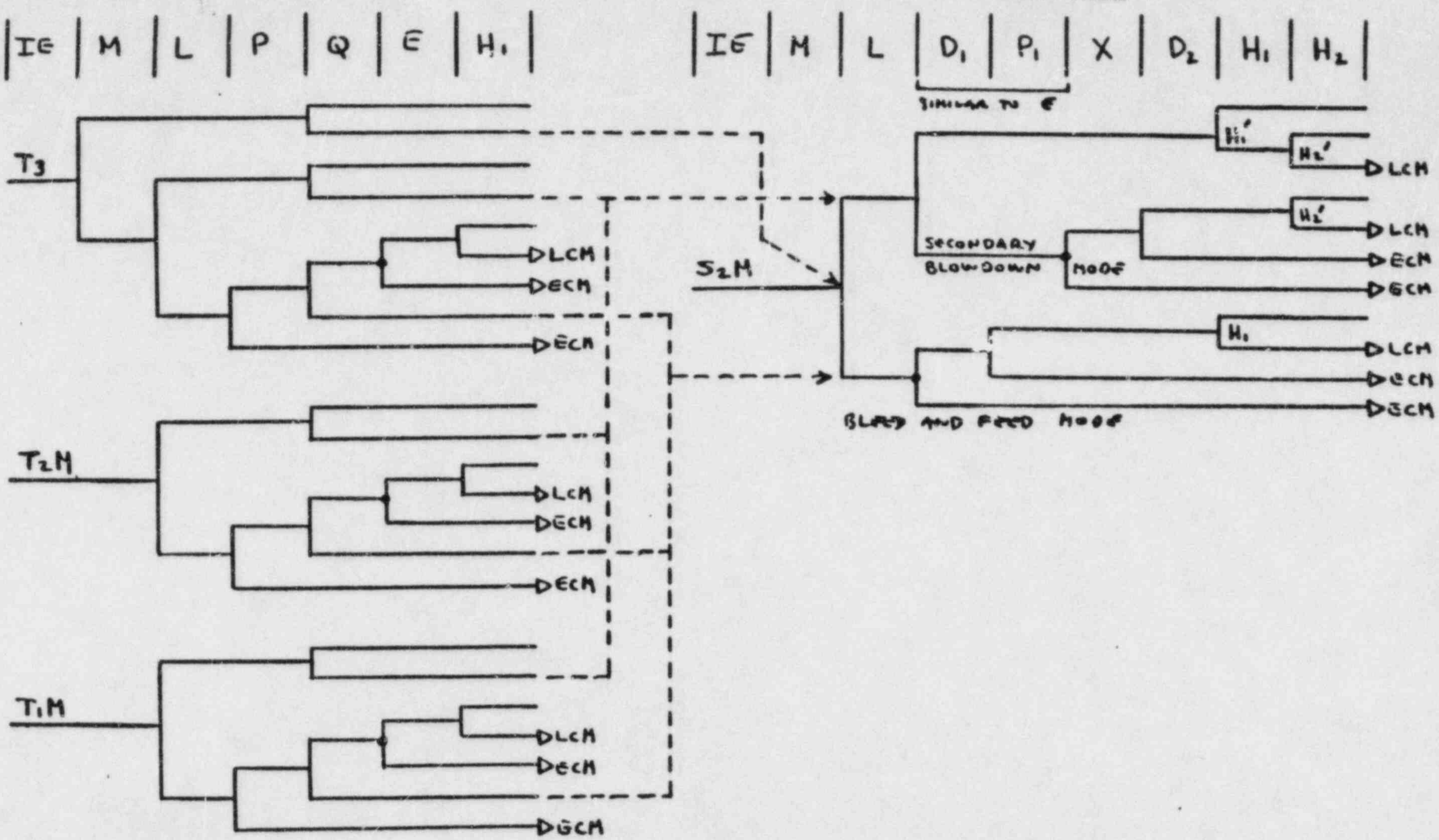
WALLIS R. CRAMOND

SANDIA NATIONAL LABORATORIES

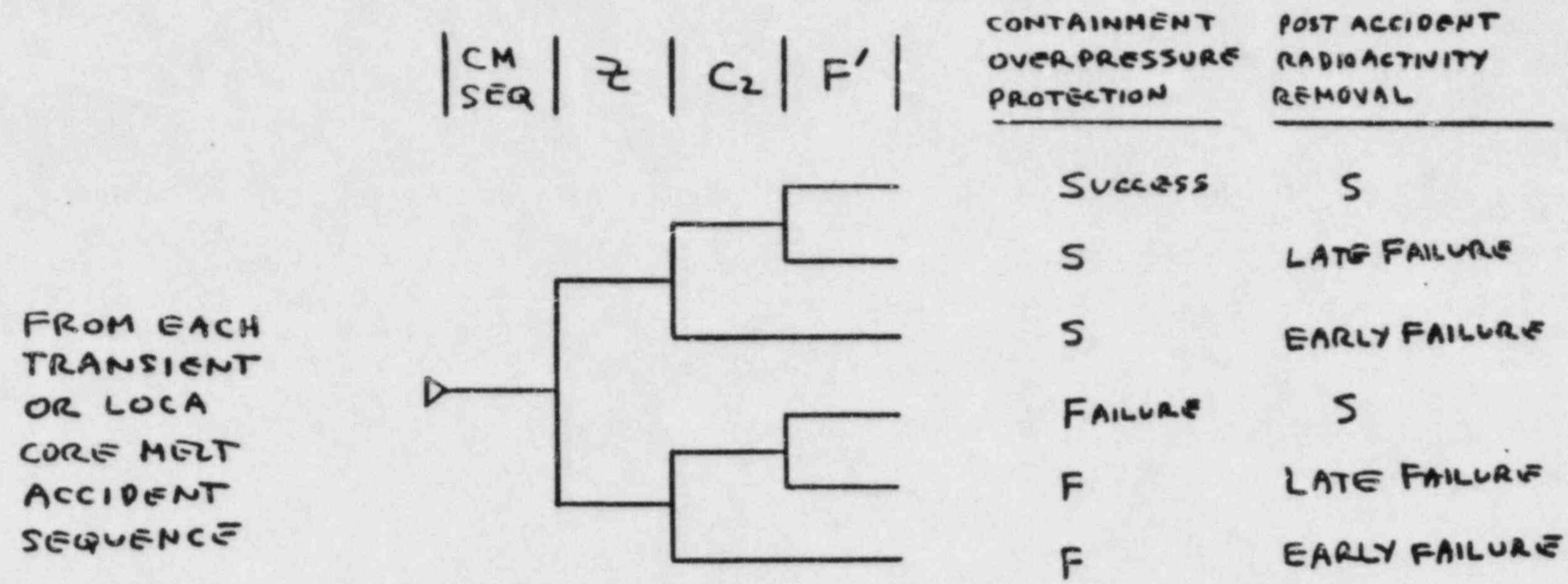
POINT BEACH SDHR SYSTEM EVENT TREES

TRANSIENT EVENT TREE

LOCA EVENT TREE



CONTAINMENT SYSTEMS EVENT TREE



$$Z = Y_1 (C_1 + F)(C_2 + Y_2)$$

POINT BEACH CORE MELT ACCIDENT SEQUENCES

DOMINANT ACCIDENT SEQUENCES	PROBABILITY BEFORE RECOVERY	PROBABILITY AFTER RECOVERY
$S_2MH_1'H_2'$	5.96E-5	5.96E-5
$T_3QH_1'H_2'$	2.95E-5	2.95E-5
T_5MLE	1.13E-5	9.69E-6
$S_2MD_1D_2$	8.50E-5	8.98E-6
T_1MLE	2.39E-5	6.66E-6
T_2MLE	9.64E-6	6.61E-6
T_4MLE	7.55E-6	6.20E-6
$T_3QD_1D_2$	4.17E-5	4.80E-6
$T_2MQH_1'H_2'$	4.17E-6	4.17E-6
T_2MLH_1	2.08E-6	2.03E-6
$T_2MQD_1D_2$	5.95E-6	6.86E-7
S_2MXD_1	1.79E-6	6.51E-7
	2.82E-4	1.40E-4

CHANGES FROM ORIGINAL POINT BEACH ANALYSIS TO CURRENT ANALYSIS

1. BASE OPERATOR FAILURE PROBABILITY CHANGED FROM 3E-3 TO 1E-3.
2. LONG TERM STATION BLACKOUT DUE TO BATTERY OR CST DEPLETION CONSIDERED.
3. CONTROL CIRCUIT FAILURES INCLUDED IN PUMP AND VALVE LOCAL FAULTS.
4. COMMON MODE OF APPLICABLE PUMPS AND MOVS CONSIDERED.
5. TEST AND MAINTENANCE DOWN TIME INCLUDED.
6. AC AND DC BUS INITIATING EVENTS CONSIDERED.
7. BATTERY FAILURE PROBABILITY CALCULATION IMPROVED.
8. ADDITIONAL SENSITIVITY ANALYSIS ON PORV BLOCKING INCLUDED.
9. ADDITIONAL SENSITIVITY ANALYSIS ON CRAC2 MODEL INCLUDED.
10. CHANGES WERE MADE TO THE SECONDARY BLOWDOWN MODEL.
11. LOSP INITIATOR FREQUENCY CHANGED FROM 0.100 TO 0.086.
12. EXTREME WIND DG EXHAUST STACK VULNERABILITY MOD INCLUDED.
13. MODIFICATIONS TO SEISMIC LOGIC MODEL ESPECIALLY FOR THE RWST.

COMPARISON OF DAS AND TOTAL CM PROBABILITY BETWEEN
ORIGINAL AND CURRENT POINT BEACH ANALYSIS

ORIGINAL ANALYSIS			CURRENT ANALYSIS		
DOMINANT ACCIDENT SEQUENCES	PROBABILITY BEFORE RECOVERY	PROBABILITY AFTER RECOVERY	DOMINANT ACCIDENT SEQUENCES	PROBABILITY BEFORE RECOVERY	PROBABILITY AFTER RECOVERY
$S_2MH_1'H_2'$	6.4E-5	6.4E-5	$S_2MH_1'H_2'$	5.96E-5	5.96E-5
T_1MLE	9.9E-5	3.9E-5	$T_3QH_1'H_2'$	2.95E-5	2.95E-5
$T_3QH_1'H_2'$	3.2E-5	3.2E-5	T_5MLE	1.13E-5	9.69E-6
$T_2MQH_1'H_2'$	4.5E-6	4.5E-6	$S_2MD_1D_2$	8.50E-5	8.98E-6
$S_2MD_1D_2$	2.8E-5	3.4E-6	T_1MLE	2.39E-5	6.66E-6
$T_3QD_1D_2$	1.4E-5	2.2E-6	T_2MLE	9.64E-6	6.61E-6
T_1MQLD_1	1.4E-6	1.1E-6	T_4MLE	7.55E-6	6.20E-6
T_2MLE	1.9E-6	6.4E-7	$T_3QD_1D_2$	4.17E-5	4.80E-6
$T_1MQH_1'H_2'$	4.7E-7	4.2E-7	$T_2MQH_1'H_2'$	4.17E-6	4.17E-6
$T_3MQH_1'H_2'$	3.2E-7	3.2E-7	T_2MLH_1	2.08E-6	2.03E-6
$T_2MQD_1D_2$	2.0E-6	3.1E-7	$T_2MQD_1D_2$	5.95E-6	6.86E-7
$T_1MQD_1D_2$	4.3E-7	1.9E-7	S_2MXD_1	1.79E-6	6.51E-7
			LTSB	1.98E-4	3.56E-5
TOTAL P(CM)	2.55E-4	1.49E-4		4.87E-4	1.82E-4

CORE MELT PROBABILITY RESULTS - INTERNAL
SEQUENCE GROUPS BY TYPE OF FAILURE

SMALL LOCA AND FAILURE OF ECC RECIRCULATION

$S_2MH_1'H_2'$ P = 6.0E-5

TRANSIENT WITH LOSS OF AUXILIARY FEEDWATER AND FAILURE OF BLEED AND FEED

T_1MLE

T_2MLE

T_4MLE

T_5MLE P = 2.9E-5

TRANSIENT INDUCED LOCA AND FAILURE OF ECC RECIRCULATION

$T_2MQH_1'H_2'$

$T_3QH_1'H_2'$ P = 3.4E-5

SMALL LOCA AND FAILURE OF ECC INJECTION

$S_2MD_1D_2$ P = 9.0E-6

SEQUENCE GROUPS BY TYPE OF FAILURE (CONT.)

TRANSIENT INDUCED LOCA AND FAILURE OF ECC INJECTION

$T_2MQD_1D_2$

$T_3QD_1D_2$ P = 5.5E-6

TRANSIENT WITH LOSS OF AUXILIARY FEEDWATER AND FAILURE OF ECC RECIRCULATION

T_2MLH_1 P = 2.0E-6

SMALL LOCA WITH FAILURE OF ECC INJECTION AND FAILURE TO ACHIEVE SECONDARY BLOWDOWN

S_2MXD_1 P = 6.5E-7

MOST SIGNIFICANT POINT BEACH VULNERABILITIES - INTERNAL

INTERNAL VULNERABILITY 1: FAILURE TO SWITCHOVER FROM EMERGENCY CORE INJECTION TO RECIRCULATION

$S_2MH_1'H_2'$	2.00E-5
$T_2MQH_1'H_2'$	1.40E-6
$T_3QH_1'H_2'$	9.90E-6
	3.13E-5

INTERNAL VULNERABILITY 2: STATION BLACKOUT DUE TO BATTERY FAILURE

T_1MLE 4.89E-6

INTERNAL VULNERABILITY 3: STATION BLACKOUT DUE TO DIESEL GENERATOR FAILURES

T_1MLE 5.49E-7

MOST SIGNIFICANT POINT BEACH VULNERABILITIES (CONT.)

INTERNAL VULNERABILITY 4: FAILURE OF ECC RECIRCULATION DUE TO RHR PUMP COOLING FAILURE CAUSED BY A VALVE FAILURE

$S_2MH_1'H_2'$	9.60E-6
$T_3QH_1'H_2'$	4.75E-6
$T_2MQH_1'H_2'$	6.72E-7
	1.50E-5

INTERNAL VULNERABILITY 5: FAILURE OF ECC INJECTION DUE TO CCWS FAILURE CAUSED BY LOSS OF COOLING FROM THE SWS THROUGH THE CCW HEAT EXCHANGER

$S_2MD_1D_2$	3.80E-7
$T_3QD_1D_2$	5.78E-7
$T_2MQD_1D_2$	8.26E-8
	1.04E-6

MOST SIGNIFICANT POINT BEACH VULNERABILITIES (CONT.)

INTERNAL VULNERABILITY 6: COMMON MODE FAILURE OF SAFETY SYSTEMS PUMPS

$S_2MH_1'H_2'$	4.00E-6
$S_2MD_1D_2$	4.60E-6
S_2MXD_1	1.20E-7
T_1MLE	2.18E-7
T_2MLH_1	2.03E-6
T_2MLE	6.61E-6
$T_2MQH_1'H_2'$	1.80E-7
$T_2MQD_1D_2$	3.22E-7
$T_3QH_1'H_2'$	1.98E-6
$T_3QD_1D_2$	2.25E-6
T_4MLE	1.18E-6
T_5MLE	5.80E-7
	2.42E-5

MOST SIGNIFICANT POINT BEACH VULNERABILITIES (CONT.)

INTERNAL VULNERABILITY 7: COMMON MODE FAILURES OF SAFETY SYSTEM VALVES

$S_2MH_1'H_2'$	8.00E-6
$T_2MQH_1'H_2'$	5.60E-7
$T_3QH_1'H_2'$	3.96E-6
	1.25E-5

INTERNAL VULNERABILITY 8: FAILURE OF THE LOW PRESSURE INJECTION SYSTEM IN THE RECIRCULATION MODE

$S_2MH_1'H_2'$	1.43E-5
$T_2MQH_1'H_2'$	9.99E-7
$T_3QH_1'H_2'$	7.07E-6
	2.24E-5

INTERNAL VULNERABILITY 9: FAILURE OF THE AFWS TURBINE DRIVEN PUMP

T_1MLE	4.35E-7
T_4MLE	4.25E-6
T_5MLE	5.71E-6
	1.04E-5

MOST SIGNIFICANT POINT BEACH VULNERABILITIES (CONT.)

INTERNAL VULNERABILITY 10: FAILURE OF THE CCW PUMPS

$S_2MD_1D_2$	1.23E-6
$T_3QD_1D_2$	6.03E-7
	1.83E-6

INTERNAL VULNERABILITY 11: LONG TERM STATION BLACKOUT CAUSED BY DEPLETION OF THE STATION BATTERIES OR THE CONDENSATE STORAGE TANK

T_1M * (FAILURE OF DGS) * (BATTERY DEPLETION AND/OR CST DEPLETION)

3.56E-5

SEISMIC ANALYSIS

- SAFE SHUTDOWN EARTHQUAKE 0.12G

- EARTHQUAKE FREQUENCIES

1-2 SSE	1.57E-3
2-3 SSE	1.34E-4
3-4 SSE	1.49E-5
4-5 SSE	3.18E-6

- SEISMIC INITIATED EVENTS

S - SMALL LOCA

EQ1 - TRANSIENT W/PCS INITIALLY AVAILABLE

EQ2 - TRANSIENT W/PCS FAILURE DUE TO INITIATING EVENT (LOSP DOMINANT EVENT)

SEISMIC CORE MELT PROBABILITIES

LEVEL (SSE)	S2	EQ1	EQ2	TOTAL
1-2	6.8E-6	6.3E-6	1.2E-5	2.5E-5
2-3	1.1E-5	2.5E-6	8.8E-6	2.3E-5
3-4	4.5E-6	2.8E-7	3.7E-6	8.4E-6
4-5	2.3E-6	3.0E-8	1.0E-6	3.4E-6
				6.1E-5

SEISMIC RELATED VULNERABILITIES

1. REFUELING WATER STORAGE TANK
2. ANCHORAGE OF ELECTRICAL BUSES, TRANSFORMERS, INVERTERS, AND BATTERY CHARGERS
3. BATTERY RACKS INADEQUATELY ANCHORED
4. INSTRUMENT AIR SYSTEM FOR PORVS

MODIFICATIONS BASED ON SEISMIC ANALYSIS

1. PUMPS AND PIPING TO MAKE SPENT FUEL POOL BACK-UP WATER SOURCE FOR RWST
2. PROVIDE ADDITIONAL ANCHORAGE FOR BUSES, INVERTERS, AND CHARGERS
3. REPLACE WOODEN BATTERY RACKS WITH METAL RACKS AND PROVIDE ADDITIONAL ANCHORS
4. INSTALL SAFETY CLASS NITROGEN BOTTLE AND ASSOCIATED EQUIPMENT

SEISMIC CORE MELT PROBABILITIES WITH MODS

LEVEL	S2	EQ1	EQ2	TOTAL
1-2	9.6E-9	1.1E-7	1.9E-7	3.0E-7
2-3	5.1E-7	3.7E-8	2.2E-7	7.6E-7
3-4	1.5E-6	1.3E-8	3.3E-7	1.8E-6
4-5	1.8E-6	6.7E-8	4.9E-7	2.2E-6
				5.0E-6

FIRE ANALYSIS

VULNERABILITIES: AFW PUMP ROOM - CABLE RUNS
SW PUMPS
MD AFW PUMPS
ALL SI AND CCW PUMPS

PROB CM 1.3E-5

4160V SWITCHGEAR ROOM
SAFETY RELATED CABLING

PROB CM 2.0E-5

MODIFICATIONS: AFW PUMP ROOM - AUTO SUPPRESSION SYSTEM
(WATER-DRY PIPE-PREACTION)

PROB CM 5.0E-7

4160 SWGR ROOM - RELOCATE DC BUS/CHARGER

PROB CM 6.9E-7

INTERNAL FLOOD ANALYSIS (SPRAY)

VULNERABILITY

INTAKE STRUCTURE - MAIN FIREWATER HEADER
SW PUMPS

PROB CM 7.7E-5

MODIFICATION

INCREASE BARRIER HEIGHT TO SHIELD PUMPS

PROB CM 7.7E-8

ALTERNATIVE SELECTION AND INTEGRATION

THIRTY-ONE POTENTIAL VULNERABILITIES IDENTIFIED

INTERNAL ELEVEN

SEISMIC EIGHT

SPRAY ONE

FIRE TWO

WIND AND MISSILE SIX

FLOOD TWO

LIGHTNING ONE

SUPPORT SYSTEMS IMPORTANT

ONLY SIXTEEN MODIFICATIONS CARRIED INTO IMPACT ANALYSIS

COMPOSITION OF ALTERNATIVES

EACH ALTERNATIVE IS THE COMBINATION OF THE MODIFICATIONS LISTED IN THE COLUMN BELOW

	ALTERNATIVE			
VULNERABILITIES	1	2	3	4
INTERNAL 1	X	X	X	
INTERNAL 2	X	X	X	
INTERNAL 4	X	X	X	
INTERNAL 8			X	
INTERNAL 9			X	
INTERNAL 11		X	X	
SEISMIC 1-6	X	X	X	
SPRAY	X	X	X	
FIRE 1	X	X	X	
FIRE 2	X	X	X	
WIND 6			X	
				ADD-ON SDHR

ESTIMATED CORE MELT PROBABILITY WITH MODS

TOTAL CM PROBABILITY BEFORE MODS	3.6E-4
ALTERNATIVE 1	1.4E-4
ALTERNATIVE 2	1.1E-4
ALTERNATIVE 3	7.5E-5
ALTERNATIVE 4	3.6E-5

OUTPUT FROM IMPACT ANALYSIS

COST OF EQUIPMENT AND INSTALLATION IN 1985 DOLLARS

COST OF REQUIRED REPLACEMENT POWER IN 1985 DOLLARS

COST OF ANNUAL OPERATION, MAINTENANCE AND INSPECTION IN 1985 DOLLARS

RADIATION EXPOSURE INVOLVED WITH INSTALLATION IN PERSON-REM

MODIFICATIONS BASED ON INTERNAL ANALYSIS

1. ADD A MORE PROMINENT ALARM WARNING THAT SWITCHOVER FROM INJECTION TO RECIRCULATION IS NECESSARY AND IMMINENT

2. INSTALL DEDICATED STARTUP BATTERIES TO EACH DIESEL GENERATOR TO ELIMINATE THE DEPENDENCE OF THE DIESEL GENERATORS ON THE STATION BATTERIES

3. INSTALL A TURBINE DRIVEN GENERATOR TO SUPPLY VITAL AC AND DC LOADS

4. INSTALL PARALLEL MANUAL VALVE TO VALVE XV30 IN THE RHR PUMP COMPONENT COOLING WATER LINE AND CHECK THE VALVE POSITIONS ONCE PER SHIFT

5. INSTALL A THIRD INDEPENDENT LOW PRESSURE TRAIN WITH ADDITIONAL SUCTION LINE FROM THE SUMP AND CROSSTIES TO ORIGINAL TWO TRAINS

6. INSTALL INDEPENDENT DIESEL DRIVEN AFWS PUMP IN PARALLEL TO THE TURBINE DRIVEN PUMP BUT SHARING THE SUCTION AND DISCHARGE LINES

7. ADDITIONAL `70,000 GAL. CST SHARED BETWEEN UNITS

CONTENT OF ALTERNATIVES

ALTERNATIVE 1:	RWST LEVEL ALARM IMPROVEMENTS
	DEDICATED DIESEL GENERATOR STARTUP BATTERIES
	REDUNDANT RHR PUMP COOLER OUTLET VALVES
	RWST SEISMIC IMPROVEMENTS
	IMPROVED SEISMIC ANCHORAGE OF ELECTRICAL EQUIPMENT
	BACKUP AIR SUPPLY FOR PORVS
	INTAKE STRUCTURE SHIELD WALL EXTENSION
	AFW PUMP ROOM FIRE PROTECTION
	SEPARATION OF DC EMERGENCY POWER SUPPLIES
ALTERNATIVE 2:	ALL ABOVE PLUS
	ADDITIONAL CST
ALTERNATIVE 3:	ALL ABOVE PLUS
	THIRD INDEPENDENT LOW PRESSURE TRAIN
	INDEPENDENT DIESEL DRIVEN AFWS PUMP
	DIESEL GENERATOR EXHAUST STACK ANCHORAGE IMPROVEMENTS
ALTERNATIVE 4:	ADD-ON SDHR SYSTEM

CORE MELT PROBABILITIES

INTERNAL	1.8E-4
SEISMIC	6.1E-5
SPRAY	7.7E-5
FIRE	3.2E-5
WIND AND MISSILES	4.0E-6
EXTERNAL FLOOD	1.9E-8
LIGHTNING	5.8E-8
	3.56E-4 BASE CORE MELT PROBABILITY

MODIFICATION OF VULNERABILITY	BASE CORE MELT PROBABILITY	APPROXIMATE CORE MELT PROBABILITY AFTER MODIFICATION
INTERNAL 1	3.1E-5	3.1E-6
2	4.8E-6	1.0E-7
4	1.5E-5	3.3E-6
8	2.2E-5	6.3E-6
9	1.0E-5	4.3E-7
11	3.6E-5	1.3E-6
SEISMIC 1-6	6.1E-5	5.0E-6
SPRAY	7.7E-5	7.7E-8
FIRE 1	1.3E-5	5.0E-7
2	2.0E-5	6.9E-7
WIND 6	4.0E-6	1.0E-7

IMPACT ANALYSIS APPROACH

INITIAL DESIGN REPORT

- INTERFACES DESCRIBED
- SCOPE OF WORK
  - BILL OF MATERIALS
  - RIP-OUT
  - MAJOR CONSTRUCTION

SITE INSPECTION PLAN

- AREAS OF INTEREST
- LOCAL PRACTICE QUESTIONS

PLANT VISIT

- LOCAL COSTS
- CONGESTION
- ACCESS
- FEASIBILITY OF LOCATION
- RADIATION LEVELS

FINAL DESIGN USING STANDARD INDUSTRY PRACTICES

POINT BEACH IMPACT ANALYSIS RESULTS

ALTERNATIVE	ENGINEERING AND INSTALLATION COSTS $	O&M COSTS $	OCC DOSE P-REM
1	7.419E6	1.1E4	17
2	14.376E6	3.7E4	17
3	22.497E6	1.71E5	27
4	59.047E6	3.79E5	486

SUMMARY OF CORE MELT PROBABILITIES WITH ALTERNATIVES

ALTERNATIVE	PROB. OF CM	DELTA PROB. OF CM	IMPROVEMENT FACTOR
BASE CASE	3.6E-4		
1	1.4E-4	2.1E-4	2.5
2	1.1E-4	2.5E-4	3.3
3	6.9E-5	2.9E-4	5.1
4	2.4E-5	3.3E-4	15.0

POINT BEACH - EXPECTED VALUE POPULATION DOSE
(50 MILE STANDARD CRAC2)

	LB SOURCE 0.1 RSS	BASE SOURCE 0.3 RSS	UB SOURCE RSS
BASE CASE	160.1	221.5	253.5
ALT. 1	59.3	83.1	97.5
ALT. 2	41.9	59.0	69.7
ALT. 3	24.5	34.2	39.2
ALT. 4	9.6	13.4	15.5

POINT BEACH - AVERTED OFFSITE DOSE (P-REM)

ALT. 1	100.8	138.4	156.0
ALT. 2	118.2	162.5	183.8
ALT. 3	135.6	187.3	214.3
ALT. 4	150.5	203.1	238.0

TABLE 9.3 POINT BEACH - SUMMARY OF IMPACTS (Based Upon 5% Discount)

Alternative No.	Change in Core Melt Probability [Central Value]	POSITIVE IMPACTS ASSOCIATED WITH MODIFICATIONS (Present Worths): Utility Costs: Installation and Engineering Costs ($ x10^{-6})	Utility Costs: Operations and Maintenance Costs (PW) ($ x10^{-6})	Replacement Power Costs: Installation ($ x10^{-6})	Replacement Power Costs: In Service (PW) ($ x10^{-6})	TOTAL POSITIVE IMPACT ($ x10^{-6})	NEGATIVE IMPACTS DUE TO AVERTABLE ONSITE COSTS (Present Worths) [U, C, & L Values]: Replacement Power Costs ($ x10^{-6})	Loss of Investment Costs ($ x10^{-6})	Site Cleanup Costs ($ x 10^{-6})	Total Avertable Costs ($ x10^{-6})	NET IMPACT ($ x10^{-6})
	ΔP_m	I_1	13.5 I_2	I_3	13.5 I_4	TI	I'_{51}	I'_{52}	I'_{53}	I'_5	NI
					Not		L 0.17	0.09	0.69	0.95	6.618
1	2.13E-4	7.419	0.149	0.0	Available	7.568	C 0.84	0.43	3.45	4.72	2.848
					Probably Negligible		U 4.19	2.17	17.25	23.61	-16.042
							L 0.19	0.10	0.80	1.09	13.786
2	2.48E-4	14.376	0.500	0.0	"	14.876	C 0.97	0.51	4.02	5.50	9.376
							U 4.87	2.53	20.09	27.49	-12.614
							L 0.23	0.12	0.93	1.28	23.526
3	2.87E-4	22.497	2.309	0.0	"	24.806	C 1.13	0.55	4.65	6.37	18.436
							U 5.64	2.93	23.25	31.82	- 7.014
							L 0.26	0.14	1.08	1.48	62.684
4	3.32E-4	59.047	5.117	0.0	"	64.164	C 1.30	0.68	5.38	7.36	56.804
							U 6.52	3.39	26.89	36.80	27.364

TI = $I_1 + 13.5\ I_2 + I_3 + 13.5\ I_4$
$I_5' = I_{51}' + I_{52}' + I_{53}'$
NI = $TI - I_5'$

Note: L, C, and U represent the lower, central, and upper bound estimate for core melt probability

TABLE 9.4-a POINT BEACH - SUMMARY OF VALUES (Based on Population Dose to 50 Miles, 5% Discount Rate)

		POSITIVE VALUES							
		Onsite		Offsite			Total		
Alternative No.	Change in Core Melt Probability [Central Value]	Averted Dose (p-rem)	Present Worth of Averted Dose @ \$1000/p-rem (\$ x10^{-6})	Averted Dose (p-rem)	Averted Dose ÷ Base Case Dose	Present Worth of Averted Dose @ \$1000/p-rem (\$ x10^{-6})	Averted Dose (p-rem)	Averted Dose ÷ Base Case Dose	Present Worth of Averted Dose @ \$1000/p-rem (\$ x10^{-6})
				[U, C, & L Values]			[U, C, & L Values]		
	Δp_m	V_1	V_1'	V_2	ADR_o	V_2'	V_{12}	ADR_n	V_{12}'
1	2.13E-4	252	0.148	L 2318	.63	1.360	2570	.65	1.508
				C 3183	.62	1.868	3435	.64	2.016
				U 3588	.62	2.106	3840	.63	2.254
2	2.48E-4	294	0.172	L 2719	.74	1.596	3013	.76	1.768
				C 3738	.73	2.194	4032	.75	2.366
				U 4227	.72	2.481	4521	.74	2.653
3	2.87E-4	340	0.200	L 3119	.85	1.831	3459	.86	2.031
				C 4308	.85	2.529	4648	.86	2.729
				U 4929	.85	2.893	5269	.85	3.093
4	3.32E-4	393	0.231	L 3462	.94	2.032	3855	.95	2.263
				C 4786	.94	2.809	5179	.94	3.040
				U 5474	.94	3.213	5867	.94	3.444

V_1 = 51500 x Δp_m x 23
V_1' = 51500 x Δp_m x \$1000 x 13.5
V_2 = Averted Dose x 23
V_2' = Averted Dose x \$1000 x 13.5
ADR_o = V_2 ÷ (Basecase Dose x 23)
V_{12} = $V_1 + V_2$
ADR_n = V_{12} ÷ (Basecase Dose x 23 + V_1)
V_{12}' = $V_1' + V_2'$

Note: L, C, and U stand for lower, central, and upper bound source term estimate

TABLE 9.4-b POINT BEACH - SUMMARY OF VALUES (Based on Population Dose to 50 Mile, 5% Discount Rate)

Alternative No.	Change in Core Melt Probability [Central Value]	NEGATIVE VALUES: Installation: Installation Dose (p-rem)	Installation: Present Worth of Installation Dose @ $1000/p-rem	Operation: In-Service Operational Dose (p-rem)	Operation: Present Worth of In-Service Oper. Dose ($ x 10^{-6})	Total: Installation and Operational Dose	Total: Present Worth of Install. & Oper. Dose @ $1000/p-rem ($ x10^{-6})	Net Value: Averted Dose (p-rem) [U, C, & L Values]		Net Value: Present Worth of Averted Dose @ $100d/p-rem ($ x10^{-6})
	ΔP_m	V_3	V_3'	V_4	V_4'	$V_3 + V_4$	$V_3' + V_4'$		NV	NV'
1	2.13E-4	17	.017	Negligible		17	.017	L	2553	1.491
								C	3418	1.999
								U	3823	2.237
2	2.48E-4	17	.017	Negligible		17	.017	L	2996	1.751
								C	4015	2.349
								U	4504	2.636
3	2.87E-4	27	.027	Negligible		27	.027	L	3432	2.004
								C	4621	2.702
								U	5242	3.066
4	3.32E-4	486	.486	Negligible		486	.486	L	3369	1.777
								C	4693	2.554
								U	5381	2.958

$V_3' = V_3 \times \$1000$
$V_4' = (V_4 \div 23) \times \$1000 \times 13.5$
$NV = V_1 + V_2 - V_3 - V_4$
$NV' = V_1' + V_2' - V_3' - V_4'$

Note: L, C, and U stand for lower, central, and upper bound source term estimate

TABLE 9.5 POINT BEACH - SUMMARY OF VALUE-IMPACT ANALYSIS (Based on Population Dose to 50 Miles; 5% Discount Rate)

				V-I ANALYSIS BASED ON OFFSITE COSTS					V-I ANALYSIS BASED ON OFFSITE AND ONSITE COSTS			
						Measures of V-I					Measures of V-I		
Alternative No.	Change in Core Melt Probability (Central Value)	Offsite Averted Dose (p-rem) [U,C,&L Values]	Total Averted Dose ÷ Base Case Dose [U,C,&L Values]	Total Impact (Central Cost) ($ x10^-6)	Present Worth of Averted Dose @$ 1000/p-rem [U,C,&L Values] ($ x 10^-6)	V-I Ratio	Net Benefit ($ x 10^-6)	Dollars per p-rem	Net Impact (Central Cost) ($ x10^-6)	Present Worth of Averted Dose @ $1000/p-rem [U,C,&L Values] ($ x10^-6)	V-I Ratio	Net Benefit ($ x10^-6)	Dollars per p-rem
	ΔP_m	V_2	ADR_n	TI	V_2'	VIR_o	NBV_o	DPR_o	NI	NV'	VIR_n	NBV_n	DPR_n
		L 2318	.65		1.360	0.18	-6.208	3265		1.491	0.524	-1.357	1116
1	2.13E-4	C 3183	.64	7.568	1.868	0.25	-5.700	2378	2.848	1.999	0.702	-0.849	833
		U 3588	.63		2.106	0.27	-5.462	2109		2.237	0.786	-0.611	745
		L 2719	.76		1.596	0.11	-13.280	5471		1.751	0.187	-7.652	3130
2	2.48E-4	C 3738	.75	14.876	2.194	0.15	-12.682	3980	9.376	2.349	0.251	-7.027	2335
		U 4227	.74		2.481	0.17	-12.395	3519		2.636	0.281	-6.740	2082
		L 3119	.86		1.831	0.074	-22.975	7953		2.004	0.109	-16.432	5372
3	2.87E-4	C 4308	.86	24.806	2.529	0.102	-22.277	5758	18.436	2.702	0.147	-15.734	3990
		U 4929	.85		2.893	0.117	-21.913	5033		3.066	0.166	-15.370	3517
		L 3462	.95		2.032	0.032	-62.132	18534		1.777	0.031	-55.027	16861
4	3.32E-4	C 4786	.94	64.164	2.809	0.044	-61.355	13407	56.804	2.554	0.045	-54.250	12104
		U 5474	.94		3.213	0.056	-60.951	11722		2.958	0.052	-53.846	10556

$VIR_o = V_2' \div TI$
$NBV_o = V_2' - TI$
$DPR_o = TI \div V_2$

$VIR_n = NV' \div NI$
$NVB_n = NV' - NI$
$DPR_n = NI \div NV$

Note: L, C, and U stand for lower, central, and upper bound source term estimate

TABLE 9.6 POINT BEACH - SUMMARY OF VALUE-IMPACT MEASURES (Central Value)

Alternative No.	Change in Core Melt Probability	Offsite Averted Dose (p-rem)	Total Averted Dose Ratio	V-I Analysis of Offsite Costs			V-I Analysis Based on Offsite and Onsite Costs		
				V-I Ratio	Net Benefit ($ x10^{-6})	Dollars per p-rem	V-I Ratio	Net Benefit ($ x10^{-6})	Dollars per p-rem
	ΔP_m	V_2	ADR_n	VIR_o	NBV_o	DPR_o	VIR_n	NBV_n	DPR_n
1	2.13E-4	3183	0.64	0.25	-5.700	2378	0.702	-0.849	833
2	2.48E-4	3738	0.75	0.15	-12.682	3980	0.251	-7.027	2335
3	2.87E-4	4368	0.86	0.102	-22.277	5758	0.147	-15.734	3990
4	3.32E-4	4786	0.94	0.044	-61.355	13407	0.045	-54.250	12104

TABLE 9.6 POINT BEACH - SUMMARY OF VALUE-IMPACT MEASURES (Central Value)

Alternative No.	Change in Core Melt Probability	Offsite Averted Dose (p-rem)	Total Averted Dose Ratio	V-I Analysis of Offsite Costs			V-I Analysis Based on Offsite and Onsite Costs		
				V-I Ratio	Net Benefit ($ x10^{-6})	Dollars per p-rem	V-I Ratio	Net Benefit ($ x10^{-6})	Dollars per p-rem
	Δp_m	V_2	ADR_n	VIR_o	NBV_o	DPR_o	VIR_n	NBV_n	DPR_n
1	2.13E-4	3183	0.64	0.25	-5.700	2378	0.702	-0.849	833
2	2.48E-4	3738	0.75	0.15	-12.682	3980	0.251	-7.027	2335
3	2.87E-4	4308	0.86	0.102	-22.277	5758	0.147	-15.734	3990
4	3.32E-4	4786	0.94	0.044	-61.355	13407	0.045	-54.250	12104

POINT BEACH SENSITIVITY ANALYSES

WITH FEED & BLEED	WITHOUT FEED & BLEED	DIFFERENCE
3.43E-5	2.57E-4	+2.23E-4
WITH SECONDARY BLOWDOWN	WITHOUT SECONDARY BLOWDOWN	
1.37E-4	1.89E-4	+5.20E-5
FEED & BLEED WITH PORVS BLOCKED	FEED & BLEED WITH PORVS UNBLOCKED	
5.60E-5	4.58E-5	-1.12E-5

IN EACH CASE ABOVE ONLY THE ACCIDENT SEQUENCES AFFECTED ARE INCLUDED HERE. THESE ARE NOT TOTAL CM PROBABILITIES.

CRAC2 Conditional Population Dose (50 mile radius for Point Beach

Standard CRAC2 Estimate

Release Category	Upper * Bound	Central Estimate	Lower Bound
1	7.9E+5	6.6E+5	4.4E+5
2	8.0E+5	7.5E+5	5.6E+5
3	9.6E+5	6.2E+5	3.7E+5
4	5.4E+5	2.7E+5	1.3E+5
5	2.2E+5	1.0E+5	4.8E+4
6	5.3E+4	2.2E+4	9.8E+3
7	2.6E+3	1.7E+3	1.4E+3

Revised CRAC2 Estimate (no interdiction, no decontamination)

Release Category	Upper * Bound	Central Estimate	Lower Bound
1	6.3E+7	1.9E+7	6.3E+6
2	1.1E+8	3.2E+7	1.1E+7
3	3.3E+7	1.0E+7	3.3E+6
4	7.3E+6	2.2E+6	7.3E+5
5	1.7E+6	5.0E+5	1.7E+5
6	1.5E+5	4.4E+4	1.6E+4
7	3.1E+3	1.8E+3	1.4E+3

* Upper Bound, Central Estimate and Lower Bound are based upon Reactor Safety Study releases and represent 1xRSS, 0.3xRSS, and 0.1xRSS levels respectively. The 0.3xRSS has been used as the central estimate for the TAP A-45 analyses.

Expected Population Dose in Person-rem Per Reactor Year (50 Mile Radius) for Point Beach

Standard CRAC2 Estimate

		Expected Dose		
Release Category	Release Category Probability	Upper Bound	Central Estimate	Lower Bound
1	1.2E-6	1.0	0.8	0.5
2	2.5E-4	200.0	187.5	140.0
3	5.1E-5	49.0	31.6	18.9
4	2.3E-6	1.2	0.6	0.3
5	1.3E-7	0.0	0.0	0.0
6	4.3E-5	2.3	1.0	0.4
7	5.7E-6	0.0	0.0	0.0
TOTAL		253.5	221.5	160.1

Revised CRAC2 Estimate (no interdiction and no decontamination)

		Expected Dose		
Release Category	Release Category Probability	Upper Bound	Central Estimate	Lower Bound
1	1.2E-6	75.6	22.8	7.6
2	2.5E-4	27,500.0	8,000.0	2750.0
3	5.1E-5	1,683.0	510.0	168.3
4	2.3E-6	16.8	5.1	1.7
5	1.3E-7	0.2	0.1	0.0
6	4.3E-5	6.5	1.9	0.7
7	5.7E-6	0.0	0.0	0.0
TOTAL		29,282.1	8,539.9	2,928.3

TABLE 9.9 POINT BEACH - VALUE-IMPACT RESULTS - No Interdiction or Decontamination

Alternative	Reduction in Core Melt Probability Δp_m		Offsite Averted Dose p-rem	Averted Dose Ratio	V-I Analysis of Offsite Costs: V-I Ratio	V-I Analysis of Offsite Costs: Net Benefit ($ x10^{-6})	V-I Analysis of Offsite Costs: Dollars per p-rem	V-I Analysis Based on Offsite and Onsite Costs: V-I Ratio	V-I Analysis Based on Offsite and Onsite Costs: Net Benefit ($ x10^{-6})	V-I Analysis Based on Offsite and Onsite Costs: Dollars per p-rem
j	Δp_m		V_2	ADR_n	VIR_o	NBV_o	DPR_o	VIR_n	NBV_n	DPR_n
		L	43194	0.64	3.35	17.785	175	8.948	22.636	66
1	2.13E-04	C	125856	0.64	9.76	66.304	60	25.984	71.155	23
		U	431848	0.64	33.49	245.908	18	89.047	250.759	7
		L	50485	0.75	1.99	14.757	295	3.177	20.412	185
2	2.48E-04	C	147131	0.75	5.81	71.484	101	9.227	77.139	64
		U	504781	0.75	19.92	281.409	29	31.617	289.064	19
		L	57063	0.85	1.35	8.638	435	1.826	15.231	321
3	2.87E-04	C	166382	0.85	3.94	72.853	149	5.307	79.396	111
		U	570538	0.85	13.50	310.075	4[illegible]	18.174	316.618	32
		L	63296	0.94	0.58	-27.012	1014	0.650	-19.907	899
4	3.32E-04	C	184575	0.94	1.69	44.174	348	1.903	51.279	308
		U	632914	0.94	5.79	307.329	101	6.535	314.434	86

Note: L, C, and U represent estimates based on lower, central, and upper source term values.

NRR STAFF PRESENTATION TO THE ACRS

SUBJECT: STATUS OF USI A-45 RESOLUTION EFFORT

DATE: DECEMBER 3, 1985

PRESENTER: A. R. MARCHESE

PRESENTER'S TITLE/BRANCH/DIV: TASK MANAGER/REACTOR SAFETY ISSUES BRANCH/DIVISION OF SAFETY REVIEW AND OVERSIGHT

PRESENTER'S NRC TEL. NO.: (301) 492-4712

SUBCOMMITTEE: DECAY HEAT REMOVAL SYSTEMS SUBCOMMITTEE.

PRESENTATION OUTLINE

- PLANT ANALYSIS REVISION ACTIVITIES AND SCHEDULE.
- SUMMARY OF REVISED POINT BEACH PLANT ANALYSIS RESULTS.
- SUMMARY OF QUAD CITIES PLANT ANALYSIS RESULTS.
- PRELIMINARY ANALYSIS RESULTS OF A DEDICATED PRIMARY BLOWDOWN SYSTEM.
- CONSIDERATION OF HIGH-PRESSURE RHR SYSTEM.
- CE/PORV ISSUE.
- SABOTAGE ANALYSES.
- PROGRAM SCHEDULE.

INTRODUCTORY REMARKS

- ROUGH DRAFT PLANT REPORTS ISSUED IN MAY.
- REVIEWED WITH ACRS SUBCOMMITTEE ON MAY 30.
- DETAILED STAFF COMMENT RECEIVED IN JUNE.
- COMMENTS REQUIRED SIGNIFICANI ADDITIONAL ANALYSES BY SANDIA.
- REVISED PLANT REPORTS RECEIVED IN NOVEMBER.
- SIGNIFICANT CHANGES IN RESULTS.

ALTERNATIVE MEASURES

- IMPROVED OPERATIONS (E.G., PROCEDURES, TRAINING, INFORMATION DISPLAY)
- USE EXISTING SYSTEMS IN ATYPICAL MODES
- ADD PORVS ONLY
- DEDICATED FEED AND BLEED SYSTEM
- HIGH PRESSURE RHR SYSTEM
- ADD-ON EMERGENCY FEEDWATER SYSTEM
- ADD-ON SUPPRESSION POOL COOLING AND LOW PRESSURE INJECTION SYSTEM
- BUNKERED AND DEDICATED SHUTDOWN COOLING SYSTEM

ROLE OF FEED AND BLEED IN A-45 PROGRAM

- ASSESS VIABILITY OF FEED AND BLEED
- DETERMINE UNDER WHAT CONDITIONS PLANTS (ONE FOR EACH PWR VENDOR) CAN SUCCESSFULLY FEED AND BLEED
- EXTEND 2ND ITEM TO A RANGE OF PLANT TYPES
- DETERMINE IMPORTANT PARAMETERS (I.E., VALVE SIZE, HPI PUMP SHUTOFF HEAD, OPERATOR ACTION TIME) TO SUCCESSFULLY FEED AND BLEED
- DETERMINE REQUIRED PLANT MODIFICATIONS TO SUCCESSFULLY FEED AND BLEED
- ASSESS FEASIBILITY OF MODIFICATIONS IN TERMS OF BACKFITTING TO OPERATING PLANTS
- DETERMINE IMPACTS (E.G., COSTS, DOWNTIME) OF BACKFIT
- ASSESS VALUE OR BENEFITS OF FEED AND BLEED
- COMPARE VALUE/IMPACT OF FEED AND BLEED TO OTHER ALTERNATIVE MEASURES TO IMPROVE OVERALL DHR RELIABILITY

PLANT ANALYSIS STATUS

°	QUAD CITIES	ANALYSIS COMPLETED DRAFT REPORT RESUBMITTED - NOVEMBER 1
°	POINT BEACH	ANALYSIS COMPLETED DRAFT REPORT TO BE RESUBMITTED - NOVEMBER 15
°	COOPER	ANALYSIS NEAR COMPLETION DRAFT REPORT IN PREPARATION DRAFT REPORT SUBMITTAL DUE - NOVEMBER 29
°	TURKEY POINT	FAULT TREES BEING EDITED/CHECKED INTERNAL SEQUENCES IDENTIFIED SPECIAL EMERGENCY ANALYSIS WELL ALONG DRAFT REPORT SUBMITTAL DUE - DECEMBER 13
°	TORJAN	FAULT TREES BEING EDITED/CHECKED INTERNAL SEQUENCES AND SPECIAL EMERGENCY ANALYSIS IN PROCESS DRAFT REPORT SUBMITTAL DUE - JANUARY 15
°	ANO-1	FAULT TREES BEING EDITED/CHECKED INTERNAL SEQUENCES AND SPECIAL EMERGENCY ANALYSIS IN PROCESS EXCEPT VULNERABILITIES NOT IDENTIFIED AE PLANS PLANT VISIT IN DECEMBER DRAFT REPORT SUBMITTAL DUE - FEBRUARY 15
°	ST. LUCIE	ANALYSIS TO START JANUARY 10 AE PLANS PLANT VISIT IN MID-JANUARY DRAFT REPORT SUBMITTAL DUE - MARCH 17

MAJOR SCHEDULE MILESTONES FOR USI A-45

°	CONTRACTOR FINAL SUMMARY REPORT ON SEVEN PLANTS	MAY 1986
°	DST DRAFT REGULATORY ANALYSIS AND TECHNICAL FINDINGS REPORT ISSUED FOR STAFF COMMENTS	JULY 1986
°	STAFF COMMENTS TO DST	AUGUST 1986
°	COMPLETED PACKAGE TO DIRECTOR, NRR	SEPTEMBER 1986
°	PACKAGE TO CRGR	OCTOBER 1986
°	CRGR REVIEW COMPLETE	DECEMBER 1986
°	ISSUED FOR PUBLIC COMMENT	FEBRUARY 1987

ANALYSIS ACTIVITIES AND SCHEDULES

SCOPE

INTERNAL ANALYSIS REDONE TO INCLUDE:

- BROADER TREATMENT OF COMMON MODE
- ADDITIONAL TREATMENT OF ACTUATION
- LONG TERM BLACKOUT
- RE-EXAM OF HUMAN FACTORS/RECOVERY

SPECIAL EMERGENCIES - REVIEWED AND MODIFIED AS REQUIRED

SABOTAGE - "MODEST" CONDITIONAL QUANTIFICATION ATTEMPTED

PLANT ANALYSIS STATUS/SCHEDULE

QUAD CITIES	DRAFT SUBMITTED SANDIA MANAGEMENT APPROVED SENT TO CECO FOR COMMENT/INPUT PUBLICATION IN JANUARY
POINT BEACH	DRAFT SUBMITTED IN SANDIA APPROVAL PROCESS SENT TO WECO FOR COMMENT/INPUT PUBLICATION IN FEBRUARY
COOPER	DRAFT SUBMITTED IN SANDIA REVIEW PROCESS
TURKEY POINT	DRAFT IMMINENT
ST LUCIE	INTERNAL ANALYSIS AT FIRST QUANT SPECIAL EMERGENCY IN PROGRESS TARGET DATE FEBRUARY FOR DRAFT
ANO 1	INTERNAL ANALYSIS IN PROGRESS SPECIAL EMERGENCY IN PROGRESS TARGET DATE FEBRUARY FOR DRAFT
TROJAN	TEMPORARILY ON HOLD

SPECIAL TOPICS

SUMMARY/GENERIC CONCLUSIONS TO DATE - IN PROGRESS
1ST DRAFT JANUARY

VALUE-IMPACT CONSIDERATIONS FOR MORTORIA - IN PROGRESS
REVISED DRAFT FEB

STRUCTURE OF GENERIC V-I TO SUPPORT REGULATORY ANALYSIS - IN PROGRESS
DRAFT JAN

SUMMARY OF VALUE MEASURE AND V-I STURCTURES - IN PROGRESS
DRAFT ASAP