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UNITED STATES NUCLEAR REGULATORY COMMISSION'S

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

DATE: Tuesday, April 3, 1990

The contents of this transcript of the proceedings of the United States Nuclear Regulatory Commission's Advisory Committee on Reactor Safeguards, (date) Tuesay, April 3,1990, as reported herein, are a record of the discussions recorded at the meeting held on the above date.

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

Subcommittee Meeting on Advanced

Pressurized Water Reactors

Conference Room P-110

7920 Norfolk Avenue

Bethesda, Maryland

Tuesday, April 3, 1990

The above-entitled proceedings commenced at 8:30 o'clock a.m., pursuant to notice, J. Carroll, committee chairman, presiding.

PRESENT FOR THE ACRS SUBCOMMITTEE:

I. Catton	R. Singh
C. Michelson	C. Miller
D. Ward	S. Ritterbusch
J. Wylie	E. Kennedy
M. El-Zeftaway	R. Matzie

PARTICIPANTS:

R. Turk

W. Fox

K. Scarola

R. Jaquith

P R O C E E D I N G S

[8:30 a.m.]

MR. CARROLL: Good morning. The meeting will now come to order. This is a meeting of the Advisory Committee on Reactor Safeguards, Subcommittee on Advance Pressurized Water Reactors.

I'm J. Carroll, Subcommittee chairman. The other ACRS members in attendance, on my right, Charlie Wylie, on my left, Carl Michelson, Ivan Catton, and Dave Ward.

The purpose of this meeting is to review the licensing review basis document developed by combustion engineering for the System 80 + Standard Design.

Med El Zeftaway is the cognizant ACRS staff member for this meeting. The rules for participation in today's meeting have been announced as part of the notice of this meeting, previously published in the Federal Register of March 15, 1990.

A transcript of the meeting is being kept and will be available as stated in the Federal Register notice. It is requested that each speaker first identify himself or herself and speak with sufficient clarity and volume so that he or she can be readily heard.

We have received no written comments or requests for oral statements from members of the public for this meeting.

As you can see from the revised agenda before you, today's meeting is basically to review the Combustion licensing review basis document. We have another meeting on this same general subject scheduled for April 26th where both General Electric and Combustion will be in to talk more about licensing review basis documents.

The point being, the Commission has asked ACRS in their SECY 89-311 to review both of these documents and provide them with comments and in particular, to look at the two documents side by side and determine whether the approach taken is "consistent."

It is probably worthwhile for the committee members as we go through today to take a look at 89-311 because it does outline other things in this general area that the Commission has asked us to look at. And it's part of Med's mailing of March 20th.

Do any members of the subcommittee have any comments they'd like to make at this time? So, Carl, I guess you and I since you have ABWR, and I kind of co-chair the 26th meeting and find out whether consistency exists.

Okay. With that, we'll proceed with the staff's presentation.

[Slide.]

MR. MICHELSON: Perhaps before the staff tells about the details of this or maybe you're going to tell us.

I'm still a little puzzled as to whether or not these licensing review basis documents are going to be approved by the staff or used for information only or just what will be their status once one finally agrees as to what the licensing basis is.

MR. SINGH: I think the final decision will be with the Commission. We are in the process of preparing a Commission paper.

MR. MICHELSON: What is your recommendation as to how they be treated?

MR. SINGH: Right.

MR. MICHELSON: Well, I asked a question. I say, what will be your recommendation?

MR. SINGH: With regard to the LRB?

MR. MICHELSON: Yes.

MR. SINGH: We are going to recommend the Commission to improve the LRB with certain comments.

MR. MICHELSON: So, it will become part of the certification docket then?

MR. SINGH: Yes, sir.

MR. MICHELSON: It will become a part of the commitments?

MR. SINGH: Yes, sir.

MR. MICHELSON: Okay. That isn't presently the status as I understand it, the ABWR licensing basis agreement.

MR. SINGH: Well, you know, ABWR, LRB was issued way back before the Commission guidance stance, as you know.

MR. MICHELSON: So, we'll go back, I guess, and as far as you know, we'll go back and also make that document a part of the docket?

MR. SINGH: We have not decided to do that.

MR. MICHELSON: You haven't decided yet?

MR. SINGH: No, no. We have not been given the specific direction by the Commission what to do with it, ABWR LRB.

MR. MICHELSON: Okay.

MR. SINGH: We haven't told what to do about the LRB.

MR. MICHELSON: It's one thing to comment on a document if it becomes a part of the requirements. It's another if it's just an information-type document.

MR. CARROLL: Well, maybe it would be useful to the subcommittee to hear from you, sort of a history of LRB's or how did this all come to be? I guess, my understanding is, it's kind of an ad hoc document. You can't go to a NUREG someplace and find out what the content and format of a acceptable LRB is. It's kind of an evolving thing. Is that a fair characterization?

MR. SINGH: I don't know all of the history behind the LRB. I do know some things though. I think the idea was to propose or discuss with the staff way back in 1986 time frame, you know, between General Electric and the staff. And it basically evolved through the years.

I have been project manager on System 80+ for the last 10 months. The first LRB with commitment to do a -- was submitted to the staff in March of last year.

And we have used that a couple of times in discussions on a number of occasions. And then in the meantime, we had specific guidance from the Commission what to do in the LRB document. And that is where I was going to start my presentation.

After the Commission guidance came in December SRM's, December 15, 1989, SRM's, we went over the Commission guidance. -- provided revised input on January 22, 1990 and I believe you all have copies of that.

MR. CARROLL: Now, which staff requirements?

MR. SINGH: December 15, 1989.

MR. CARROLL: 1989?

MR. SINGH: Yes, sir.

MR. MICHELSON: I assume that's a SECY 89-311?

MR. SINGH: Right.

MR. CARROLL: Well, that doesn't tell me much. I mean it starts from the premise that something called a licensing review basis document exists. What was the guidance as to what belongs in it?

MR. SINGH: Yeah, the guidance from the Commission was that LRB document ought to have two things. One is, they ought to cover all of the policy issues involving that design and the Commission will make decisions for them before the final LRB is issued. That's one.

The second thing is they ought to have a -- with every -- these two major points were made in the SRM and they went back and put those things into the LRB, the proposed LRB document and presented it to us in January.

MR. MICHELSON: Now, when you say you look at, I think you said, compare it with the EPRI requirements?

MR. SINGH: Yes.

MR. MICHELSON: When you do that, that means the entire lightwater requirements document, all the chapters? Is that right.

MR. SINGH: That's my understanding of the Commission guidance.

MR. MICHELSON: Okay.

Thank you.

MR. SINGH: So we have the revised input from CE, the staff review is virtually complete. We have drafted a Commission Paper.

MR. CARROLL: Let me go back. Revised input. I guess you alluded to the fact that Combustion had submitted something earlier that was also called a Licensing Review Basis Document?

MR. SINGH: Yes.

MR. CARROLL: And it was a commitment to do what?

MR. SINGH: In general, earlier versions of the LRB document contained a commitment of what the scope of the design will be, what are the major technical issues involved and what is proposed revisions regarding those issues.

MR. CATTO : Okay. So that was the earlier versions of this. The revision you received on 1/22/90 was all of that plus the points that the Commission had made about comparison with EPRI requirements, and so forth.

MR. SINGH: And policy issues.

MR. CARROLL: Okay.

MR. SINGH: That is exactly what the revised policy input is.

MR. CARROLL: Okay. But I am correct in saying there is no document I can go to if I want to get into the business of designing a reactor for certification on my kitchen table, I can't go to a document and it will tell me what you expect to see in a Licensing Review Basis Document.

MR. SINGH: No. I don't know of any. Like I say, this idea of Licensing Review Basis Document has evolved over the years and I do not know exactly how it started out.

MR. CARROLL: Okay.

MR. SINGH: So, the staff review is virtually complete. We have prepared a Commission Paper which is in concurrence at this moment. That paper is going to go to the Commission soon and to the ACRS. We plan to meet with you again, and the Commission, followed by guidance from the Commission and then we will issue the final LRB document. We expect sometime this summer, if not sooner, to issue the final LRB document.

MR. CARROLL: Now, is there an intention on the part of the staff, once you have been through one of these, this one in particular, to provide some guidance for future Licensing Review Basis Documents? For example, for the passive plants or whatever?

MR. SINGH; There is another one -- as a matter of fact, the Commission had asked us to propose how to streamline the process for the review and approval of the LRB document as well as applications for design certifications. And we are going to present a paper to the Commission. That paper has been drafted and is going to go to the Commission on the 14th of this month, which would have a process, measured steps for reviewing and approving an LRB document, for example, for passive plants and it would have some major steps that the staff is going to follow in reviewing the design certification application. So, you would see those things in that part of the

Commission Paper. We will be providing copies to you, of course.

MR. MIC'ᴇLSON: So we can expect to see that document before the 14th of this month?

MR. SINGH: No, not before the 14th. It is due to the EDO on the 14th.

MR. MICHELSON: We will see it when it goes to the Commission, of course.

MR. SINGH: Of course, yes. And there is a Commission meeting, as you know, on the 27th of this month and those aspects are expected to done.

MR. CARROLL: Does that suggest, Carl, that we might want to think about waiting until we get that to have our joint meeting?

MR. MICHELSON: Well, yes. I didn't realize they were putting together such a document, of course.

MR. SINGH: You may have seen SECY 90-065.

MR. MICHELSON: No. What's the subject?

MR. SINGH: SECY 90-065 had the proposed process and a schedule for the review of ABWR.

MR. MICHELSON: I have seen that already, I'm quite sure. That's the one with a very busy one-page chart of where everything goes.

MR. SINGH: Right.

MR. MICHELSON: Now that really is --

MR. SINGH: In that paper, we made a commitment that since the process looks like it's going to delay all the reviews, we offered to streamline the process and still meet the Commission's objectives. We said that in that paper.

MR. MICHELSON: By that you mean you are going to stay on the original schedules if you streamline that process? Is that what you are suggesting?

MR. SINGH: We are trying to be close --

MR. MICHELSON: The original schedule for ABWR being the end of this year, completion.

MR. SINGH. Right. But, you know, a lot of other things have happened.

MR. MICHELSON: Well, I think the staff has been blaming the process for the delay when in reality that's not where the problem really is. I hope that's taken care of because at the rate we are going -- we haven't even gotten all of Module 1 done, and between now and December you are not going to get through all the rest of that on ABWR. I don't care what kind of funny drawing you make of the process. So it's unrealistic to think that the process is the problem. The problem is just getting the review work done.

MR. SINGH: Like I said, a streamlined process with a better estimate of the schedules and review are going to be coming in the Commission Paper this month.

MR. MICHELSON: Now, you are going to the Commission, then, on the 27th to discuss this new paper --

MR. SINGH: Plus the 15 issues.

MR. MICHELSON: -- and I would say yes, in all likelihood we ought to wait until after that's available and make it a part of our meeting. We only need about a half a day on the comparison of the two and the other half of the day can be spent looking at the final -- what was thought to be the final process, and so forth. I assume the Commission might want our comments on it anyway.

MR. SINGH: Yes.

MR. MICHELSON: So, let's reschedule our meeting until such time as this paper is available, assuming it is in the near-term. I mean, it really is that imminent?

MR. SINGH: The Mission Director has to be given the paper ten days before they meet with us on April 27th.

MR. MICHELSON: Okay.

MR. SINGH: That's how the date came about.

MR. CARROLL: And this goes to the EDO on the --

MR. SINGH: Fourteenth.

MR. CARROLL: And he, presumably, is going to have it off his desk and on the way to the Commission by the --

MR. WARD: Well, when are you going to get the paper?

MR. MICHELSON: I hope on the 14th. If it gets to us on the 14th, that should be enough time.

MR. CARROLL: Do we want to see what comments the Commission has?

MR. MICHELSON: It is going to get a briefing that day.

MR. CARROLL: It sounds like tight timing to me.

MR. WARD: If you really don't get it on that day, about the 14th, then it is a problem.

MR. SINGH: Thank you.

[Slide.]

MR. KENNEDY: Good morning, gentlemen. My name is Ernie Kennedy. I'm here from Combustion Engineering. I'm the Manager of Nuclear Systems Licensing. Let point out that today is the first time we've been to talk to you as ABB Combustion Engineering, Nuclear Power. As most of you may know, Combustion Engineering was acquired by Boveri last January. Our designation now as ABB Combustion Nuclear Power, Combustion Engineering Incorporated still exists as a U.S. Corporation and it is under that name that we are applying for design certification.

You'll begin to see the ABB logo on our presentations from here on out as we adopt the corporate identity. That is something new for you. In general, we would like to structure the agenda today a little differently from what's in front of you. We're certainly very flexible.

I would like to very briefly introduce you to the LRB and perhaps add some light to the questions you've been asking on the history of the LRB and how we got to where we are today.

MR. MICHELSON: Excuse me. Before we get into that, as long as you've put in a little pitch for your new affiliation, maybe you could explain to me to what extent the System 80 Plus might be able to take advantage of the expertise provided by this new affiliation. In other words, how will the foreign expertise be brought in, if at all, into System 80 Plus?

MR. KENNEDY: Well, the first large advantage to us is, last year, we committed to certify an entire plant, not simply the nuclear steam supply system as we did on System 80. The biggest advantage to us right now of being part of the ABB corporate family is that ABB Is very active in turbine generators, balance of plant, architect engineering services for the rest of the plant.

It gives us an in-house capability to provide that extended scope. It also provides us with large corporate resources in research and development. The ABB group believes in basic research and development and has a very large program. Is there anything that you'd like to add to that?

[No response.]

MR. KENNEDY: Basically, those are the two points.

MR. MICHELSON: Well, really, though, as far as the Nuclear Island portion of that, I guess it would be the same as if the affiliation hadn't existed. There won't be any additional real engineering thought going into System 80 Plus from your foreign affiliate.

MR. KENNEDY: From the Nuclear Island, the content will still be largely combustion engineering content. ABB's expertise in that area is in boiling water reactors, large, and there's not a whole lot of overlap there, so it will be largely combustion engineering content.

MR. MICHELSON: Thank you.

MR. KENNEDY: On the agenda today, the LRB, as will see, discusses a number of technical issues as well as policy and process issues. In order to put those in perspective, we are going to walk you through an overview of the design and talk about those issues in the context of the design. We'd like to leave this meeting not only with you having an understanding of the LRB, but some general understanding of the design.

We, of course, will be expecting to come back to this Committee several times in the course of the review and talk about the design in much greater detail. Today, we'll simply try to give you a high level overview. Let me also point out that Ed Sharer, our director of nuclear licensing, whom you may remember from some years back, was hoping to make it to the meeting today, but a group of ABB management showed up at our offices this morning, and he's unable to make it today. He does send his apologies for not being here today.

[Slide.]

MR. KENNEDY: Again, our objectives, very briefly, are to obtain your comments from this meeting and any later meetings on our LRB and to review the System 80 Plus design features with you. A little history of the LRB, to go to your question:

We first proposed our LRB back in July of 1987. That LRB went through several revisions before the issuance of Part 52, the Standardization and Certification Rule. This really was a break point in how our LRB was structured. Before this, our LRB discussed largely the process for certification and a number of policy issues.

Part 52 settled that. Part 52 defined the process and settled some policy issues; for example, prior to this point we were still trying to certify the nuclear steam supply system. Part 52 says you can only certify an essentially complete plant. That settled the issue.

We revised our LRB after the issuance of Part 52 to incorporate the Part 52 requirements. We took out a lot of the procedural steps that used to be in our LRB because they were covered by Part 52. We committed to the complete plant and there were several revisions in this timeframe.

As Robbie Singh pointed out, there were two staff requirements memoranda in December of 1989 where the Commission said they would like to see comparisons of the EPRI requirements. They would like to see some policy issues. We have revised our LRB after the staff requirements memoranda, the latest revision in January of 1990, and that's the version that we are discussing here today. So, yes, it has evolved and it has changed. Those are really the two milestones that have driven us.

MR. CARROLL: This is probably an inappropriate question, but do you have any sense as to how close your LRB is to the GE one?

MR. KENNEDY: We started out being very practical. We took the GE LRB and almost xeroxed it.

MR. CARROLL: Which was about a year earlier?

MR. KENNEDY: Yes. Since that time, mainly in the area of technical issues, issues which the staff in a number of forms has asked us to address in the LRB, we have added issues to the LRB. Also, the General Electric LRB was back in this timeframe before Part 52. It does discuss process. We don't need to discuss that anymore; we can simply reference Part 52.

MR. CARROLL: They have not done what you have done with the advent of Part 52.

MR. KENNEDY: Not to my knowledge.

MR. CARROLL: We'll get to that one.

MR. KENNEDY: Since our's has not been approved, we've been revising it. I don't believe General Electric has revised their's, once it was approved. There are a number of other documents, I think, that document staff agreements, but they did not revise their LRB.

MR. MICHELSON: Now, when you say their's was approved, I think you're using that term rather loosely.

MR. KENNEDY: Yes.

MR. MICHELSON: Okay, it's not in any sense a formal approval.

MR. KENNEDY: I believe -- I may be speaking out of turn here, but I believe there was one letter, but as far as any legal standing of the LRB, I'm not aware of any.

MR. MICHELSON: I'm quoting from the August 7th letter from Murley to General Electric which was the so-called approval. It says, "The licensing review basis represents our understanding of certain approaches which GE proposed and committed to follow in the ABWR design and license application design in order to permit the review to proceed efficiently until final Commission positions and staff requirements are defined and implemented."

In other words, it's a gentleman's agreement that you're heading in the right direction.

MR. KENNEDY: That is my understanding.

MR. MICHELSON: That's about all it appeared to be. Since then, of course, we're going to have some new thoughts about what these are, but at that time, it was not approved in the sense of regulatory approvals.

[Slide.]

MR. KENNEDY: I understand. That brings us to today. Given Part 52, what do we see as the purpose of the LRB? Well, we believe it serves three primary roles right now. One is to implement Part 52 -- not to duplicate it, but to implement the Part 52 process; to define a schedule for both the submittal of our application and the staff review so that we can work to a common schedule. Thirdly, to identify important issues that we in the staff need to address during the technical review of the application.

Those, right now, are the functions we see being served by our LRB.

[Slide.]

MR. KENNEDY: This is a slide, a very busy slide right here which the staff has shown to the ACRS on a number of occasions. This is the staff flow chart for design certification. What I wanted to point out is that in the lefthand side here in the discussion of the LRB, we had hoped to be at this point, ACRS Review of the LRB, after completing staff review.

The staff still has our LRB under review, so we're not quite there yet, but we thought it was still worthwhile to come talk to the ACRS because, although we don't have the staff review completed, I think I can say that I don't know of any substantive disagreements that we have with the staff that can't be resolved between us. I believe we're very close.

MR. MICHELSON: Could we just interrupt a moment and ask the staff when they think their review will be completed?

MR. SINGH: The review of the LRB document is virtually complete. It is going -- we have drafted a recommendation paper.

MR. MICHELSON: Is that the same Commission paper we talked about a little earlier?

MR. SINGH: Right.

MR. MICHELSON: Okay, it will be in there?

MR. SINGH: I'm sorry. I talked about several Commission papers. There is a Commission paper --

MR. MICHELSON: The one that's going to be out on April 14th?

MR. SINGH: No, it's not the same Commission paper.

MR. MICHELSON: You mean then, even if we hold a meeting on the 27th, we still don't have the staff's position on the LRB?

MR. SINGH: We may not.

MR. MICHELSON: I don't think we would want to meet until we do.

MR. CARROLL: You're talking about 9016?

MR. SINGH: EPRI 27.

MR. MICHELSON: I assume from what I just heard that the staff is going to prepare some kind of an approval letter for the CE's proposed LRB; is that right?

MR. SINGH: Right.

MR. MICHELSON: It's that letter that I would like to think that we had before we discuss the differences between these two.

MR. CARROLL: Let me see if I can say it for you: I think what he's saying, Carl, is that until the process of getting back Commission views on 9016 is complete, they're not going to be able to complete their letter on Combustion LRB; is that right?

MR. SINGH: That's right, because many of the issues are common.

MR. MICHELSON: Yes, that's true. I'm asking the question, though; until we do have that letter, do we want to have a Subcommittee meeting? You know the Subcommittee meeting is coming up shortly and it's not clear that even on the 14th of April that that letter will yet be available.

MR. SINGH: I can't give you a date when the Commission letter will go to the Commission.

MR. MICHELSON: We don't want to look at it but once, and we'd like to know, so I guess we just have to postpone that meeting until later.

MR. CARROLL: We're in that loop also because the Commission has asked us to comment on 9016 and we haven't sent our comments in yet.

MR. MICHELSON: Our's are getting close to completion, though, at least most of the items.

MR. CARROLL: I hope.

[Slide.]

MR. KENNEDY: Let me, in very general terms, talk about what's in our LRB. First, our LRB describes the scope of the System 80 Plus design. You'll hear a little bit more about that later, but it is a complete plan. The LRB then discusses the schedule that we are working for to achieve design certification.

The milestones are for us to complete our application -- to complete the modules of our application by the end of this year. We are shooting for final design approval by December of '91 which is consistent with the schedule of the staff requirements memorandum and we're targeting for design certification a year after that at the end of 1992.

[Slide.]

MR. KENNEDY: Jus to remind you of an acronym here that we have been using, our application, the safety analysis report that we refer to is CESSAR-DC, the Combustion Engineering Standard Safety Analysis Report Design Certification. CESSAR-F was the document which you approved, or which the NRC approved for our System 80 design. We're referring to this one as CESSAR-DC.

MR. CARROLL: You're going to have to get clever and somehow or other work Asea Brown Boveri into all of that, too.

MR. KENNEDY: We really haven't quite figured out how to do that. It gets somewhat unwieldy.

MR. MICHELSON: Just to be sure I understood what you just said, the only document you want to certify is actually CESSAR-DC and not anything earlier?

MR. KENNEDY: Correct.

[Slide.]

MR. KENNEDY: What we have done is, we have been submitting portions of our application in modules. These modules; what we did is, we took our existing System 80 document, our CESSAR-F and we began to amend it as we incorporated design changes. So, the document has been essentially under continuous revision. We began this in November 1987 with the first submittal, and as you can see, we continued that through the end of 1989.

I would point out that in March of 1989, you begin to see us expanding into areas which were not part of CESSAR-F. We began to implement the entire plant approach in our March 1989 submittal. You begin to see a balance of plant systems containment buildings. In December of 1989, we began to submit our PRA methodology and our Level 1 PRA results and also we begin to include our resolution, our technical resolution to the USIs and GSIs, the Generic Safety Issues and Unresolved Safety Issues.

MR. MICHELSON: Excuse me. What's a Sabotage Projection Program?

MR. KENNEDY: That should be protection.

MR. MICHELSON: I thought maybe you had something else in mind.

[Slide.]

MR. KENNEDY: We have three remaining submittals scheduled. This month, we will be supplying an additional input to our USI/GSI resolutions and will be submitting our ECCS and Containment Analysis descriptions and results. In August of this year, we will complete the safety analyses; we will complete the Level 3 PRA and our severe accident analyses, seismic methods and complete the building layouts for the plant.

Then at the end of this year, December of 1990, we expect to send in the rest of the material, including the technical specifications, the inspections tests and analyses that are required by Part 52 and the Maintenance and Reliability guidelines which the staff has requested as a part of the certification application. We hope to finish those by the end of the month.

MR. CARROLL: Are those guidelines part of Part 52?

MR. KENNEDY: I don't believe maintenance and reliability guidelines are mentioned specifically in Part 52.

MR. CARROLL: But the staff just thinks this is a good idea?

MR. SINGH: Excuse me; let me clarify that for you. Commission sent an SRM back, I believe, in July August timeframe last year with respect to ABWR. Commission wanted to know when the staff expects the maintenance and reliability criteria document from GE, okay? Maintenance and reliability program, reliability issue and design issues; they are mentioned in Part 52.

But it doesn't say like it's shown in the slide, but the -- obviously the Commission intended to have some of these, and it is said in the SRL.

MR. CARROLL: All right. On the issue of USIs and GSIs, what's your understanding of what you have to commit to? I read it somewhere on the plane yesterday. Does it exist?

MR. KENNEDY: The words, I believe -- I think I can quote them relatively accurately -- is to provide a technical resolution to all of the unresolved safety issues and to the median and high priority generic safety issues as documented in NUREG 0933, six months before the date of the application.

MR. CARROLL: Now, the date of the application is what?

MR. KENNEDY: We sent in an application for design certification, a formal letter, in March of 1989. The staff still has not officially set up a docket number for me. I'd have to ask the lawyers whether or not that counts as a date of application, but that's beside the point.

We are using Supplement 9 to NUREG 933 which is after that date. Supplement 10 has been issued. We are looking at that to see if there are any substantial changes, but our submittals were made to Supplement 9 of NUREG 933 and there is one supplement after that that is on the street.

MR. CARROLL: I have one -- that the staff keeps telling us that they're going to come and talk to us about and they never come, is on the CE PORV issue.

Now, is that -- since that hasn't been resolved, you're not going to be committing to that?

MR. KENNEDY: No, we will address all of them, particularly those that have not been resolved by the staff. Part 52 requires us to propose a resolution. So, for those even which are unresolved as far as the staff status, we will be proposing what we think is an acceptable resolution for the System 80+ design.

MR. CARROLL: Okay.

MR. MICHELSON: Well, then you leave me with a little bit of confusion then. What does it have to do with the date of the application?

MR. KENNEDY: That is simply what is written into Part 52 as a benchmark for this list that you have to address.

MR. MICHELSON: Well, later on we'll get back with the staff on why GE has committed to the FDA date for the resolution of these issues and not to the application date.

MR. SINGH: Let me make a comment about the date of application. We have recently gotten guidance from our lawyers on what is the date of application as referred to in Part 52.

Now, our lawyers have told us the date of the application is when all the submittals are in. In other words, not when an applicant sends a letter of intent to apply for certification, but, rather all the submittals are in.

MR. MICHELSON: That would be sometime during 1990 then?

MR. SINGH: Right.

MR. MICHELSON: Okay. Now, --

MR. SINGH: That is the guidance.

MR. MICHELSON: At least that will be close.

MR. SINGH: Yes.

MR. CATTON: Could you get me -- send the PORV.

MR. KENNEDY: We will be discussing that in our technical presentation. The answer is, we have a safety depressurization system that Mr. Turk will be talking about.

MR. CATTON: Okay.

[Slide.]

MR. KENNEDY: Very quickly, graphically, this simply shows the schedule in graphical form, FDA at the end of '91, design certification at the end of '92.

MR. MICHELSON: Back on your previous slide in December of '89, you indicated a PRA methodology in level 1. That PRA I guess was submitted?

MR. KENNEDY: Yes.

MR. MICHELSON: Does that include external events?

When will the external events portion be submitted?

MR. JACQUITH: My name is Bob Jacquith from Combustion and we will be submitting the level 3 PRA in August is the schedule and that includes external events.

MR. MICHELSON: And that will be a level 3?

MR. JACQUITH: Right.

[Slide.]

MR. KENNEDY: To continue again briefly with what's in the LRB, there is a section in the LRB that discusses severe accident issues, how we're going to resolve USI's and GSI's, how we're going to conduct the PRA, and a number of severe accident performance goals. Mr. Jacquith will be discussing this today as part of his presentation.

[Slide.]

MR. KENNEDY: The LRB also contains a discussion of a number of other issues. These issues come from a number of sources from letters we've received from the staff, from meetings we've had with the staff, of issues they would like for us to address in the LRB.

Without going through this list in detail, let me point out that there is another list that's been discussed recently, the so-called 15 technical issues. Of these 15 technical issues which are being discussed currently, 13 of them are presently discussed in our LRB.

The reason the other two aren't discussed in our

LRB, is we weren't smart enough to anticipate those two. There is no reason we could not discuss them in our LRB if the staff thought it was appropriate for us.

But, in our January, 1990 version, we simply have no discussion on two of these issues.

[Slide.]

MR. KENNEDY: Now, what we would like to do today since these issues are of current interest, as we go through today's agenda, we are going to, at the appropriate point in the presentation when we're talking about a design feature, discuss each of these 15 technical issues in the context of the design.

So, as we go through today, you will see in our presentation, each of these 15 technical issues.

MR. CARROLL: Do you think 15 is the right number? What would you add to the list?

MR. KENNEDY: Well, it's interesting, as part of our LRB back in January, the staff requirements memorandum, we were asked to identify what we thought potential issues were. We came up with a shorter list.

Frankly, we think there are some things on that 15 issue list that don't really involve policy questions. So, I think we've come up with a shorter list. This is the list we came up with.

MR. MICHELSON: And what would you define as policy matter? You know, that's apparently how you differentiated why some of them don't belong on the list. What were you using as a definition?

MR. KENNEDY: I would say we're not using anything cast in stone. What we have been using is an issue which we believe is a policy issue of sufficient merit that the Commission needs to give the staff guidance because it goes well beyond current regulations and current regulatory practice.

MR. MICHELSON: Now, well beyond means that some of the others could go beyond but it isn't a policy issue?

MR. KENNEDY: There are some issues which could go beyond current staff requirements but are within the range, I would say, of the interpretation of the requirements. It's a gray area as to what's a policy issue and what's not.

MR. MICHELSON: So, those that are gray don't need to be policy issues. If they're black and white, clearly then they're policy issues.

MR. KENNEDY: If they are grey, we would prefer to, first of all, negotiate with the staff to see whether or not we can reach an appropriate resolution with the staff before we say it requires a Commission decision.

We might be able to reach a perfectly agreeable resolution with the staff.

MR. CARROLL: And "we" could even be broader.

"We" could be the industry?

MR. KENNEDY: That's true.

MR. CARROLL: We, as you were using in the context of Combustion.

MR. KENNEDY: We could be, for example, in the EPRI requirement document. There are a number of issues that are being pursued on the EPRI requirements document which I think might be satisfactorily resolved there and we would simply adopt a resolution.

MR. CARROLL: Do we have a copy of that?

MR. KENNEDY: It is in the LRB. If you have our LRB, it's one of the sections right up front in the LRB, the list of policy issues which we were asked to identify.

MR. MICHELSON: Let me ask you. In appendix A to the LRB is where you discusses differences with the EPRI document.

MR. KENNEDY: Yes.

MR. MICHELSON: Am I to conclude that those are the only differences?

MR. KENNEDY: We will be going through that list as part of our presentation today.

MR. MICHELSON: Was that the intent -- unless listed in appendix A, you were in agreement with the requirements document?

MR. KENNEDY: Yes.

MR. MICHELSON: Okay. Thank you.

MR. CARROLL: Page three, Dave.

MR. KENNEDY: And I can get you a copy of the slide if you'd like it, but, it should be brought out at the LRB.

MR. CARROLL: We have it.

MR. KENNEDY: That was the completion of my introduction, gentlemen. If you don't have any questions, I would like to turn the floor over to Dr. Regis Matzie to give you an overview of our design program.

MR. MICHELSON: Before you leave, though, let me ask you something that bothers me, and I don't know -- maybe you're going to get into it in great length later or maybe not -- and that's this question of the completeness of design that you're presenting.

Were you planning on talking about it anymore than you might have mentioned already?

MR. KENNEDY: You mean level of detail in the design?

MR. MICHELSON: For instance.

MR. KENNEDY: Or the completeness of the scope of the design?

MR. MICHELSON: Well, no. It's the completeness of design identified in the standardization policy statement and so forth.

MR. KENNEDY: If I could, then, I would like to come back to that issue at the conclusion of our technical presentations. I will address that.

MR. MICHELSON: Okay. What constitutes an essentially complete design is the question, because that's what we are, presumably, certifying.

MR. KENNEDY: Okay. I will address that issue at the closing of the meeting.

MR. MICHELSON: Okay. That will be great. Thank you.

MR. CARROLL: Let me point out to the Subcommittee that, I guess, Combustion would like to complete the meeting by 2 o'clock today. Is that right?

MR. KENNEDY: If possible, we would like to try to catch a 3:15 flight, if that's agreeable. If that's not agreeable, we can make other arrangements.

MR. CARROLL: So far, you're 11 minutes ahead of schedule.

[Slide.]

MR. MATZIE: My name is Regis Matzie. I'm the Director of Advanced Water Reactor Projects, and I'll give you a programmatic overview of the System 80+ design certification program. I'll be followed by a series of presentations on the technical details of the design.

[Slide.]

MR. MATZIE: The objectives of our System 80+ program are rather broad and generally encompass what are viewed as some of the requirements for future plants: enhanced safety, increased margin, improved operability and maintainability, reduced cost, and the use of proven technology. And we're doing this to obtain NRC certification to, number one, reduce licensing risk to a prospective customer, and finally, then, the result of that, possibly, is to retain nuclear as a viable option for future capacity additions in the United States.

[Slide.]

MR. MATZIE: The program that we have been involved with is not only a Combustion Engineering program but a rather broad industry program, and at the start of that program, in terms of what a future plant should be, is the EPRI ALWR requirements document. Combustion Engineering, teamed with Duke Power Company, has been a key player in the development of the requirements in the EPRI program since 1986. We have been a partner with Duke to develop those requirements, and we have continued to work with Duke to develop the balance-of-plant aspects of the System 80+ design.

In addition to the EPRI requirements, we have been involved rather heavily in a number of other programs, as you can see here, all of which provide input to our design, and that input is collected and documented in our CESSAR-DC, under the sponsorship of a Department of Energy program called the DOE ALWR Design Verification Program, and that leads, then, to the submittals that Mr. Kennedy spoke of earlier to the NRC and, hopefully, on schedule, the certification of the System 80+ design.

[Slide.]

MR. MATZIE: The approach that we have taken to develop System 80+ is to start with our rather successful System 80 design, which had final design approval in CESSAR-F for the NSSS, and as a starting point, we have taken the Duke Cherokee/Perkins balance of plant as the reference from which we would then incorporate changes to upgrade and update the design to conform to the EPRI ALWR requirements for evolutionary plants, the NRC required changes and, mostly notably, in the area of severe accidents, and operational feedback from our own units and, particularly, Palo Verde -- the startup and operation of Palo Verde.

MR. MICHELSON: How does the Cherokee differ from the Yellow Creek? Are they same vintage?

MR. MATZIE: They are basically the same vintage.

MR. MICHELSON: Is Cherokee a later one or an earlier one?

MR. MATZIE: I think Cherokee probably had more design completion on some of the balance-of-plant aspects, but they're the same vintage, same timeframe.

MR. MICHELSON: Okay.

MR. MATZIE: These potential changes, then -- and there's a whole set of these, obviously -- we assess with respect to safety, performance, operability, maintainability, and cost, and we use probablistic risk assessment and cost-benefit techniques to help us decide which changes to incorporate into the System 80+ design.

MR. MICHELSON: Excuse me. Was Cherokee a spherical containment, also?

MR. MATZIE: Yes.

MR. MICHELSON: Thank you.

MR. MATZIE: Those that we then select have been documented and submitted to the NRC as part of the CESSAR-DC.

[Slide.]

MR. MATZIE: The System 80 design was a major part of a nuclear power plant but not a complete plant. It was basically the nuclear steam supply system, as defined here.

[Slide.]

MR. MATZIE: We have, as discussed earlier, expanded the scope of the design to an essentially complete nuclear power plant, and the categories of systems that we are now including in the design and design certification are shown here. Everything required by 10 CFR, Part 52, and that which the staff will need to review the design under the standard review plan is included.

[Slide.]

MR. MATZIE: Of course, Part 52 recognizes that certain site-specific features should be addressed only by presentation of the conceptual design level. To this end, conceptual design descriptions and interface requirements are being provided in CESSAR-DC for the following systems and structures, consistent with the requirements of 10 CFR, Part 52.

MR. WYLIE: Excuse me. You don't list the turbine generator building. Is that not included?

MR. MATZIE: The turbine generator building is included in the System 80+ design.

MR. WYLIE: Thank you. And the auxiliary building.

MR. MATZIE: That's correct.

A very high level comparison of System 80+ to System 80 is shown on the next two slides.

MR. MICHELSON: Before you get to that, let me ask: On the portable and sanitary water, why isn't that detailed in the auxiliary building, control building, places like that, where it could be a potential threat to safety-related equipment? Why can't you detail the sewer arrangement, the drinking-water arrangements, and so forth in the reactor building?

MR. MATZIE: From a practical standpoint, systems like that have not been included from a cost perspective.

MR. MICHELSON: They're trivial systems, virtually, compared with everything else you are doing, and they could be a potential threat if done improperly. You can write all kinds of interface requirements, but an inexperienced designer may not interpret them properly. The staff will never see or review them until that cooling water line over the control building going to a cooler in the corner leaks one day and drips on the control panel. Then everybody will be aware of it.

So, within sensitive areas, I don't know why you aren't considering such things as the drinking water in the design. There aren't going to be many of these. It's almost trivial. But why do we leave out something like that?

MR. MATZIE: When we were trying to settle the scope of what we were including and what we were not, that fell on one side of the fence. We'll take it under advisement.

MR. MICHELSON: The sanitary water -- heck, sanitary drains can back up and so forth. I don't know what the interface -- you know, the interaction might be with safety-related equipment and not knowing what the arrangement is, and probably never knowing, it's not clear to me how you do a safety analysis of these kinds of non-safety systems.

MR. CATTON: You mean you don't think it turns up in the PRA?

MR. MICHELSON: No. You know it isn't going to turn up in the PRA. It isn't going to turn up anywhere, including in nobody's mind, if it's never been detailed until the day that Podunk Electric buys it and, apparently, goes in and puts the sewers into this nuclear island and then the water coolers, which it will stick in the control room, right over the control panel, for all I know.

It's so trivial. It seems like you ought not to leave it out.

MR. WYLIE: Is someone going to discuss the offsite power systems interfaces further?

MR. MATZIE: Yes.

[Slide.]

MR. MATZIE: A very high level comparison of System 80+ and System 80 is shown on the next two slides. The details of this will be discussed subsequently by the other speakers. I wanted to give you a feel early-on for the kinds of things that we have done without going through the details at this point in time.

In the reactor area, the principal objective was to maintain a proven design and to meet utility performance requirements.

There are relatively few changes to the design and one example of such a change is the fact that we have included part strength or weak or grey -- whatever the terminology you want to use -- control rods for some of the rods to enhance load following capability, which will likely be a requirement in the future as utility capacity in the nuclear area gets to be a higher percentage.

In the reactor coolant system area, the principal objective was to improve plant margins and some of the examples of this are shown for changes from System 80 in terms of temperatures, system volumes and materials and these will be discussed in detail later.

The safeguard systems, a principal objective was to reduce the core melt frequency to meet a goal that we have established which is in agreement with the general industry goal and I'll show you that in a minute.

We have therefore redesigned the safeguard systems to be essentially in compliance with the current EPRI/ALWR requirements for evolutionary plants and as was already mentioned, we have added a safety depressurization system which will be described later.

[Slide.]

MR. MATZIE: In the auxiliary systems, principally the CVCS, we have taken the objective of simplification and the major simplification and result of that has been to design a non-safety CVCS. There is no safety function of the CVCS as it is currently designed.

The containment design principal objective was to address severe accidents and meet utility maintenance requirements. That has resulted in the use of a dual spherical steel containment that will be described to you.

In the instrumentation and control area our objective was to provide state-of-the-art human factors engineered instrumentation and control systems and control room and that has resulted in an advanced control complex that we call NUPLEX 80+, again which will be described.

In the electrical distribution and support system area, improved reliability consistent with the safeguards systems improvements, greater redundancy and greater diversity are the types of changes we have implemented there.

[Slide.]

MR. MATZIE: The next two slides will give you a very broad overview of improvements in the areas of cost and operation. We have looked at the construction schedule with the changes we have made and it is a significant improvement over the average experience in the United States, very consistent with the best experience in the U.S. and experience overseas in terms of that schedule.

Similarly, with respect to plant costs, we have good confidence that we can meet these objectives in an environment where the design is prelicensed and there's a significant level of detail completed prior to start of construction.

MR. WYLIE: The capital costs doesn't include the cost of money during construction?

MR. MATZIE: That's correct. That was the overnight capital costs.

[Slide.]

MR. MATZIE: In the area of improved operation, we are designing the plant for a 60 year design life, for a high availability, for a relatively short outage time, for significant reduction in unplanned scrams or plant trips, for a low personnel exposure and for improved maintainability.

MR. WARD: Regis, when you talk about a sixty year design life, is there anything explicitly different that's been done than if it you had specified a forty year design life, let's say?

MR. MATZIE: In terms of the way the plant was designed, let me give you the basic overview of that issue and the issue is anything that we do not have high confidence from the standpoint of design criteria that can meet sixty year lifetime we have specifically ensured that that is easily replaceable.

As an example, despite the fact that we have improved the design of steam generators substantially in this design which will be described, we have gone through and made sure that the steam generators can be replaced in one piece without cutting containment.

We have looked at the ability to handle and move those generators out of containment. That's an example.

Basically besides structures --

MR. CARROLL: But you have really hopefully taken care of the problems that require replacement.

MR. MATZIE: That's correct. In addition to design improvements we have made that accommodation and that is true of all the major pieces of equipment with the exception of the reactor pressure vessel which we do not believe will need replacement and which we did not make provisions to replace and --

MR. WARD: What provisions for annealing?

MR. MATZIE: We have not made any specific provisions for annealing. We don't believe it will be necessary and the design aspects of the reactor vessel will be covered to show how we can get a sixty year life.

MR. MICHELSON: On your NUPLEX 80+, is that in any power plant operating today?

MR. MATZIE: No, it is not. There are bits and pieces of the design that are going into some replacement, power plants and new units under construction in Korea, but those are bits and pieces and not the whole thing.

MR. MICHELSON: So we really don't have much operating experience yet with the instrumentation and control system that will control this generation reactor.

MR. MATZIE: In terms of the type of equipment I think that is true.

MR. MICHELSON: So we are speculating a little bit on how many unplanned trips we might get from it and all the other good things -- we are thinking it is a highly reliable system not subject to environmental influences that might generate spurious scrams or things of that sort but we don't really -- do you have test data to back it up, its susceptibility, its vibration sensitivity, its humidity sensitivity, all this sort of thing?

MR. MATZIE: We do have test data and you can ask those questions of Mr. Scarola when he presents the material.

MR. MICHELSON: Because you're going to a new technology and yet you are predicting extremely low unplanned trips and its very high availability.

MR. MATZIE: That's correct.

MR. WYLIE: Is there somewhere where you are going to go into detail as to what you have done to try to accomplish the goals you have set forth, such as unplanned trips?

MR. MATZIE: Yes.

MR. CARROLL: What is your definition of refueling time?

MR. MATZIE: The definition of refueling time is off-line to back on-line in terms of breaker closure, opening and closing.

MR. CARROLL: So it isn't just refueling, it's a refueling and maintenance?

MR. MATZIE: That's correct, that's correct.

MR. CARROLL: And your fuel cycle is how long?

MR. MATZIE: The fuel cycle that we are showing in the licensing documentation is 18 months fuel cycle. As with a number of our reactors the capability for 24 month cycles has been looked at and we have the capability for 24 month cycles. That tends to be a option that the utility will select from the standpoint of its own grid structure and the replacement power, whether he is anywhere from a year to two years.

MR. CARROLL: So the outage time information you have there is on the basis of an 18 month fuel cycle?

MR. MATZIE: That's correct.

MR. CARROLL: So in other words you're going to have 30 days down, 45 -- so you're saying -- let's see, oh, okay. Never mind. I got it.

[Slide.]

MR. MATZIE: The safety goal that we have chosen for the System 80+ design is consistent with those safety goals that you have probably seen quite a bit of recently. In particular they are the ones adopted in the EPRI/ALWR program, a core damage frequency of less than 10 to the minus 5 events per reactor year and a severe accident release goal of 10 to the minus 6 events per year for an occurrence of doses greater than 25 rem at the site boundary.

MR. MICHELSON: Is that at half-mile or at the site boundary?

MR. MATZIE: Pardon?

MR. MICHELSON: At a half-mile or the site boundary?

MR. MATZIE: That's synonymous in this terminology.

MR. MICHELSON: You mean the site will automatically have a boundary out a half-mile from the plant?

MR. MATZIE: That is approximately.

MR. MICHELSON: Is that the assumption?

MR. MATZIE: That's approximately where the site boundary would bee.

MR. MICHELSON: Okay.

MR. MATZIE: It's obviously site-specific.

MR. MICHELSON: But in calculating it is a half-mile?

MR. MATZIE: That's correct.

I am only going to discuss the differences from the EPRI requirements in terms of these global statements. There is a detailed accounting in a subsequent presentation of what the major differences between System 80+ and the EPRI requirements are as per our Licensing Review Basis Document tabulation.

I can say that we have a very high degree of compliance with the EPRI requirements and I can say further that, in terms of performance and safety-related requirements that are included in the EPRI requirements, we are at essentially at 100% agreement. There are a number of specific requirements that we are in disagreement with and those will be articulated to you by a subsequent speaker.

Although there is a list in the LRB at this point in time, there is obviously potential for changes. No. 1, the EPRI requirements document for evolutionary plants is currently under review by the staff and as comments come back those requirements end up changing.

Similarly, we have not completed our design and there may be changes to the design even after our last submittal, based on interactions with the NRC staff. So, although the differences may be a different list finally, the snapshot you see in the LRB is where we are today in terms of conformance to EPRI requirements.

That really concludes my presentation. Are there any questions from a programmatic standpoint before Mr. Rick Turk goes through the start of the detail portions of the presentation?

MR. MICHELSON: I don't have a question for you, but I have a question for our subcommittee chairman and that is when we have our next meeting in which we compare these two documents, meaning the System 80 and the ABWR, I assume at that time Combustion will come back to answer detailed questions on the Licensing Basis Agreement so we don't have to spend today getting into a lot of that detail, rather, do it next time.

MR. CARROLL: Well, I think what you say is true, but to the extent there are questions, I think we ought to get them out on the table.

MR. MICHELSON: But not necessarily expecting the answers today. We will expect the answers next time.

MR. CARROLL: Right.

MR. MICHELSON: Okay. Because otherwise it's hard to write a letter at this time without knowing where we're at.

MR. CARROLL: Right.

MR. MICHELSON: OKay.

[Slide]

MR. TURK: My name is Rick Turk. I am the Project Manager for System 80+ Development.

What we would like to do over the next couple of hours is go back through this overview that Dr. Matzie put up related to the changes from System 80 to System 80+, show you specifically what those changes were and then relate them to some of the policy issues that were discussed earlier and mentioned in regard to the LRB. So, we will essentially start with the reactor, look at the fluid systems, Mr. Scarola will then talk about the electrical and INC systems, Bill Fox from Duke Engineering Services will talk about the containment and balance of the plant, and then we will finish up with Bob Jaquith from our PRA group talking about the safety significance in PRA space.

MR. MICHELSON: Before you get into that, let me ask the previous speaker one more question on the overview. The Licensing Basis Agreement talked about, of course, providing amendment sheets to CESSAR-F, and so forth. Is that going to all be amended, now, to indicate that you, in reality, are going to submit a final CESSAR-DC, which is self-contained and complete?

MR. KENNEDY: Let me answer that. This is Ernie Kennedy.

By the time we finish the amendment process, every page in the document will have been amended and it will be a complete new document at the end of the process.

MR. MICHELSON: Well, let me ask, as we proceed with the review, now, over the next several months, are we going to have in front of us CESSAR-DC to review for the particular sections under consideration, or are we still going to have to go back to the old CESSAR-F?

MR. KENNEDY: You should have all of the CESSAR-DC amendments in front of you. The volume should be complete with all the submittals we have submitted.

MR. MICHELSON: Okay. So the discussion in here about being amendment sheets and being identified and marked where they are and all that, is no longer relevant?

MR. KENNEDY: If you go to your CESSAR-DC binders, you will find printed pages there. You will see amendment bars in the margin to show when we amended it. But it should be, more or less, a complete document. When we finish, the whole thing will have been amended. You will have a complete self-consistent document.

MR. MICHELSON: So we really don't have to ever refer CESSAR-F. It's all CESSAR-DC we are going to look at.

MR. KENNEDY: Correct.

MR. MICHELSON: Okay.

MR. KENNEDY: The old material that is there, we will hope would provide a frame of reference for those portions of the design which were not changed. But the more we have gotten into it, we realized we have got to change the entire document.

[Slide]

MR. TURK: We will, however, continue to talk today primarily in terms of those features that have changed in that those are the features that are probably of the most interest.

I would like to start with the reactor where, as we said, we have changed relatively little. We want to maintain what we feel is a very proven design, that is, the Palo Verde design, making some performance changes.

[Slide]

MR. TURK: This cutaway or cross-section of the reactor vessel highlights those changes. As was mentioned, we have added additional control and drive mechanisms for additional control elements and we will show those changes in the core scheme in a couple minutes.

One addition that we will talk about in the safeguard systems is the addition of a direct vessel Injection Nozzle 4, the safety injection system. We will see that we have lowered the reactor coolant hot leg temperature, primarily, in order to again provide additional margin from our operating conditions to our thermal limits. That's also reflected in the core.

We will see that our vessel material and construction method has changed going from a rolled plate construction used at Palo Verde to a ring forged construction which, by the way, has been incorporated in the 2825 megawatt version of System 80 that is currently under construction in Korea.

MR. MICHELSON: Roughly, where are the welds for the ring forging?

MR. TURK: Roughly, they are right below the nozzle area in here to the lower head here, a ring containing the nozzles.

MR. MICHELSON: Well, the main ones of concern, of course, are around the core anyway.

MR. TURK: That's right. To keep them out of the core area.

MR. CARROLL: So this is a complete ring forging, no horizontal or vertical welding.

MR. TURK: That's right.

Let me just ahead just a slide, as long as we are on the subject.

[Slide]

MR. TURK: You can see, basically, a comparison between the exploded view of the System 80 Palo Verde construction versus the ring forge construction that we are using for System 80+. That eliminates about 135 feet of linear weld. It takes it out of the beltline region, for one thing, and also reduces it in total as far as ISI inspection.

MR. CARROLL: Now, the ring labeled lower shell is the one you were describing being in the core region.

MR. TURK: Right.

MR. CARROLL: Okay.

[Slide]

MR. TURK: Now, as far as the actual core design, it's virtually unchanged from Palo Verde. The same --

MR. CARROLL: Going back to the vessel, I do have -- Paul Schuman, our metallurgical witch doctor was unable to be here, but he left us some questions.

He says, I was once told by CE that System 80 had a 40 year fluence of 4 times 10 to the minus 19th greater than one MEV, which is quite high.

Is that a fair statement?

MR. TURK: I believe that was. Our 60-year fluence for System 80+ is 6 times 10 to the minus 19th, slightly higher.

The changes we have made relative to the 60-year life are, first of all, with regard to materials. We have gone from the 533 plate material to the 508 material, 508 for forging with much lower copper/nickel content. We have taken our initial RTNDT from -- I believe, on Palo Verde Unit 1 we had one plate that was plus 40 degrees Fahrenheit. We are going to spec System 80+ ring forgings at a minus 20 degrees Fahrenheit.

MR. WARD: I am puzzled by the difference between the end of life fluence in the System 80 versus the 80+. It seems to amount to the same thing. Are you talking about fluence in the weld, in the worst weld? Is that what you are talking about?

MR. TURK: Yes. Regis, do you want to elaborate on that a little bit?

MR. WARD: I mean, because the 80 has a weld in the, you know, right in the middle of the core. And you seem to have gotten away with that. I am surprised that the fluence isn't much lower in the System 80+.

MR. MATZIE: This is Regis Matzie.

The fluence that we are talking about is the peak fluence in the beltline region that is on the vessel inner wall.

MR. WARD: Okay. But there is no weld there.

MR. MATZIE: That's correct. But in the modern vessels, the weld material has been as good, if not better, than some of the plate material. So, it really ends up being the ring forging metallurgical properties that dictate the shift now.

MR. MICHELSON: Well, just for the skeptics, what is the fluence at the weld?

MR. TURK: I don't know what it would be.

MR. MATZIE: I'm not sure. You would have to look how it lines up to the peak fluence around the core azimuthally.

MR. MICHELSON: So you don't have a number on the maximum weld fluence.

MR. MATZIE: Not in front of me, no, I don't.

MR. TURK: We can find that out.

MR. CARROLL: Yes. On Paul's list, I guess the only question you haven't answered at this point is, what is the maximum percent sulphur for the reactor pressure vessel?

The same that it meets ASME specs isn't an acceptable answer. It's either .04 or .015.

MR. TURK: It's .015.

MR. CARROLL: All right. We've answered Paul's question.

MR. TURK: The other point I was making with that slide was the fact that the essential array of fuel elements is the same. It's 241 array. It's the same fuel elements used in Palo Verde.

But as mentioned, we did --

MR. WARD: Leave that out for a minute. I've got a couple of questions. Well, unless you're going to come back to it.

MR. TURK: No, go ahead.

MR. WARD: Let's see, you said you have a reduced hot -- temperature.

MR. TURK: Correct.

MR. WARD: Is the thermal rating lower than Palo Verde then?

MR. TURK: No, the thermal rating is the same.

MR. WARD: How did you manage that?

MR. TURK: By lowering steam pressure associated with the unit, there is some increase in steam flow then. But we're essentially operating at a lower temperature.

MR. TURK: A lower steam --

MR. WARD: Right.

MR. TURK: So the power density is identical with Palo Verde?

MR. WARD: That's correct.

MR. TURK: But the gray rods are different. Are you going to talk about the gray rods any place?

MR. WARD: I will --

MR. TURK: To ATWS?

MR. WARD: Not in relation to that. I will show you where they fit in and at that point, maybe I'll have

Regis comment a little bit more on the details since he was a little closer to that design than I was.

[Slide.]

MR. TURK: In terms of what it does relative to the difference between normal operating conditions and thermal limits, we've lowered the temperature. Palo Verde, for instance, had a th of 621. We've lowered this now to 615 degrees.

MR. CARROLL: And what however is not as low as the EPRI requirements document?

MR. TURK: That's correct. The EPRI requirements document which first of all were predicated on a 1,000 megawatt electric plant asked for 600 degrees. That is an exception we've taken with EPRI. It's based on two things.

One, that we did not see any significant benefit in terms of predicted material performance in the generators with that extra 15 degrees reduction.

Second of all, at 3,800 megawatts, the size of the steam generator necessary to maintain the thermal rating with those transfer temperatures become prohibitively large.

So, we say like today, a 615 temperature --

MR. CARROLL: It isn't prohibitive if you have to change out steam generators three or four times of the life of the plant.

MR. TURK: Well, that was the basis for the first reason I said that we could not identify any advantage relative to the material performance going from 615 to 600.

MR. CARROLL: If you had an EPRI hat on up here, how would you argue the other side of it? Why did they pick 600?

MR. TURK: I often think because it has two zeroes and it's a nice round number, but, I'm not so sure.

MR. CARROLL: I guess I'm coming from experience with Westinghouse. But, on the Westinghouse generators, I sure think you ought to get down to 600.

MR. MATZIE: Yes, this is Regis Matzie. The data base in terms of tubing material in the generators that had most of the failures that were in the evaluation as part of the EPRI Program, the material was different than what Combustion Engineering has traditionally specked out.

And we have not had the types of problems that the data showed that if you reduced temperature you got out of. We have not had those problems and therefore we said that that did not influence our design.

Furthermore, we're changing the tubing material to an improved corrosion resistant material. I think the belt and suspenders approach to this issue was overdone.

MR. CARROLL: So you think EPRI was dealing with the Westinghouse problem?

MR. MATZIE: Primarily from the standpoint of the data that they were using to evaluate the issue.

MR. CARROLL: Okay. That's fair.

MR. WARD: Why did you reduce hot leg to the extent you did?

MR. TURK: Primarily the benefit we see in reduced hot leg temperature is the thermal margin benefit, the operating farther away from the thermal limits. The 621 was, you know, a number that came out of the megawatt race when System 80 was being designed, trying to push the designs to their absolute limit.

And one of the philosophies of EPRI's program and our program is that it's to drop back a little bit and not press the designs quite as hard.

MR. MATZIE: Regis Matzie again. Another reason for that is, the plant has been designed for a two-year fuel cycle. And if you'll look at the fuel managements that you would want to implement, you can get to fuel burnups in the 55,000 megawatt day per ton burnup range.

And the reduction in hot leg temperature allows us to go to higher burnups on the fuel without getting increased water site corrosion of the cladding.

MR. MICHELSON: One question yet. On the vessel, was this a Palo Verde vessel?

MR. TURK: In dimensions, yes.

MR. MICHELSON: Now, my vague recollection is that

Westinghouse has elongated their vessel significantly in part to provide for better coverage of the field for certain of the accidents.

MR. CARROLL: That's correct.

MR. MICHELSON: And does CE think that sort of action is not necessary for future plants?

[Slide.]

MR. TURK: We made a significant change in our Palo Verde vessel. Our Palo Verde vessel is significantly different than the previous vessels for instance at San Onofre, Waterford, St. Lucie, okay? To some degree we think that Westinghouse was playing a little bit of catchup.

MR. MICHELSON: Well, what difference now was the significant difference?

MR. TURK: Well, the significant difference was in the, actually, in the structure of the upper head and guide tube and the arrangement with the fingers for the control element.

So, you would see in San Onofre, the core being much higher in the unit and the nodule --

MR. MICHELSON: Higher than is shown there, you mean?

MR. TURK: Okay.

MR. MICHELSON: Higher than shown on this drawing?

MR. TURK: Yes. Yes.

MR. MICHELSON: I don't see how it could be much higher but I admit it could be another foot maybe.

MR. TURK: No, no, because the nozzles were also higher.

MR. MICHELSON: Okay.

MR. TURK: I don't have it with me.

MR. MICHELSON: It is a different vessel.

MR. TURK: It is an improvement that we made at the Palo Verde level.

MR. MICHELSON: What was the clearance between top of core and bottom ID of the exit nozzle?

MR. TURK: I don't recall that offhand.

MR. MICHELSON: And how has that changed from the older vintage to Palo Verde and on to this one? That's what counts in terms of where the water is going to be during an accident.

MR. TURK: Yes. The reasons for the changes weren't exactly those particular reasons.

MR. MICHELSON: Yes, they weren't driven for that reason.

MR. TURK: No, they were mechanical reasons.

MR. MICHELSON: Well, it would appear of course that it is a nice conservative thing to have a little deeper

MR. TURK: We'll show you a little later in the presentation the results and comparisons of line break analysis for Palo Verde relative to System 80+ and the changes that have been made and how that meets the EPRI goal, for instance, of maintaining core covering for breaks in excess of six inches in diameter.

MR. MICHELSON: What break size did you finally end up with as not uncovering the core?

MR. TURK: I think when we get there, I think it's 10 inches.

MR. MICHELSON: All right. You'll get to it later?

MR. TURK: Which of course corresponds to our larger --

[Slide.]

MR. TURK: There are other margin aspects that go along with the reduced hot leg temperature. With the lower core temperatures, because of the higher density, we get a higher mass flow density which also gains in thermal margin. There are a combination of uncertainty changes we're making in our core monitoring systems which will improve our margin.

MR. CARROLL: That's not anything physical you're doing?

MR. TURK: No, that's -- but it determines the room the operator has in operating prior to initiating an alarm condition. At the same time, it helps with the CPCs being the trip producer, the issue of reducing our unanticipated trips by providing more maneuvering room.

MR. CARROLL: So the way you get this four percent gain is by sharpening your pencil, so to speak, in terms of uncertainties and evaluating those parameters.

MR. WARD: I guess I don't see what you're adding up there. The two percent for higher core flow; how is that different? Why are you adding that to the three percent above it?

MR. TURK: Well, the 3 percent is coming strictly from operating at a lower temperature relative to starting condition and the limit. The 2 percent is the power equivalent then of operating at a higher mass flow rate at that temperature.

MR. MATZIE: This is DNBR over power margin.

MR. WARD: You're talking about margin to DNB?

MR. MATZIE: That's correct.

MR. WARD: Some of it is from temperature and some of it is from velocity.

MR. MATZIE: Right, which has traditionally been limiting in our CE plans.

MR. MICHELSON: How much higher velocity are we talking about?

MR. WARD: Two percent, it looks like.

MR. MICHELSON: I didn't know that was necessarily the increase in velocity.

MR. MATZIE: For that particular parameter, it's one for one, essentially.

MR. MICHELSON: Okay, now, is this higher than was used at Palo Verde?

MR. MATZIE: In terms of mass flow velocity, it's 2 percent higher.

MR. WARD: Now, at Palo Verde you got some surprises from high flow problems, vibration problems and so forth, as I recall. Is that worked out here?

MR. TURK: It's worked out in terms of mechanical changes that have been incorporated into the design. The basic fixes from Palo Verde have been incorporated into the design and designed for these flow rates.

MR. MICHELSON: Hopefully, Palo Verde was designed for its flow rate, too, but you've got a surprise. But now you think you understand it.

MR. TURK: That's exactly right. Of course, at Palo Verde, we were going to, like I said before, a completely new design, whereas this is the same basic design being changed slightly.

MR. MICHELSON: Will the core test be -- a core internal test be required for certification? I'm asking staff. Do you know yet?

MR. SINGH: I don't think I have an answer to that.

MR. CARROLL: What do you mean by that, Carl?

MR. MICHELSON: Well, generally, if you can point out somebody else who has done the same test already, then you don't have to go and do a core internal vibration monitoring test. I just wondered if 2 percent more -- I don't know; did Palo Verde do one?

MR. TURK: Yes, they did do one and we would not anticipate doing one.

MR. MICHELSON: So the 2 percent more doesn't necessarily mean you've got to do it over.

MR. CATTON: How do you make that decision? What percent leads you into a new core vibration regime? You didn't anticipate the Palo Verde problems. Do you think there may be some lurking out here?

MR. TURK: I think the question of determining it would be based upon looking at the range of parameters that were done in the analysis and the test program at Palo Verde and whether or not that's easily and acceptably extrapolated at this range.

MR. CATTON: If you don't plan on doing it, I have to assume that somebody's gone through that exercise. It must be documented somewhere.

MR. TURK: I would have to go back and talk to the core designers and the vessel designers. Lyle, do you want to address that?

MR. GERDES: Lyle Gerdes, CE. The comprehensive vibration assessment program that was run on Arizona initially still did not pick up the problems at that -- within the internals. It was only after operation that they went back and retested, because the instrumentation was not at the proper locations.

I might add also that it was not in regions of safety problems. The small changes that were made from the Arizona to the System 80 Plus can easily be shown by analysis that there will be little or no difference. One of the main purposes of the comprehensive vibration assessment program is to verify your analysis techniques.

The analysis techniques that are being used for System 80 Plus are identical to those that were used for Arizona.

MR. CATTON: Does that mean it's not documented? I just asked if it was documented.

MR. GERDES: The analyses will be documented. The analyses are not completed yet for the internals.

MR. CATTON: If you didn't anticipate the problems on PV, what leads you to believe there won't be any problems on the new vehicle?

MR. GERDES: Because the analysis techniques are the same and there are very few differences structurally.

MR. CATTON: If the analysis techniques are the same and you missed it one time, why aren't you going to miss it again. I mean, what have you done differently?

MR. TURK: I think the answer is that we really haven't done anything differently.

MR. CATTON: Is it identical?

MR. TURK: Well, Palo Verde certainly runs in this regime as it transits up in temperature. In other words, we're talking about coming down in temperature 15 degrees which puts the pump operating --

MR. WARD: I guess they're saying they reduce the specific things that troubled them at Palo Verde.

MR. CATTON: But now they've reduced the temperature which increases the density a little bit. They've increased the velocity a little bit, and all these things kind of lead in the wrong direction. What makes you believe that with this change, you're still all right?

MR. TURK: We've changed the steady state operating point, but this is still a portion on the map of parameters that Palo Verde operates in. They have to transit through this.

MR. CARROLL: But vibration often tends to be a fatigue problem and cycles accumulate at the normal operating point.

MR. CATTON: I just think that, considering the fact that there were problems before, that somehow this ought to be addressed and put to bed. Maybe it's easy to do. If it is easy to do, then it shouldn't be much of a chore.

MR. CARROLL: Didn't somebody say you have different internals than Palo Verde?

MR. TURK: No, exactly the same internals. I said Palo Verde was a change from San Onofre and Waterford. These are exactly the same, including the fixes that were made to Palo Verde.

[Slide.]

MR. TURK: The only change is the change to the control alternate assembly design where we have kept the 48 B-4C full strength, 12-finger shutdown rods, however, have taken the four finger control elements and reduced them in number to 20 and changed the material to silver Indium Cadmium to increase the lifetime, and then added 13 part length rods, while deleting -- I'm sorry -- adding 25 part strength rods, Inconel rods while deleting the 13 part length four finger rods that were included in the original System 80 design for a net increase of 4 control element assemblies with now a 20 year lifetime versus the 10 year lifetime.

MR. CARROLL: Having said all that, translate it into terms of what it does to the hydraulics of the core.

MR. TURK: I don't think it really has any effect on the hydraulics of the core.

MR. MATZIE: It really doesn't have any effect. If you look at the design, with that center Calandria region -- I don't know if you want to put it back up -- which was the major design change for System 80 relative to previous plans, there's an individual shroud for every control rod finger location. We don't use all the locations on System 80. We're using a few more of those locations on System 80 Plus.

That section where he's pointing now, the Calandria region, that's where the flow turns and goes out of the nozzles. All those tubes are alr[illegible]here for not only the additional rods we've added, b[illegible]er rods that in a future design actually could be added.

MR. CARROLL: I guess where Ivan and I are is, we'd like at some future time to be more comfortable with the idea that the operating point changes 2 percent in flow and this won't do anything bad from an internal vibration point of view.

MR. WARD: All the problems here weren't internal. I mean, there was a pump problem, for example, as I recall. Are you using the same pumps as you did at Palo Verde?

MR. TURK: Yes, and we'll get into the reactor coolant system next. There were some design changes to the pumps that were made and some materials changes that I can address.

MR. CATTON: There were problems at Palo Verde and I'd like to be comforted a little bit, considering that there were those problems. How much margin do you have in the flow vibration, particularly if the design is so similar. What have you done, and what's the rationalization to lead you to believe that you have this kind of margin?

MR. TURK: We can address that in more depth than we have here.

MR. CATTON: The pumps were part of the problem, as I remember. So, it's sort of the whole flow loop that I'd like to see addressed at one time, not start separating out different pieces.

MR. KENNEDY: This is Ernie Kennedy. If it's acceptable to the subcommittee, at one of our future meetings, we will put that on the agenda and discuss the Palo Verde problems, walk through how we've changed the designed and what confirmatory work we have done. I will have the appropriate people here to do that.

MR. CARROLL: All right. We'd be delighted to see that.

MR. KENNEDY: We'd be happy to do that on one of our future meetings.

MR. CARROLL: Okay. Moving on.

MR. WARD: Let me ask about ATWS now. I don't know if this change in the control elements or at least the -- has that changed the ATWS picture at all? As I understand it, the Palo Verde type design doesn't have the ability to ride out the worst ATWS scenarios, and that's the same with the System 80+?

MR. TURK: You may have more background than I do.

MR. MATZIE: Let me make a few comments. The issues with ATWS are typically related to the moderator temperature coefficient value because that's a negative feedback without control rods, obviously, and the volumetric sizes to accommodate expansion of the RCS.

We have two things in this design. One is the minimum allowable moderator temperature coefficient, which, you know, is negative any time above 50 percent power, and I believe we'll have at least a .5 at full power, .5 times ten-to-the-minus four moderator temperature coefficient. We've also, and Rick will get to that, we've increased the size of the pressurizer, which allows you the volumetric expansion and less pressure increase during an ATWS.

MR. WARD: Okay. What about the relief from the pressurizer? Is that significantly -- I guess you've added this, you know, depressurization system, but I don't know if that --

MR. TURK: It really has no ATWS mitigation bases.

MR. WARD: Okay. It doesn't add significantly to the overall capacity?

MR. TURK: Yes. One thing I would say about the ATWS as an issue, you know, first of all the analyses were done many years ago, the ones before the staff and the one that you're speaking of. The resolution then moved to some hardware changes in the trip system and the alternate protection system, which we'll show in the I&C section how we've incorporated it. At that point, the analysis really stopped until we started looking at it again for System 80+. That analysis work hasn't been completed yet because the issue resolution is really in the hardware realm. But with improvements in analysis techniques, our indication is that the predicted ATWS performance is probably a lot better than was predicted a few years ago. But that's basically analysis techniques.

MR. WARD: Okay. Well, the hardware change has been accepted as a -- certainly helps with the ATWS situation by some likes. It isn't the total answer. Will we at some point hear more detail about what a fresh ATWS analysis looks like?

MR. TURK: We can do that, yes.

MR. WARD: I'd like to hear that at a future meeting.

MR. CARROLL: At a future meeting, yes.

One of our members, and I guess I share his view is that -- Bill Kerr believes that PWRs can make the ATWS a non-problem by proper field design in terms of moderated temperature coefficient, and he thinks that's a lot cleaner way to solve the problem than the hardware changes, which you really can't -- you're down in a reliability area where it's very hard to really say that it's that reliable or an order of magnitude on either side.

MR. TURK: We will talk later on as far as the hardware, but I think we would like to come back and show you the analysis results later on.

[Slide.]

MR. TURK: What I'd like to do now is move on to the -- and we've kind of migrated into that area, but move on to the reactor coolant system where our main focus was really one of changing margins, adding margin -- in this case, I mean margin in terms of this larger system that is challenged last. This is kind of a summary of some of these changes.

MR. CARROLL: This is a fairly lengthy section, isn't it?

MR. TURK: Say again?

MR. CARROLL: I say this is a fairly lengthy section on the coolant system?

MR. TURK: Yes.

MR. CARROLL: Okay. Why don't we take a break until 10:35.

[Recess.]

MR. CARROLL: Let's reconvene.

MR. TURK: I wanted to move on now to the reactor coolant system and address essentially the sizing changes that have been made and a few other changes. They are summarized on this slide in terms of larger pressurizer. I'll spend a little bit more time in a minute talking about steam generator and the impact of the lower hot leg temperature, the changes in steam generator relative to flow also.

But first, with regard to the pressurizer, the larger pressurizer is a significant performance impact.

[Slide.]

MR. TURK: If you look here, for instance, at a reactor trip and pressurizer level following that trip, you see that on the standard System 80, essentially we come relatively close to the top of the heater's level now with significant margin to the top of the heaters.

[Slide.]

MR. TURK: Likewise, pressure shows significant margin above the pressure set point for safety injection actuation.

[Slide.]

MR. TURK: On the over-pressure size side, the loss of condenser vacuum, which now analyses show challenging primary safety valves as a design bases, we no longer challenge primary safety valves on the loss of condenser vacuum.

MR. CARROLL: That's the worst abnormal transient that --

MR. TURK: Over-pressure transient -- the only worse case is the -- no. That is really virtually identical to the isolation of the steam stops. They're functionally identical. We've had one isolation of feed stops at St. Lucie which did lift safety valves so that would no longer happen. Yes, that is the worst case.

MR. CARROLL: While we're talking about pressurizers, do you have a surge line stratification problem, or have had, and if so, have you dealt with that?

MR. TURK: The surge line stratification will be addressed in the routing of the surge line, which is going on as far as the actual routing in the containment design. Lyle, do you want to add anything to that?

MR. GERDES: Lyle Gerdes. I have nothing really to add to that, Rick, other than the fact that it is being addressed in the design and the layout of the surge line. So, it's being explicitly addressed in the design process.

MR. CARROLL: And you have had some indication of problems in past designs?

MR. TURK: There has been indication, very layout dependent indication, in some of the operating plants. I know Calvert Cliffs made some measurements of stratification.

MR. CARROLL: Okay. And how about the Calvert Cliffs --

MR. CATTON: Heater. Well --

MR. CARROLL: -- heater problem. That's been dealt with?

MR. TURK: That work is ongoing an we will be incorporating the work that results in the System 80+ design, probably in terms of both material changes and a change in the actual well design. I don't have any other details on that. I don't know if anybody else does. That's an ongoing issue that's working right now.

[Slide.]

MR. TURK: This figure kind of summarizes the changes in the steam generator. The steam generator for the EPRI requirements and in dealing with the lower TH, the lower steam pressure, we've taken steam pressure now from 1070 to 1000 pounds; as I mentioned, hot leg pressure from 621 to 615. That's essentially increased or increased the required heat transfer area from 124,000 square feet to 146,000 square feet.

The number of tubes has increased from around 11,000 to 12,000. That's been accomplished basically in an overall increase in the height of the unit of about five feet. The average tube length has increased from 57 feet to 60 feet.

The overall downcomer volume has been increased by lowering the conical section of the generator somewhat, increasing the upper dome section. So we have about 25 percent more liquid volume in the downcomer to boil off in terms of decay heat removal margin prior to the introduction of emergency feedwater.

MR. WARD: So the increase in the number of tubes doesn't require a bigger diameter vessel, just a taller one?

MR. TURK: A taller vessel, yes.

MR. MICHELSON: What do you know about the potential vibration problems for this generator since you've lengthened the tubes and changed the flows, apparently redesigned a flow distribution and so forth?

MR. TURK: Based upon essentially the same geometries as the previous units and analyses -- do you have anything, Regis?

MR. MATZIE: Yes. Regis Matzie. Let me answer that. The vibration problems were detected and temporarily designed, in-place design change occurred at Palo Verde. Subsequent to that, we are redoing the design of the inlet flow area in that distribution of economizer flow.

That design is going into our Korea units, and we've got a testing program for that design to verify that localized flow vibration problem that we did detect at Palo Verde will not happen in the future.

MR. MICHELSON: Was any of the vibration problem related to things happening in the upper part of the generator along the, you know, where the tube bends are?

MR. MATZIE: No, it was not.

MR. MICHELSON: It was all down at the base?

MR. MATZIE: That's correct.

MR. TURK: Well, it was a separate issue with the bat wings. We have incorporated it because it -- it's on the slide. You can see here that we're talking about a new bend support.

MR. MICHELSON: Yes. I thought you had problems up there. And you're now going to lengthen the tubes another five feet roughly, is that right?

MR. TURK: That's correct.

MR. MICHELSON: And you think that you won't introduce any -- well, what kind of testing will you do to verify this doesn't introduce any vibration problems?

MR. TURK: There is currently no plan to do any testing.

MR. MICHELSON: You're just going to build it?

MR. MATZIE: The testing that's going to go on is primarily in the economizer region where we're making a design change and incorporating that into our currently under construction unit.

MR. MICHELSON: Okay. What other changes to the steam generator are there, if any, from the vintage used at, say, Palo Verde?

MR. TURK: Most of the others are indicated here. We are changing the dryer design from the CE Chevron dryers to a slightly different configuration from Peerless. We've increased manways sizes from 16 inches to 21 inches for access. We've reoriented the primary manways on the lower shell to provide a more direct access, directly up, making it easier to get in and out.

We have added a recirculation nozzle to allow for generator recirculation in a cold wet lab condition. I thin those are the most significant of the changes, and I mentioned a few of the others.

MR. CARROLL: What's a "permanently marked tubesheet," lower lefthand corner.

MR. TURK: Yes, I see that. I'm not really sure. Regis, do you have that --

MR. MATZIE: Regis Matzie. That's for identification of tubes for inspection. I guess one other thing -- I don't know if you mentioned it, Rick -- Inconel

690 tubing is going to this generator.

MR. TURK: Yes.

MR. CARROLL: So, what? Next to each tube, I have some indication of --

MR. MATZIE: That's my understanding, yes.

MR. CARROLL: Of what? The tube number and -- okay.

Now, you do depart from the EPRI requirement document in that they are advocating handholds at each support plate, and you're only going to have them down at the bottom?

MR. TURK: That is one of the departures, yes. Again, because we really have not identified the advantage of the hold -- I don't believe the EPRI requirement was for each and every support plate, but I don't have that in front of me.

I think one thing to point out is that some of the EPRI requirements that are not -- are still under review, as Regis indicated before, still looking at some of the EPRI requirements in terms of the design. I think that that actual requirement did come up after we had gone through most of the work on the steam generator. I don't really have anything else to say on that.

[Slide.]

MR. TURK: While we're discussing the reactor coolant loop, one of the issues that has been of interest is the issue of mid-loop operation, operating in the partial drain situation work on the loop.

This is an area where we have worked with the EPRI requirements. The staff has reviewed the EPRI requirements and their draft SER makes some particular comments. Our design basis has been to minimize the probability of losing decay heat removal during mid-loop operation.

And to do that with specific design features, this issue on operating plant is being addressed primarily through changes in procedure.

Amongst those features are the installation of a dedicated permanent safety grade level indication to be used during shutdown to provide level detection all the way to the bottom of the hot leg, to provide that indication in the control room available to the operator.

The layout of System 80+ is very favorable in comparison to many of the operating plants that have had problems in this area in that first of all, the hot leg is a 42 inch hot leg versus a 30 inch hot leg in many four-loop plants.

The section piping is oriented vertically directly off the bottom of the hot leg to give maximum benefit of the available height of water. The RHR pump or shutdown cooling pump as you'll see when we look at some of the plant arrangements is located in the subsphere region below the spherical containment providing a maximum in net positive suction head.

We'll see in a few minutes that the redesign of the safety injection system allows for one of four high pressure injection pumps could be made available procedurally to supply makeup to the system if needed.

We have eliminated the shutdown cooling system auto closure interlock from the design by providing adequate over pressure protection in the RHR system. We are, and this is where I alluded to the draft SER from the staff, in conjunction with EPRI considering whether requirements are necessary to provide a design change in the RHR nozzle off the hot leg to decrease vortexing. This would essentially be an increase in diameter going down into the RHR suction line.

And then as I mentioned, the operating plants through our owner's group are coming up with many operationally oriented, tech spec, oriented changes in this area and those of course would also be incorporated into the System 80+ design.

MR. MICHELSON: You said something about the staff safety evaluation.

MR. TURK: The EPRI requirements document as each go and the staff then returns with a draft safety evaluation report.

MR. MICHELSON: And it's on the EPRI document that you're referring to?

MR. TURK: Correct, yes.

MR. MICHELSON: Okay. Thank you.

MR. TURK: We are of course paying attention in that most of our design changes are encompassed in the EPRI requirements.

MR. MICHELSON: On your slide that talks about level detections at the bottom of a hot leg, aren't you providing full vessel range level detections?

MR. TURK: We are providing full vessel range protection. I need to check very quickly whether that was a misprint as far as the off line system. In other words, we'll have two vessel level systems.

We'll have the on line system which is the heated Junction thermal couple which provides a stagger through the upper region and the off line system. And I believe that was a misprint that it goes all the way to the vessel but I don't have the material to check that with me.

MR. MICHELSON: Maybe somebody else can confirm. But, you think it really is to the bottom of the vessel and not just to the bottom of the hot leg. It clearly covers to the bottom of the hot leg but it goes further?

MR. TURK: Right.

MR. WARD: Could you let us know?

MR. TURK: We can check that, yes.

MR. CATTON: There were some difficulties, at least I recollect, at least with the heated junction thermal couple design early on. Have these been addressed? I'm not even sure I recollect what they were.

MR. TURK: I'm not aware of that. I know of no current problem with the heated junction thermal couple.

MR. CATTON: To get good response time, the power to them had to be cranked up or something?

MR. TURK: I don't recall that.

MR. CATTON: Is there anywhere I could find out what the heated junction thermal couples in the new system look like relative to the old and maybe get some background information on the difficulties that came up? EPRI was involved in it. There were some concerns about the design and the efficacy of the whole process for measuring levels.

MR. TURK: Okay. I really am not aware of that. We can check into it.

MR. KENNEDY: Let me, if I could, address that generally. This is Ernie Kennedy. There was back at the time we were designing and backfitting the heated junction thermal couple in operating plants. There was first of all, a large school of thought by some plant owners that no level detection at all was required and there was that series of arguments.

On our particular heated junction thermal couple, there were a number of technical concerns with the separator tube where we separate the air and the water into an equivalent collapsed level and whether or not there was adequate supporting test data on that.

I believe that was all satisfactorily resolved through a combination of testing and that each plant, the heated junction thermal couple separator tube was divided into appropriate segments consistent with the geometry of the upper head.

So, for example, in some plants there is not one continuous measurement of level from the top of the head down to the bottom of the heated junction thermal couple, but, it is segmented because the upper head region is segmented.

And I believe that issue was resolved satisfactorily and the test results from the operating plant shows it works appropriately.

Since the units have gone into operation, there have been some problems with the materials of some of the heater wires themselves. We've had burnout problems and failures of individual of the sensors.

That is now being fixed. There is a change both to the material and I believe the manufacturing process and

I believe we've qualified an alternate vendor and we are now supplying replacements that address those material problems.

Those are all the problems that I'm aware of.

MR. CATTON: I'd like to see somewhere where these lessons are all brought to bear on what you're going to do in the new plant.

MR. KENNEDY: Okay. I think that fits into your Palo Verde discussion. As I listen here, you are asking for us to tell you how we have incorporated operating experience into this design in a rather broad context. I kind of get that tone from the Subcommittee.

MR. CATTON: I think he was. I'm more narrow in my view.

MR. KENNEDY: Okay. We'd be more than happy. If you like to pick a list of specific items, then we'd be happy to discuss those.

MR. MICHELSON: While you were out, they also discussed the steam generator which is about five feet taller than the old one. It has some modifications to help take care of, again, some of the Palo Verde problems, steam generator vibration, tube vibration.

MR. CATTON: It sounds to me like there's another topic for future discussion.

MR. KENNEDY: I added that to my list to talk about at our Palo Verde meeting as I was listening to you.

MR. CATTON: The steam generator is a different beast. At least you're dealing with single phase flow vibration in the core. When you're in the steam generator, it's two-phased and you get into this fluid -- instability that Westinghouse is talking. There's just all kinds of things.

I don't think the analytical tools are really there. I want to see you how you can culminate this.

MR. KENNEDY: Okay. As we go through today's meeting, please, bring up these areas and I'll add them to the list to discuss.

MR. CATTON: Maybe it might be a good idea at the end for them to show us a list to make sure that you've got all of them.

MR. KENNEDY: Okay. Yes.

MR. CARROLL: I would mention to Combustion that ACRS has something called, an adopted plant program and Hal Lewis has adopted Palo Verde and -- and I have an interest in Palo Verde. Three of us are going to visit Palo Verde on the 20th of April. I believe that's the tentative plan. So, we're going to come back real smart about Palo Verde here.

MR. CATTON: That's a rather big assumption you're making.

MR. WARD: To go back just a minute to mid-loop.

Since you have responsibility, you know, the whole plant design, under what conditions is mid-loop operation? I mean, is mid-loop operation ever necessary? Is it necessary to have the containment open for some operations where it would be in mid-loop? Has there been any thought to the relationship of mid-loop operation and whether or not containment is open?

MR. TURK: I think the answer is, no, in the sense that dictating that kind of requirement on top of a maintenance outage like that, I think would severely impact the kind of goals that we're trying to reach in terms of availability and ongoing evolution.

MR. CARROLL: Put that issue on your list too because I don't think that's true. I think with nozzle dams, you don't really have an outage impact.

But, I think Dave and I both have some very long-standing concerns about going into mid-loop without having containment integrity.

[Slide.]

MR. TURK: Mid-loop kind of sets the stage for then proceeding onto the next area where you have really made the most substantial changes to the design, and that's in the safeguards systems area.

MR. MICHELSON: Before you get to that, what are inlet and outlet pipe sizes?

MR. TURK: 42 inch hot leg and a 30 inch cold leg, four coid leg nozzles, two hot leg nozzles.

MR. MICHELSON: Thank you.

MS. TURK: Those safeguard systems, and I might say this was done very very closely with the EPRI requirements and the EPRI requirements in this area are probably also the most significant changes or the significant aspects in the EPRI requirements and this is the area where we did just recently receive the staff's SER on those EPRI requirements. But specifically we've gone to a four-mechanic train safety injection system with -- set down cooling and containment sprays essentially being separated from the safety injection system. We no longer ask duel service of our low pressure pumps to be both an injection pump and a RHR pump.

We have added as we have mentioned earlier the safety depressurization system to provide essentially a feed and bleed capability, and one of the key differences in implementing this feed and bleed system is the incorporation of an in-containment refueling water storage tank which provides an in-containment receptacle for the bleed process and it also provides a suction source for the safety injection system that does not require a recirculation actuation signal. You're essentially always in recirculation as opposed to initially taking suction outside and having to switch over.

[Slide.]

To go into those in a little bit more depth and in the interest of time I'm going to skip over the word slides and look at those as we look at the system diagrams, but the safety injection system as I mentioned is four mechanical trai · divided into quadrants. You'll see when we look at the containment layouts that this fits very nicely with the subsphere region and the overall layout of the plant in terms of separation. We now inject directly into the vessel -- this feature essentially comes into play in terms of the sizing of the system and not having to postulate that during the design base line break that all of one train of injection is lost out of that break, that then allows us to go with the four pumps which are essentially the same pumps we're using now in Palo Verde to provide sufficient flow for all the design base accidents without the need to credit automatic injection of the low pressure pump. We've maintained the four safety injection tanks inside containment to provide fluid on actuation, the in-containment refueling water storage tank is shown here again providing, as I mentioned, the suction for injection without the need to switch from an external tank to recirculation.

What does that do for performance?

MR. MICHELSON: Excuse, is suction, pumps one and three, intricately tied, is that correct? There's a line there.

MR. TURK: Yes, that is correct.

MR. MICHELSON: There is common suction for those two and then there are two over, two more on the other side.

MR. TURK: Correct.

MR. MICHELSON: Certainly they aren't four independent drains with a common suction, if I'm reading the drawing correctly.

MR. TURK: You are reading the drawing correct, whether the sketch is correct --

MR. MICHELSON: Well, I'm reading the sketch.

MR. TURK: Yes, I understand that. Bob Jacquith, do you remember the correct assumption in the PRA in the diagram? I don't believe that cross connect needs to be there.

MR. JACQUITH: In the PRA it was assumed that the cross connect is not there and the last I recall about a month ago there was a little bit of debate back and forth between designers as to whether it was going to be there or not.

MR. MICHELSON: So, you don't know yet?

MR. JACQUITH: Right.

MR. TURK: That's the answer, and we'll confirm the correct configuration. It can be confirmed from the actual PNID.

MR. MICHELSON: Now, to return to the refueling water storage, is that for test purposes only?

MR. TURK: That is correct. It provides a full flow test capability.

MR. MICHELSON: Well, the valve there is showing normally open.

MR. TURK: That's the mini-recircuit through the orifice, the normal --

MR. MICHELSON: But at any rate again it's not an independent drain because it's got a common discharge back of the tank and if that valve spuriously opens during a need for the systems both pumps are lost, unless there are more valves than appear on the sketch.

MR. TURK: There are more valves, but I'm not --

MR. MICHELSON: The return --

MR. TURK: The return --

MR. MICHELSON: No, no, back down below, that guy.

MR. TURK: Yes, well, this guy is normally accepting the return through the orifice mini-flow research which have to be on for normal operation.

MR. MICHELSON: Well, that's still a substantial flow, the minimum flow requirements --

MR. TURK: Are designed to accepted --

MR. MICHELSON: Well, maybe what's puzzling me, I thought that you were going to build in a full flow test capability.

MR. TURK: There is, the full flow test capability is established by opening the bypass valves around the orifices.

MR. MICHELSON: And those are intended to be manual.

MR. TURK: That's correct.

MR. MICHELSON: So, the mini-flow is only a few hundred gallons a minute, maybe even less than that.

MR. TURK: It's less than that.

MR. MICHELSON: But at any rate there will be a partial loss of flow if you spuriously open the return line.

MR. TURK: This line is normally open and recircuit normally -- is normally accountable for. In other words, when the pump, the pump is speced, it is speced for its design flow plus recircuit.

MR. MICHELSON: Are you saying then during an accident that it is normally recirculation, recirculating a portion of its flow?

MR. TURK: Correct, because during the accident procedures you may wish to throttle down procedurally later in the accident.

MR. MICHELSON: So, it's already accounted in the design.

MR. TURK: Yes, now this is a sketch and not all valves are shown, so in terms of doing any scenario postulation would look at the actual PNID that's in the FSAR.

MR. WYLIE: These are four 50 percent --

MR. TURK: These are four 100 percent.

MR. MICHELSON: But they're not independent because again if they're -- if the problem of the valve spuriously closes you've lost minimum flow protection for two out of the four trains, by that sketch at least.

MR. TURK: I'm not, say it again --

MR. MICHELSON: If you're minimum -- if your valve spuriously closes on the return line, it removes minimum flow protection from two out of the four trains, now that's hardly independent.

MR. TURK: That's correct. I also said they're mechanical in that two pumps are essentially supplied from the same diesel generator, they're not four diesel generator trains either, so we have a two-division system.

MR. MICHELSON: Okay, it's a two train system.

MR. TURK: It is a two train --

MR. CARROLL: It could take the power off.

MR. MICHELSON. Yes.

MR. WYLIE: I guess somebody's going to over what you do when you take one diesel out of service.

MR. TURK: Yes, we will cover that from an electrical standpoint. The answer is per the EPRI requirement we have included an alternate AC power source.

MR. WYLIE: You would fire that up.

MR. TURK: That would be -- that's correct.

MR. MICHELSON: This is two train electrical as I understand it.

MR. TURK: Two train electrical with a -- we'll get into that a little later in the afternoon with an alternate AC source that has the capability of picking up one train.

[Slide.]

The question was asked earlier about the capability to handle a given break diameter, this shows a comparison of the system 80+ versus system 80. System 80, if you remember, had only two high-pressure injection pumps in each train. We now have -- has one in each train, two total, we now have four, two in each train. This analysis assumes the loss of the diesel generator, in other words, single-failure analysis shows that for the 10-inch diameter cold leg break, previously we were showing --

MR. MICHELSON: Well, the largest cold leg break, though, can be thirty inches.

MR. TURK: The double ended rupture, yes, the 10-inch size is the largest line that we have coming off the -- that's the RHR line I believe.

MR. CARROLL: Now, okay, so smaller -- how about hot leg breaks?

MR. TURK: In terms of performance?

MR. CARROLL: Yes.

MR. TURK: Again, we have a larger flow capacity available at higher pressures, so our system is now much more attuned to the small break. The hot leg performance would be -- the large break hot leg performance would be essentially the same.

MR. CARROLL: There are no lines coming off the hot leg is what you're saying.

MR. TURK: The only one would be the surge line to the pressurizer.

MR. CARROLL: Right, how big is that?

MR. TURK: That's either a 10-inch or 12-inch line, and I believe that's -- because that's a -- I believe it's a nominally 12-inch schedule 160 line which I'm not sure what it is in terms of actual diameter, internal diameter, it's significantly less than 12 inches.

MR. CARROLL: But you can handle that break also without uncovering --

MR. TURK: No, I don't believe so, I don't believe the double ended of the search line, we don't have a LOCA analyst with us, but we can answer that.

MR. MICHELSON: What accounted for the improvement on system 80+.

MR. TURK: The improvement is essentially the increased high-pressure injection capacity, four pumps instead of two pumps, and the injection directly to the vessel where there's no flow loss, minimum flow loss to --

MR. CARROLL: Plus bigger pressurizers.

MR. TURK: Bigger pressurizer, yes, that factors in also that more -- there's more -- the larger inventory on the secondary side of the steam generator also helps in that it takes up some of the heat.

MR. MICHELSON: In doing the analysis, did you assume single failure?

MR. TURK: Yes.

MR. MICHELSON: And assumed the single failure is the electrical supply to two of those four HPI pumps, since it's a common electrical source.

MR. TURK: Right.

MR. MICHELSON: Then you're down to two pump operation, is this drawing the two pump operation?

MR. TURK: Yes it is.

MR. CARROLL: What happens if one of those two pumps happen to be out for maintenance.

MR. TURK: Yes. That is true.

MR. WYLIE: It would if you assumed one diesel generator.

MR. TURK: As far as that scenario being treated, that scenario would be treated in our PRA, and I don't believe it would be a core melt scenario. I believe that one pump, although it may result in core uncovery, is not treated. Bob, do you remember how that case is analyzed in the PRA?

MR. JACQUITH: One pump is sufficient.

MR. TURK: So one pump from a PRA standpoint is sufficient to prevent. What do you use as the criteria?

MR. JACQUITH: It keeps the core below 2200 degrees.

MR. MICHELSON: I am still puzzled by the figure. If the figure for System 80, how many pumps was operating when you made that calculation?

MR. TURK: Only one pump.

MR. MICHELSON: Is that a one-pump figure?

MR. TURK: That is correct.

MR. CATTON: Are these calculations done using best estimate?

MR. TURK: These calculations, no, these are calculations using the LOCA codes. These are the design basis calculations. These are the Chapter 6, Chapter 15.

MR. CATTON: I hear you. Are you guys going to enter the real world of best estimate calculations, or stay with the fiction of Appendix K?

MR. TURK: The calculations that Bob Jacquith just talked about, as far as analyzing for our PRA response, what we get with one pump, is all based on best estimate calculations.

MR. CATTON: Has your best estimate code been qualified?

MR. JACQUITH: Our best estimate code has not been qualified.

MR. CATTON: Is it being qualified?

MR. JACQUITH: It is not being qualified. It was not quite correct that we are relying solely on it. We are relying on the, primarily on the safety codes. We are using the best estimate codes where we see that it is needed, in order to do scoping and --

MR. CATTON: I think you misunderstood me, or at least misunderstood my concern. My concern is that we are entering a new world and we are proposing a new reactor called System 80-plus, yet you are using tools that are antiquated. It seems to me that that is kind of silly. Shouldn't you be using best estimate in the new world, completely? We now have the best estimate tools. NRC has promulgated a new rule that allows you to use best estimate. You don't have to work in this world of fiction. Why do you do it?

MR. TURK: I think the answer to that, relative to the Chapter 15 analysis, was one of being able to show, using the old tools, that we meet the requirements, and not having the need.

MR. CATTON: Why not show that you meet them with new tools?

MR. TURK: Ernie?

MR. KENNEDY: I think I understand the question, let me see if I can address it. This is Ernie Kennedy again.

MR. CATTON: It is a simple question.

MR. KENNEDY: We have not yet taken advantage of the revision to Appendix K that allows us to update cur models. One reason of that is, to be perfectly frank with you, largely commercial. None of our current operating customers have expressed an interest in asking us to go do that work for them, to present the model to the NRC and get it approved. So from a licensing point of view, we have a best estimate model. It is not going anywhere right now. Your question on System 80-plus is a good one, why we are not at least pursuing that on System 80-plus, as far as applying that new model. And I will go back and look into that one.

MR. CATTON: I think Westinghouse is pursuing it because their system has a lot of margin. Your not pursuing it sort of leads me to believe you don't have very much margin. And you certainly wouldn't want to leave me with that fiction, would you?

MR. KENNEDY: We would not want to leave you with that impression.

MR. CATTON: Good.

MR. CARROLL: So that is on our list of topics for a future meeting.

MR. MICHELSON: Let me clear up one more point on System 80. What was the HPI pump size for System 80, roughly?

MR. TURK: I don't recall the rated gallons per minute.

MR. MICHELSON: Well, let me ask, is it the same pump for System 80-plus?

MR. TURK: It is the same pump. Only 4 instead of 2.

MR. MICHELSON: When I look at your previous slide, I still have a great deal of difficulty wondering why, if the principal is just one extra pump pumping during those about 60, 70 seconds, how you can make up all that volume difference identified by that curve, I don't know. There's got to be something else. It hardly whimpered with two pumps, and it dumped way down to the 12-foot level with one pump, but recovered immediately at 100 seconds.

MR. TURK: The pressurizer was a factor.

MR. CATTON: It could be that in the two-phase mixture it is 99 percent void, Carl; then it would do that.

MR. MICHELSON: If it was void enough, and that is the two-phase mixture, all right, if it were void enough --

MR. CATTON: And this curve just really isn't adequate to tell you what is going on.

MR. MICHELSON: Yes. I guess maybe that is it. I'll take their word for it for the moment.

MR. CATTON: You get really nothing from this curve.

MR. MICHELSON: Yes. It left me a little cold.

MR. CATTON: If you don't have the void fraction distribution, then you have no idea what the heat transfer capability of a two-phase mixture is. So this curve really tells us nothing.

MR. MICHELSON: I want to make sure the pumps are essentially the same pumps.

MR. CARROLL: What does two-phase mixture height mean?

MR. CATTON: Typically it is a 99 percent cutoff.

MR. CARROLL: I guess that is the question in my mind.

MR. MICHELSON: But they are both two-phase mixture curves, of course. Yet in one case it hardly changed, and in other case it bottomed out.

MR. CATTON: But again, you know, if it is just a few percent moisture, it is not a big difference on that curve.

MR. CARROLL: What does it mean; what is the definition of --

MR. TURK: I don't have the actual definition with me. But we can get that.

MR. MICHELSON: Those pumps, I don't think, are that big. But you weren't able to tell me the EPM rating and pressure or something.

MR. CATTON: You really need to have a better picture, and you need to have other information, void fraction distribution, all sorts of things, in order to make an assessment of coolability of the core. You can't, from this diagram by itself. But that is going to be part of the future topic, right?

MR. CARROLL: I believe they got it all.

[Slide.]

MR. TURK: The major differences in the shutdown cooling and containment spray system, again based upon the EPRI requirements, are, first of all, the incorporation of a second heat exchanger, a dedicated containment spray heat exchanger. Whereas on System 80, the heat exchanger was shared between the two systems, the two loops are essentially again from the incontainment refueling water storage tank through the containment spray heat exchanger, through back and into the spray headers in the containment, or the shutdown cooling loop as we mentioned, off the bottom of the hot leg cooling and back into the reactor vessel.

The most significant change here, though, is probably not in configuration, but in upgrade of the overall system design pressure. That is, the portion of the system outside containment, outside the third isolation valve, has been upgraded to a 900-pound design pressure, which is sufficient to ensure that even pressurized as high as 2,500 pounds, we would not expect failure of the system.

MR. MICHELSON: Those systems are cross-tied. Is the other one rated for the 2,500-pound also?

MR. TURK: Yes, they are both rated for that.

MR. MICHELSON: The fact is, there must be some isolation valves, but you just didn't show them going back through the containment, in the suction for the containment spray.

MR. TURK: Yes. There would be a similar isolation.

MR. MICHELSON: Both systems are 2,500-pound system, then?

MR. TURK: Both systems are 900-pound systems, when looked at in terms of ultimate failure.

MR. MICHELSON: Now, you think ultimate failure includes the seals on the pumps, things of that sort?

MR. TURK: It would not prevent seal leakage to some degree.

MR. MICHELSON: How large a leak do you expect from a containment spray pump when it is pressurized to four times design, well over four times the design of the seal?

MR. TURK: We do not have that figure yet.

MR. MICHELSON: Those will be 900-pound seals?

MR. TURK: Yes.

MR. CARROLL: How about the tubes and the heat exchangers?

MR. TURK: The heat exchanger will be designed for 900 pounds.

MR. MICHELSON: There isn't the same margin in the tubes as there is in the pipe, so they will burst first.

MR. TURK: Bill, do you have any information on that from Tom or not?

MR. FOX: No.

MR. TURK: Okay.

MR. CARROLL: I guess the Staff keeps telling us about designing these systems to accommodate primary system pressure. But we never seem to get very good answers about some of the things like seals, and heat exchangers.

MR. TURK: We will provide information on seals and heat exchangers.

MR. CARROLL: And are their gasketed joints in the system, and things like that.

MR. MICHELSON: Valve bonnets?

MR. CARROLL: It's not too tough to design to get that rating on the piping, but there is a lot more to these systems than just piping.

MR. MICHELSON: The piping is probably the strongest thing in there and the most over-designed. But the valve bonnets and molding and so forth are not necessarily designed anywhere near those kind of allowances. The valve body is, but not necessarily the molding.

[Slide.]

MR. TURK: The other safeguard system that was mentioned earlier and that is new to the System 80 is the safety depressurization system.

It's being added really for several different functions. The one of most note I think is the function of a safety grade method to depressurize the reactor coolant system when there is no heat removal from the steam generators and that is accomplished by two trains of valving off the pressurizer that looks configuration-wise as a PORV configuration may be, the difference being as they are not pilot operated or power operated relief valves but rather the manual valves.

MR. CATTON: What is the size of the lines?

MR. TURK: The lines are I believe 10 by 6, 10 inch inlet, 6 inch outlet, but I would have to check that, and then the second one would be a 6 by 6.

MR. MICHELSON: I suspect it is 6 inches into the valves and 10 inches out, isn't it?

MR. TURK: Oh, you're correct.

MR. MICHELSON: It's got to be or should be.

MR. TURK: Six inch inlet, 10 inch outlet.

MR. MICHELSON: What kind of valve will you use to take that kind of a pressure drop?

MR. TURK: These will essentially be block valves, the same valves that would be used for PORV block valves.

MR. MICHELSON: That's just the gate valves used in that case.

MR. TURK: Right.

MR. MICHELSON: And you are going to use gates here but you are not going to throttle with them, just going once wide open and leave it there?

MR. TURK: We provide a small vent capability up through the gas vent system.

MR. MICHELSON: Are you intending to throttle with these depressurization valves?

MR. TURK: We have not identified a throttling need nor is there a throttling design basis. This is a depressurization.

We did at one time have a design based on an upstream throttle valve that if we identified a design basis requirement that required a throttling capability we would use but the basic design function now is twofold.

One is in the case of loss of all heat removal to the steam generators, which is essentially a feed-and-bleed operation and establishing makeup through the high pressure injection system.

The other is in a severe accident scenario, also opening the valves to allow the plant to depressurize.

MR. WARD: When you say feed-and-bleed and supply through the high pressure injection system but you're really just opening up these, what are they, six inch valves wide, with no provision for controlling flow, so you've been calling it feed-and-bleed. It's really not. It's depressurization.

Then why -- I mean what does the transient look like? Do you need the high pressure injection then?

MR. TURK: Yes.

MR. WARD: Okay. The pressure doesn't come down to the point where the low pressure injection pumps will handle it?

MR. TURK: There are no low pressure injection pumps.

MR. WARD: Okay.

MR. TURK: There are no low pressure injection pumps.

MR. CARROLL: Now how do you deal with steam generator tube ruptures when you are trying to equalize pressure between primary and secondary?

MR. TURK: When heat removal conditions are maintained on the secondary side, okay, and it's a matter of just venting the depressurizer in order to reduce plant pressure, overpressure, where we would normally use main sprays if reactor coolant pumps are available which are not safety grade or then go to auxiliary spray which is also a non-safety system.

If neither of those are available, then we have a small vent line of approximately one inch, again safety grade, that allows us to vent off the pressurizer, to back up the aux spray capability and bleed down pressurizer pressure while removing heat through the steam generators.

MR. CARROLL: And that gets you down to an equalized condition quickly enough to avoid serious offsite doses?

MR. TURK: Yes.

MR. MICHELSON: That's a one inch pipe?

MR. TURK: It is a one inch line, yes.

This system normally exists. The other system, the other function of this system is to bleed non-condensible gases off the top of the pressurizer and off the top of the upper head.

You can see in the upper head arrangements it is orificed because the only function there being the non-condensible gases. Unorificed the one inch line is shown to be sufficient to bleed down pressurizer pressure as long as heat removal can cool the system as well and you are cooling down as well.

All you have to do is relieve the saturated conditions in the pressurizer.

MR. MICHELSON: Okay. At some point I think I would like to be led through the various steam generator tube rupture scenarios to be satisfied --

MR. TURK: Yes, we can do that.

MR. MICHELSON: But you're within the capability of the reactor drain tank during that bleed down?

MR. TURK: Yes. The reactor drain tank then also overflows or actually rupture disks to the in-containment refueling water storage.

MR. MICHELSON: Then you are not within the capability of it, so you rupture a disk and flow over.

MR. TURK: No. I do not know that we rupture a disk for that scenario. I am just saying that the physical design of the ruptured disk is there. Whether it ruptures or not depends upon the length of the bleed and that drain tank is the tank that now takes the safety valve flow-down so my guess is that for any tube rupture scenario you would not rupture the rupture disk.

MR. MICHELSON: Using the same size drain tank yet, for this new arrangement?

MR. TURK: Yes.

MR. CATTON: Where does the relief from the steam generators go?

MR. TURK: The safety valves, steam generator safety valves?

MR. CATTON: Right.

MR. TURK: To atmosphere.

MR. CARROLL: Okay. They are on the steam line. You don't dump it --

MR. TURK: They are outside.

MR. WARD: I'm sorry, I may have missed it but in handling the steam generator tube rupture, do you expect that the auxiliary spray will be able to -- I mean is this the primary approach?

MR. TURK: This is the backup.

MR. WARD: It's the backup.

MR. TURK: But it is the safety grade method.

One of the basic design changes in compliance with the EPRI requirements is to go with a non-safety grade chemical volume control system, which is where the auxiliary spray is normally supplied from.

If you remember, one of the issues on Palo Verde was the issue of establishing that function as a safety grade function within this non-safety system so the conclusion we reached was that that system would be a non-safety system and this is the analyzed system for safety grade.

In the normal occurrence of a tube rupture, 99 percent of the time the operator is going to have his main sprays available to him with reactor coolant pumps running.

Even if he doesn't have reactor coolant pumps, he will probably have the aux spray even if he has lost off-site power because you'll see we have this gas turbine that we mentioned earlier which is capable of supplying the charging pumps for aux spray.

This then becomes the final line in the tertiary depressurization.

MR. WARD: Okay. So main spray is off the reactor coolant pumps. RH spray is off the charging pumps. Neither of those are safety-grade.

MR. TURK: Correct.

MR. WARD: But this is a safety grade system?

MR. TURK: That's correct.

MR. WARD: Okay.

MR. MICHELSON: The big valves to depressurize with are manually only operated? By that I mean remote manual?

MR. TURK: Remote manual only, yes.

MR. MICHELSON: Are they on different divisions, is that the idea or something?

MR. TURK: Yes.

MR. MICHELSON: With the three and the four?

MR. TURK: Right.

MR. MICHELSON: So there is no spurious opening of both of them --

MR. TURK: Right.

MR. MICHELSON: -- because this is a very large hole in the pressurizer compared with spurious opening of a relief valve which is about a one inch or so port. This is a six inch hole.

MR. TURK: The capacity of these valves is virtually identical to the capacity of a PORV that would be needed to provide any kind of feed-and-bleed capability.

MR. MICHELSON: You mean this is equivalent to a one inch port PORV?

MR. TURK: No, a one inch PORV would not provide you a feed-and-bleed cooling capability.

MR. MICHELSON: No, it doesn't say that. I thought you meant compared with more normal PORVs which are about an inch and a half.

MR. TURK: No, I guess I was referring to, for instance, the PORVs that were supplied to provide a feed-and-bleed cooling capability as opposed to an overpressure protection capability.

MR. MICHELSON: I was just trying to think in terms of the kind of depressurization rate you get from a six inch gate valve. That depends almost entirely on what kind of sparger you have put in the refueling water storage tank as to what the ultimate capacity is but it's very hard so that depressurizes very fast.

MR. TURK: Like a stuck open safety valve.

MR. MICHELSON: I think it's even bigger than that. The safeties don't have as big a port as those gates.

MR. TURK: Well, the sizing on the valve is essentially the same as a safety valve.

MR. MICHELSON: Well, safety valves, those are not more than three inch ports at best, are they?

How big a safety valve are you putting in? Let's settle it that way.

MR. TURK: I think the 410s --

MR. MICHELSON: What's the port size?

MR. TURK: I don't know that dimension offhand but we can provide that.

MR. MICHELSON: But the gate valve is a six inch hole.

MR. TURK: Yes. I may have misspoken on the two gate valves.

We may have decided on the upstream globe valve and we can verify that and get back to you.

MR. MICHELSON: That would make a lot of difference, of course. Yes.

MR. WARD: We should hear more about that.

MR. MICHELSON: Yes, I think we need to hear a lot more about that.

MR. CARROLL: Do you intend to test these valves to prove that the motor operators will close them under maximum flow conditions?

MR. TURK: We have not addressed the actual -- are you talking about a preoperational test, or are you talking about in-service testing or both?

MR. CARROLL: Or a prototype test.

MR. WARD: Design verification, really.

MR. TURK: It would be a function of whether or not the actual valves we choose were tested as part of the EPRI valve test program back a few years ago. I think the requirements -- in meeting those requirements, if the valves have not been previously covered by that EPRI valve test program, they would have to be --

MR. MICHELSON: We know a lot more about it than we did then, and you'll find that there's a lot more that has to be done, even if that EPRI work were to be repeated. It just was the start of the motor operated valve problems, as you probably are well aware.

You never told me that you really had to reclose those valves. You told me the idea was to open them once and dump it.

MR. TURK: That's correct.

MR. MICHELSON: I assume that's two lines that will be opening to dump at the same time; is that correct?

MR. TURK: How the operator would address that in procedure; I don't think we've got to the point of writing the procedure. Whether he would be told to open one; verify it's flow and if he didn't get it open, open the other. They are redundant in function.

MR. MICHELSON: I was trying to get your intent mainly. It would probably be just one at a time.

MR. TURK: I believe so. They are sized redundantly. Each one is sufficient.

MR. MICHELSON: But no intention to reclose them?

MR. TURK: Certainly there's an intention to reclose them. They are not --

MR. MICHELSON: There is no need to reclose them.

MR. TURK: That's correct.

MR. MICHELSON: You do the analysis as if there was a one -- then you don't worry about reclosure, but that's an awful fast depressurization.

MR. CARROLL: Does one control switch open both valves in series?

MR. TURK: Ken?

MR. SCAROLA: They are separate -- Ken Scarola; I am supervisor of I&C. They are four channel valves where we have an A, C, B and D. There are four separate switches on each one of those valves.

MR. WARD: Now, if those valves are -- you say they have the same flow capacity -- or the system does -- as the safety valve has --

MR. TURK: Right.

MR. WARD: That means they do -- it seems to me they would contribute significantly to an ATWS scenario.

MR. TURK: If you could open them fast enough.

MR. WARD: All right.

[Slide.]

MR. TURK: The other system that we have taken from the balance of plant and added as a dedicated engineering safeguard system is the emergency feedwater system. We have a separate emergency feedwater system and startup feedwater system.

The emergency feedwater system is dedicated only to emergency functions. It's a four pump system that consists of one motor and one turbine driven pump per train.

MR. MICHELSON: Excuse me. Before you ge to that, I have one more question on your safety valve arrangement. You show a common discharge header. Is it really common, or each safety valve has its own header, or each one of these depressurization valves?

MR. TURK: It will probably be a separate header for the safety valves and a separate one for the depressurization valves.

MR. MICHELSON: But all the safety valves would be on one, hopefully very large, header so it doesn't affect the setpoint.

MR. TURK: That's correct, and that's the way it is at Palo Verde.

MR. MICHELSON: But a separate header for the gate valves?

MR. TURK: Yes.

MR. MICHELSON: Okay, thank you.

[Slide.]

MR. TURK: The emergency feedwater system, as I said, a four pump system and a turbine motor for each steam generator. One other key feature that we have eliminated is that on the current systems, there's a relatively convoluted isolation logic that measures steam pressure and it tries to identify a good generator or a bad generator and appropriately isolate.

We have eliminated that logic by installing flow limiting cavitating venturis and appropriately designing both the containment and the reactor coolant system to accept the flow from the system to, for instance, a broken steam generator and then rely on manual isolation after 30 minutes, as opposed to trying to concoct an automatic isolation system.

MR. CARROLL: I worry about cavitating venturis for some reason. Do you intend to do some testing?

MR. TURK: We're using essentially the San Onofre emergency feedwater system. We backfed -- Combustion Engineering, working with San Onofre cavitating venturis to that design for essentially the same function.

The flow rates here are actually a little less.

MR. CARROLL: Have you actually determined that the thing doesn't tear itself up?

MR. TURK: It's been operating for -- that was about five or six years ago that we made that installation. I don't have any data in front of me or performance, but that is our basis for the design. We can provide some additional information.

MR. CARROLL: Your situation is different than Westinghouse where they're using, because you're just dealing with one steam generator.

MR. TURK: What is the concern in the other design?

MR. CARROLL: That if this thing breaks piping because it vibrates so badly, you'd end up blowing down two steam generators.

[Slide.]

MR. TURK: Several issues associated with the safeguard systems, we'll go through and try to indicate our approach. One of the key issues -- and we've alluded to it a couple of times today - is the in-service testing of --

MR. MICHELSON: Excuse me. Before you get to that, I guess you're not -- are you going to discuss any further the cross tying of the emergency feedwater system? I thought that that was kind of an issue also.

MR. TURK: There is a cross tie shown here, isolated, and essentially, it provides the capability to address those multiple failure scenarios; in other words, scenarios beyond the design bases, where for some reason this may not be the generator that needs to be supplied and that we have multiple failures in the train aligned to the good steam generator, affectively allows any pump to feed any steam generator, or any pump to feed each steam generator.

It was added to our design and it shows up as an exception to the EPRI requirements, only because the EPRI requirements are based on a four steam generator system. From a PRA standpoint, we show a clear advantage. We've talked about it with EPRI and they've agreed -- at least I believe they agree -- that for a two steam generator system, that is the correct flexibility.

MR. MICHELSON: They are providing four independent feedwater systems then; one to each generator in the EPRI case?

MR. TURK: The EPRI case is looking at four steam generators.

MR. MICHELSON: Feedwater to each of them independently?

MR. TURK: No, it's not independent. Two steam generators -- any -- one pump can feed either of two steam generators, so it's not a total separation; it's a geometry factor that is affected by one steam generator versus two.

MR. MICHELSON: Okay, thank you.

MR. TURK: Our approach relative to in-service testing pumps and valves, we've seen for some of the major cases, the major pumps, we have designed in full-flow test capability. We are complying with the EPRI requirements.

We are using the documented test program at Palo Verde for which an SER has been issued, and are establishing a goal of trying to address by design any exceptions that

Palo Verde had to take in their establishment after the fact of a test program.

MR. MICHELSON: How do you test your safety injection pumps to full flow?

MR. TURK: They can be recirced to the in-containment refueling water storage tank.

MR. MICHELSON: You kind of assured me a little earlier that that was just a mini flow line. The bypass --

MR. TURK: The bypass --

MR. MICHELSON: That's a big pipe, but it may even flow normally.

MR. TURK: Yes.

MR. MICHELSON: Okay. So, the bypasses are cranked open to do it?

MR. TURK: Yes.

MR. MICHELSON: Okay. Good. How big a pipe, then, is that?

MR. TURK: I don't have that size off-hand.

MR. MICHELSON: Okay. It's got to be large.

MR. TURK: Yes. Really, probably the correct way to show that is to show the valve in line and the orifice as a bypass, if you want to be --

MR. MICHELSON: Because that's the norm.

MR. TURK: You know, that would make it a little diagrammatically correct.

Okay. This is really something that at the phase of development we're in, we're really just entering into in terms of the details on a per-valve basis.

MR. MICHELSON: Now, you're acquainted with Generic Letter 89-10, I'm sure.

MR. TURK: Yes.

MR. MICHELSON: And I assume that anything done for this plant will certainly meet the requirements at least as proscribed there?

MR. TURK: Right. What we're saying is that we're starting with the known response on the System 80 design which is largely consistent, and then we want to go in and address the exceptions that had to be taken.

MR. CARROLL: Check valve testing is also emerging as a big issue that ought to be factored in.

MR. TURK: Yes.

MR. CATTON: Are you participating with NIC, the Nuclear Industry Check-valve Program?

MR. TURK: On the service side of our organization, there is participation, and then the feedback comes from the service side of our organization through the system. So the answer is yes.

MR. CATTON: Okay.

MR. CARROLL: There are probably a lot of things one can do at the design stage to make testing of check valves more easy.

[Slide.]

MR. TURK: Source term. Source term again is an issue on the EPRI requirement document, one that both EPRI and the staff I know have talked to the committee about it on several occasions.

Our approach right now, primarily based upon what we have heard and been told by the staff as far as what they see as the relative timing necessary for approval, is to use currently approved methodology -- that is the TID -- for our design base analysis, that is the Chapter 6, Chapter 15 analysis in the SAR, meeting the requirements of 10CFR 100.

We are using, in our severe accident evaluations for the PRA, a more realistic source term.

MR. CATTON: Did you develop --

MR. TURK: That discussion is ongoing and is related to the discussions with EPRI on the subject.

MR. CATTON: Did you develop your own method of doing a more realistic source term calculation, or are you just going to use what EPRI advises?

MR. TURK: I think the actual source terms comes about in using the MAPP code. In other words, we're using -- Regis, do you want to respond?

MR. MATZIE: Yes. Regis Matzie. We're using MAPP code as it's being modified to support advanced lightwater reactors, and that, I think is consistent with the EPRI source term direction. So, we're in line, I think, with the industry with respect to a more realistic source term for beyond design basis events that are accidents.

MR. CATTON: When I read through some of the paper that came before this meeting, there was discussion of something called MAPP-3B and MAPP-DOE. What's what? What are these codes? Where do they come from. I know what the MAPP code is, but what does the 3B mean?

MR. MATZIE: Regis Matzie again. MAPP-3B is, I think, the latest version of the MAPP code that is under extensive V&V, verification and validation, through EPRI, and is probably going to be used in the IPEs by the operating reactors.

The MAPP-DOE is a version that has had some modifications to incorporate the features being added to ALWRs. As an example, to get an IRWST, I believe, into the coding arrangement of the containment and other features like that, there needed to be software changes to MAPP.

MR. CATTON: Does the DOE mean that DOE paid for it?

MR. MATZIE: That's correct. DOE is sponsoring the advanced reactor severe accident program, and that's what that means.

MR. CATTON: Okay. Thank you.

[Slide.]

MR. TURK: Some of the remaining issues -- we have already touched on the issue of the intersystem LOCA where our primary concern has been to shut down cooling system and increasing the design pressure to 900 pounds, which we mentioned.

We have extended the Class I portion of the system out one more valve. Rather than two-valve isolation, we're going with three-valve isolation within the Class I portion of the system.

MR. MICHELSON: Does that mean two outside and one inside normally or --

MR. TURK: Yes.

MR. MICHELSON: -- is it normally two inside?

MR. TURK: I hesitate the look at the sketch to answer that, but I believe that' correct: two outside, one inside.

MR. MICHELSON: Or is it just a mixed bag?

MR. TURK: I don't think it's an absolute in all cases, but for most cases, it is; it's two outside, one inside.

MR. MICHELSON: Okay. Thank you.

MR. TURK: There are other aspects that we're applying on all systems in one way or another. In other words, that the system ultimate at rupture strength is equal to the pressure, and if it's not, that we can show that the charging pumps can make up the lost inventory, for instance in the sampling system; that the system break would actually occur inside containment and not result in --

MR. CARROLL: Notice you're saying system piping. That's where we have a problem.

MR. TURK: I understand your concern from before as far as seals and valve caps and --

MR. MICHELSON: And instruments and things like that.

MR. TURK: Again, this is the key, I think, to the acceptability or non-acceptability of those kinds of performances, and we --

MR. MICHELSON: Keeping in mind the real concern is that these breaks will occur in what otherwise might be designed only for mild environments and whatever because this was never an anticipated rupture mode even because of the unusual way in which high pressure is gotten back into a water system or whatever. So, even if the pipe doesn't rupture, blowing out seals that have a few hundred gallons a minute flow out of them could be catastrophic to the environment that sensitive equipment might be located in. We just don't know because we don't know where the break is, we don't know what all's happening.

MR. CARROLL: This is from a systems interaction point of view. Flooding or spraying water on other equipment.

MR. MICHELSON: Right. And the environmental qualification --

MR. CATTON: In high pressures like that, if that jet hit something or the spray hit something, it'll rip it right off the wall. It's a little bit more than just the normal kind of environmental damage.

MR. MICHELSON: Yes. We never postulated leaks from high pressure. We postulate leaks from low pressure in some of these compartments and designed for that, but not high pressure leaks, and they behave quite differently. The energy, the temperature and the pressure of the fluid coming out is quite different, besides the size of the hole, which is no longer a leakage crack. It's now a big rupture.

MR. CATTON: This ought to be a topic for the future meetings as well, I think, peeking into this a little bit.

MR. MICHELSON: Well, I think the main thing we're waiting for is the staff position on interfacing system LOCA, which is going to come out one of these days.

MR. CARROLL: Yes. This is one of the 15 issues on 90-16 that we're looking at also.

MR. CATTON: It's more than just a leak. The interfacing system LOCA I don't think really addresses these questions. So, we ought not let the new plants get away with it.

[Slide.]

MR. TURK: The last fluid system that I'd like to address is the non-safety chemical volume control system, which I mentioned the major change is taking that to a non-safety system which allows it to be simplified.

The other major change we have is going from the positive displacement charging pumps that we have used in the past and have had maintenance problems to centrifugal pumps, and moving the letdown heat exchanger onto the high pressure side of letdown so we're letting down cooler water and moving the heat exchanger itself inside the shield building.

MR. MICHELSON: Before we leave interfacing system LOCA, there is one other thing one has to be very careful about, and that is heat exchanger tubing. The tubing may be the weak point, and it ruptures. Everything else holds on in that 900-pound system you put in. However, the rupture in the tubing pressure or overpressurizes the shield side water system, which may only be a couple-hundred-pound design, and now you're talking about ruptures I don't know where the weak point then moves to, and that's where the water starts popping out. This all has to be a part of interfacing system LOCA consideration. So we will chase the thing on out to the end.

The pipe is probably too strong. Unfortunately, the rupture will be where you least expect it, ultimately.

MR. CATTON: Maybe they need a fuse.

MR. MICHELSON: You need a fuse. Precisely. You need a rupture disk.

MR. TURK: I would like to turn the attention now to the electrical systems and the I&C systems. Ken Scarola, our supervisor of I&C design. Let me ask the committee if you'd like to break at this point?

MR. CARROLL: Yes. How long is this presentation?

MR. KENNEDY: About a half hour.

MR. CARROLL: All right. It sounds like we ought to break for lunch. It also looks like we have reached, what, about the 10:50 point in the schedule you guys had set out. I guess it appears to me that two o'clock is not realistic, at least with presenters this afternoon. So, I would suggest you do something about your plane reservation.

MR. KENNEDY: We'll do that.

MR. MICHELSON: The NUPLEX system is going to take a lot of discussion.

MR. KENNEDY: Let me just remark ahead on the NUPLEX. We would fully anticipate that we could do that in an all-day meeting on NUPLEX 80 advanced control rooms, so I fully expect that in the review of the design, we would come back in to give you an all-day presentation on that. Today is just, if you will, to orient you. But it's an interesting subject.

MR. MICHELSON: Well, what we're trying to do is understand everything enough to talk about this licensing basis agreement and whether the right things are in there.

MR. KENNEDY: Correct.

MR. MICHELSON: That's why we need a little of a feel for this as we go along.

MR. CARROLL: In addition to that, ACRS has established a new subcommittee chaired by Dr. Lewis which is going to go into all the potential foibles of computer-based control systems.

MR. KENNEDY: We understand.

MR. CARROLL: Okay. We'll reconvene at one o'clock.

[Whereupon, at 12:00 p.m., the hearing recessed for lunch, to reconvene this same day at 1:00 p.m.]

AFTERNOON SESSION

[1:05 p.m]

MR. CARROLL: Okay. Shall we continue?

[Slide.]

MR. SCAROLA: It seems like the I&C people are always the ones who are forced to keep everybody awake right after lunch, but I will do my best. That is, if I don't fall over the cord.

I am supervisor of Advanced Instrumentation. My name is Ken Scarola, and I will be speaking about the control complex for System 80+, as well as the electrical distribution. Since I don't have slides that really address the concern that was voiced this morning about the advanced technology, let me tell you something about what we're doing there.

First of all, the control complex for System 80+ is referred to as the Nuplex 80+ Advanced Control Complex. And we use the term "advanced" because the application of human factors engineering, as well as computer technology, far and away exceeds anything that you've seen in any existing operating reactors. On the other side, all of the hardware that is in Nuplex 80+ who exists right now. You can walk into places, you can see it, you can feel it, you can touch it, and at CE, we have extensive mock-up facilities, development facilities, where all of that hardware exists.

From an overall qualification point of view, we are going through extensive rigorous qualification that includes seismic testing -- the electromagnetic interference testing -- we are meeting the licensing criteria for things like environmental testing for environmental qualification. So, in summary, the hardware is all proven technology; it exists right now by make and model number. You can walk into places and you can touch it, and we are basically going through the application of that technology in a nuclear power plant program right now.

MR. CARROLL: Everybody always says they're really doing a first-rate job on human factors engineering. Tell me how you're doing this.

MR. SCAROLA: Okay, let me address that, though, as we go through the presentation.

MR. CARROLL: Okay.

[Slide.]

MR. SCAROLA: Now, what I'd like to do since there's not a lot of time, though I will overview the design bases of Nuplex 80+, I will go through an overview of what the scope is of the overall design, then we will hit specifically human factors, then I will go into the handful of identified issues that we have on the agenda.

So, first of all the design basis. There are four major design bases and they're listed here, and I will highlight some of the important areas underneath each on of them. First of all, we are meeting all of the existing regulatory and the industry criteria, and I focus on human factors engineering because that is a major focus of our entire design effort, as well as fire protection and sabotage, and I have slides that will address each one of those.

Second two will improve plant safety. Before, you heard basically about the four train-engineered safety feature systems that we have. We also, inside the protection system itself, the I&C systems, we have gone to fully automatic testing. And that does not mean simply that the hardware is verified. It also means that the software trip paths are continuously exercised.

The next one in the overall design bases is improved plant availability. You know, we talked this morning about, how do we achieve less than one reactor trip a year. The things we're doing in the I&C area are not the only contributors for that, but they are major contributors. One is, we're using fault tolerant systems. Basically, all of the systems in the I&C area have built-in redundancy such that they can tolerate failures in hardware. They automatically switch over and there is basically no impact on the plant. We also look at the process of the plant itself, and as we approach limiting conditions, we do initiate automatic control actions and thereby avoid trips. This is basically an extension of features such as reactive power cutback that we're now using at the Palo Verde.

Lastly is a thrust on improving the overall cost effectiveness of the I&C packages for nuclear power plants, and we look at all phases, all of the phases of those costs. That's through the design phase, through construction, as well as operations and maintenance. I will address all of these issues to some level as we go through this.

MR. WARD: I have a question, before you -- the term, "accident management" has become sort of a code, set of code words for activities to address or improve procedures for following accidents, possible accidents, beyond the usual, tradition design basis regions, in regions where there might be more failing than were counted on, where there might actually be core damage. Does your design think about this accident management space at all?

MR. SCAROLA: Yes it does. We have in CE plants what we call the "optimal recovery procedures," and then we have "functional recovery procedures." The optimals --

MR. WARD: Yeah, but are those extended into, I guess you've had those for some time.

MR. SCAROLA: Yes, and they are extended into the man-machine interface design, and I will show you a little bit of that later.

MR. WARD: But are they extended into what are called severe accident space, rather than the more traditional EOP space.

MR. SCAROLA: Only from the standpoint that the functional recovery that will handle those types of things; not beyond that, no. I think that we will address severe accidents later and, you know, maybe we can elaborate more on that.

MR. KENNEDY: Let me, could, if I can, make a comment on that. This is Ernie Kennedy. Right now, our procedural guidelines, which we prepare generically for our plant owners, are being looked at for operating plants for accident management considerations. We would expect, toward the end of our system 80+ design effort, that we are going to have to go back and revise our emergency procedure guidelines to coincide, first of all, with the System 80+ design, and at that point we would pick up in those emergency procedure guidelines the accident management work that's being developed for operating plants that extends into the severe accident regime.

MR. WARD: Okay, do you think there might be, that sounds like a program that's appropriate for an existing plant, but what about this plant of the future that for the design isn't complete. Is there going to be anything in the design to address that area?

MR. MATZIE: This is Regis Matzie. We have made a number of design changes to the plant to mitigate the consequences of a severe accident. The design changes we've made to the systems that we've already described and will continue to describe, but try to reduce the core melt probability and, in addition to that, we have made changes, as an example, to the containment to reduce the consequences. So, the answer is the design has been addressed from that standpoint --

MR. CARROLL: Well, I think what you're saying, Dave --

MR. WARD: But has the man machine interface that might present some different sorts of problems been addressed?

MR. CARROLL: For example, I think, Dave, what you're saying is if you, in fact, had these accident management procedures in place right now, it might influence additional instrumentation or ways of displaying it, or whatever.

MR. WARD: Yeah. You're providing for, let's be gross about it, for core on the floor. Is the operator going to have any information telling him what the situation is -- is there core on the floor, or does he just throw up his hands, or what?

MR. SCAROLA: Oh, I think right now, at this point in time, we would have to say that the man-machine interface designs do not specifically define the instrumentation that would be required for those scenarios. That will be occurring in a later part of the design effort. We have not looked at the severe accident scenarios with regard to the man-machine interface design changes or the design additions that may be required. I think that one of the things that we have going for us here is that a flexibility toward the introduction of specific displays or the alarms for those scenarios are very simple to add in a later stage of the design, although at this point in time, I have to be honest; they are not in there.

MR. CARROLL: Is there room to add them. That's been the historic problem.

MR. SCAROLA: I think when you'll see this design, you'll see that there is more than sufficient room in the control room to add them. It's not a space consideration, as it is in existing plants. It's basically a depth consideration in the information displays, and we'll show that. This is a highly dynamic control room, as opposed to a control room that has fixed displays for every piece of information.

MR. CARROLL: Let me back up. Okay. You've got V and V down there as an item and you're going to meet all current and regulatory and industry requirements. I guess I have some apprehensions that current isn't probably good enough as we move off into the world of computer-based control and safety systems.

MR. SCAROLA: Okay. One thing I can point out there is that CE has been supplying computer-based systems for more than 15 years now in the safety area. And we have basically incorporated all of the lessons learned throughout that time period into the V and V program.

So CF's V and V program goes far beyond what the industry now requires in Reg Guide 1.152 for example. So, there's a lot more in our program.

MR. CARROLL: But is that good enough as we give these systems more responsibility? I guess I think to the Canadians who are still struggling with whether they can really rely at Darlington on the new computer-based safety system.

MR. SCAROLA: I understand your concern. We addressed V and V as one part of an overall system reliability program. We will talk about a diversity as well and overall systems qualification.

I think all of these have to be looked at synergistically and not just V and V by itself.

MR. CARROLL: Okay. Well, I don't think today is the day we spend hours on the subject, but, I think it is a subject that the Committee is going to want to hear about eventually.

MR. SCAROLA: Okay.

[Slide.]

MR. SCAROLA: This slide is a block diagram overview of the entire scope of the NUPLEX 80+ Advance control complex. At the very top of the picture is the main control room and I will be showing you more information on that.

There's a separate remote shutdown room and then over here we have the technical support center. Those are basically the man/machine interface areas.

Now, behind that, there a number of systems that support those man/machine interfaces. The first level here are the display systems. This system here that we call the data processing system which is a redundant super mini-computer based system that is responsible for all of the CRT based information inside the control room.

There is a diverse and completely separate system that is responsible for the spatially dedicated display inside the control room. Those are things like the meters, the alarm tiles, things that we have retained from the existing control room design because they're good. And I will be showing you those later.

The next level down are the control and protection systems. On the left hand side of the drawing are the protection systems and you can see that they are multi-channel four-train systems and on the right hand side, are the fault tolerant control systems.

Further down in the system are the interfaces or the fingers into the plant.

MR. MICHELSON: Excuse me. Where did we leave the control room area now in this drawing?

MR. SCAROLA: Okay. We have left the control room area and I'll show this on a later slide, as soon as you get down below this line. All of this equipment is located in the I and C equipment room from here to here.

MR. MICHELSON: Okay.

MR. SCAROLA: And there are five I and C equipment rooms, four channels for safety and one for non-safety. And then from here out, we are basically out into the plant. And these boxes that you see on the bottom are what we call remote field multiplexers.

MR. MICHELSON: They're out in the various locations in the plant.

MR. SCAROLA: They're out in the reactor building, turbine building. There are none inside the containment but they are basically in the locations of all of the mechanical equipment.

The intent of these is basically to meet the design basis that I had identified earlier and that is lower cost.

MR. MICHELSON: You drew lines from there on in to what I guess, what's the significance of that dotted area down at the bottom?

MR. SCAROLA: This is basically showing the inside containment building.

MR. MICHELSON: Well, certainly --

MR. SCAROLA: There is not multiplexing internal to the containment. You wire everything out.

MR. MICHELSON: But there must be a lot of multiplexing coming from outside the containment but outside also of the I and C equipment room.

MR. SCAROLA: Okay. Yes, that's my point. This line is the end of the I and C equipment room.

MR. MICHELSON: Yes.

MR. SCAROLA: Everything that's above here is in the I and C equipment room and everything that's lower than here is in the plant.

MR. MICHELSON: Those multiplexers are looking at information coming from outside of containment as well as inside containment?

MR. SCAROLA: Both.

MR. MICHELSON: Okay. It wasn't clear from that drawing that that was the case.

MR. SCAROLA: I'm sorry.

MR. CARROLL: What's your problem with multiplexing from inside?

MR. SCAROLA: There are a number of things. One is the maintenance access concern. One is the radiation hardening, the accident environment. We just decided not really to go that step for this advanced program.

We are going that step for some of the other programs we're working on with DOE but not this particular one.

MR. MICHELSON: Now, could you tell us just briefly how you handle it, starting with a given instrument, like a pressure sensor, where do you start in with solid state transmission to the multiplexer or do you?

MR. SCAROLA: It depends on the specific transmitter. For example, if the transmitter is required in a single system, then the multiplexing occurs right in the four to 20 milliamp control loop or the instrumentations. The multiplexer is located as near to that sensor as we possibly can.

MR. MICHELSON: But the sensor, let's say, is inside containment.

MR. SCAROLA: Okay. So we route the wires, three wires inside the containment, through the containment penetration and then the multiplexer sits right in the containment penetration area.

MR. MICHELSON: That's the point at which you do -

MR. SCAROLA: There we do an A to D conversion, an analog to digital conversion and then the signal that goes from the multiplexer back into the intelligent processor is basically a digitized signal of the analog value.

MR. WYLIE: Is any of this fiber optic?

MR. SCAROLA: Yes. I will show you that after. We're using fiber optics in all places where we require electrical isolation.

MR. WARD: Do you have reason to expect maintenance, reliability problems with these A to D and multiplexer units?

MR. SCAROLA: No, we don't.

MR. WARD: You said you didn't put them in containment for that reason.

MR. SCAROLA: Basically, for the access into the containment. The MTBF numbers that we are looking at for all of this equipment is around 10 years. Those are mean time between failure numbers.

Most of the equipment, as I said, has fault tolerance. There are situations where there is no fault tolerance in the equipment itself where we have multiple safety channels because that in itself is the fault tolerance.

The MTFR, the mean time for repair is on the order of 30 minutes. But it was simply the access inside the containment at power for repair that we thought was a limiting condition.

MR. MICHELSON: How many multiplexers are we really talking about? This is just a figure that shows nine, but, how many multiplexing cabinets do you expect or locations?

MR. SCAROLA: Okay. There are roughly 100 of them in the plant.

MR. MICHELSON: Spread around? I'm talking about outside of the I and C equipment room.

MR. SCAROLA: On one side of the sphere for the containment in the reactor area, in the shadow areas where we have aux equipment, on the other side of the sphere. Inside the turbine building. Inside what we call the aux control building.

MR. MICHELSON: There's quite a number of them?

MR. SCAROLA: Yes, there's quite a number of them.

MR. MICHELSON: Now, what kind of environmental qualification is this equipment? In other words, what is its fault tolerance for high temperature, high humidity, whatever?

MR. SCAROLA: Okay. All of the equipment that we're using is 60 degree C equipment or 104 degree F.

MR. MICHELSON: Does that mean 140 ambient in the air that's used to cool the equipment?

MR. SCAROLA: No. It means that the maximum outside air temperature is 104 degrees F.

MR. MICHELSON: So, you're rating only up to 104 F?

MR. SCAROLA: For the outside air. And the reason for that is, we have to take a heat rise to go inside the closure and we have to take the --

MR. MICHELSON: So, 104 is not really very high. What do you now about power blackouts or other situations wherein the room areas get warm or a small pipe breaks or whatever? How does this equipment behave when the ambient air gets over 104 degrees?

MR. SCAROLA: Well, certainly nothing is going to fail instantly. So, the equipment behaves is it basically gets an extremely shorter life.

MR. MICHELSON: That's true for a few degrees above this. But, let's go up to 130 right away. Do you think that none of this will drift or change state?

MR. SCAROLA: Yes, it will.

MR. MICHELSON: Okay.

MR. SCAROLA: And we accommodate that in the single failure analysis in that the locations for the equipment are basically subject to the same single failure criteria of HVAC, ambience fires et cetera that we would apply to any four-channel safety --

MR. MICHELSON: That single failure analysis is one failure at a time. Is that right?

MR. SCAROLA: One train at a time, yes.

MR. MICHELSON: Well, one failure, I think would do it in doing single failure analysis and it might result in a train going out or whatever it causes it to go out.

But this can be multi-channel because this can be high temperature in large areas containing both trains of equipment and so forth unless you've got some special provisions to prevent it.

MR. WYLIE: I think that this whole area is one that we're probably going to spend a day on.

MR. MICHELSON: I just want to see roughly where they're at.

MR. SCAROLA: I think basically the approach we're taking is, we're maintaining segregation of the I and C equipment by trains. So, we our limiting case is loss of an entire train.

MR. MICHELSON: But of course, common cause events like station blackout and so forth, it's going to start warming up more than one train.

MR. SCAROLA: Let me address station blackout at a later slide.

MR. MICHELSON: Okay. Now, the 104 degree max design of course, you can certainly get equipment that will handle more than that. Apperently you had reasons to select that particular number. Not all vendors of these systems are selecting that same number. Some are going much higher.

So, the closer that is to normal room temperatures, the more sensitive the problem becomes. And the 104 is not far from what some of these areas see routinely particularly in the summer time in the south.

So, I think this will be an area we'll pursue very hard later on if you're going to design for 104 cooling air inlet.

MR. SCAROLA: In the room.

MR. MICHELSON: Yes.

MR. SCAROLA: Right. Okay.

[Slide.]

MR. SCAROLA: That was an overview of the control complex itself. Let me talk a little bit about the approach that we have taken to the design of the man-machine interfaces.

First, we established a multidiscipline design team. And that consisted of human factors specialists, reactor operators, nuclear system engineers, as well as I&C engineers. People who are designing the information for the control room or reactor operators.

MR. CARROLL: These are utility reactor operators?

MR. SCAROLA: Past utility licensed operators, people that now work for Combustion Engineering but in the past have held operating licenses for utilities.

MR. CARROLL: Is the same true of the I&C engineers? Is there any utility flavor there?

MR. SCAROLA: Well, there is utility flavor in that we interact with Duke Power on everything that we do. So there is a utility influence in the design. They are part of the design team.

MR. CARROLL: Because in my experience, I think vendor I&C engineers and utility I&C engineers often have different perspectives on these issues.

MR. SCAROLA: We often clash. There is no doubt about it.

MR. CARROLL: Okay.

MR. SCAROLA: But I think what we have ended up with is a design that is basically meeting all the requirements for both sides.

Okay. That team does a system analysis as well as we do an independent analysis by separate design team that establishes the functional requirements for the information and controls in the control room. We basically look at the systems, we look at the operating procedures, and we see this is the information the operator has to have. That is often referred to as function task analysis. And that is part of the overall design process. A later part of the design process is the validation through mockups, actual full-size control panels, the operating displays, et cetera, where we go through walkthroughs of all the information displays along with the procedures. So that is roughly the process.

[Slide.]

MR. SCAROLA: Now, I have a few 35-millimeters here that are in your handouts, in black and white. Let me switch on the projector.

Okay. This is a picture of the control room itself. Now, let me go through it in part. this is what we call the controlling workspace. This is basically where the operators are going to run the plant. And we have designed this in a segregated manner basically to keep non-operating personnel out of the controlling workspace. There is a master control console where one man can run the plant through all normal plant excursions. But the work space is large enough to accommodate six people for any sort of abnormal events.

In those six people, we include a control room supervisor that would be resident at the supervisor console, as well as a shift technical advisor.

In the front of the control room is a large screen overview display that I will be showing you more on after. In the back of the control room are the offices for the operating staff, auxiliary reactor operators when they are not at the controls, the control room supervisor, and behind this wall, there is an office for the shift supervisor.

All of this, including the offices, is a secured area.

This second floor that you see over here is what we call a technical support center. That is a separate security zone. It allows people to come in and get freer access, visibility into the control room so they can view what is happening. We intend that this would be used, not only for the accident conditions of the plant but also as a visitor's gallery. And that is why we made this a separate security zone.

MR. CARROLL: What is the glass security between it and the control room?

MR. SCAROLA: The glass is fully bulletproof as well as the floor is as well.

MR. CARROLL: Nothing is fully bulletproof.

MR. SCAROLA: Well, it meets the bulletproof criteria that have been established.

MR. CARROLL: Okay.

MR. SCAROLA: Let's put it that way.

In all of the offices as well as the TSC and throughout the control room, you can see that these small boxes are CRT displays. They are basically windows that go into the plant computer that allow the personnel in any location to have full access into the entire plant database.

We also support through CRT information the emergency offsite facility where again there are CRTs located for access into the plant.

What we have done here as compared to a nuclear power plant control room that is in operation now is, we have retained those features of that design that are good. There are certain spatially-dedicated aspects of existing control rooms that are very good.

We have also looked at those and said we have a tendency to overload the operator with information, and therefore we have reduced the amount of information that we have spatially dedicated.

I have slides on --

MR. CARROLL: Now, your tree over in the corner there is to combat the greenhouse effect to keep the temperature down?

MR. SCAROLA: That is an artist's --

MR. WARD: Let me ask you a couple questions. I think that is beautiful.

MR. SCAROLA: We have a similar comment.

MR. WARD: I think that is beautiful. I like it, that tree. In Belgium they have fish bowls, or fish tanks.

Is there something called an SPDS or is that an antiquated concept?

MR. SCAROLA: It is basically a function that exists, but not as a dedicated piece of hardware. The SPDS function is integrated because there is a human factors philosophy that we have that says that an operator uses daily what he is going to use during an accident. So there is nothing here that he uses only for accidents. It is an integrated part of the design.

MR. WARD And is NRC staff happy with that?

MR. SCAROLA: We don't know that.

MR. SINGH: We haven't looked at that yet.

MR. CARROLL: You get one vote from me. I think that is good philosophy.

MR. WARD: What sort of guidelines do you have for this review? Do you expect to see SPDSes in plants? Or is that strictly a backfit?

MR. SINGH: We are going to visit facilities later on this month to get a little better understanding. The human factors people are developing some criteria, or guidelines, on what we will be looking at.

MR. WARD: Okay.

MR. SINGH: But we don't have anything on paper yet.

MR. SCAROLA: There are no functions of existing SPDS systems that are not found inside this control room. The only difference is the operator uses the media that he uses for an SPDS-type display all the time, and he uses what we call a function-based operating approach, all the time in this plant, not simply for handling accident recovery. We use critical functions day to day. And I will be showing you a display on that.

MR. WARD: But I think your first statement, there is no function that is not available here, could be said for plants before the SPDS era, too. That was the point of the SPDS, if there was one, that it concentrated them somewhat.

MR. SCAROLA: Okay. We are doing that as well.

MR. WARD: Okay. What would you do in a multi-unit plant?

MR. SCAROLA: Separate control room.

MR. WARD: No connection at all?

MR. SCAROLA: Right. For a light water plant. There are some advanced designs that we are looking at multi-unit. But for the light waters, there are separate control rooms.

MR. MICHELSON: Let me make sure I understood what you were showing us up here correctly. Are you saying that that is a visitor's gallery shown on the left there?

MR. SCAROLA: It is defined as the technical support center fulfilling the requirement of NUREG 0696.

MR. MICHELSON: Well, that is not a visitor's gallery, of course.

MR. SCAROLA: I'm sorry?

MR. MICHELSON: That is not a visitor's gallery.

MR. WARD: That's just for visitors like ACRS members. Not school kids.

MR. MICHELSON: Certainly not the public.

MR. SCAROLA: No. We would anticipate that you would bring visitors in there, because visitors frequently visit power plants, and right now they come into the control room and they are basically somewhat of a disturbance.

MR. MICHELSON: I thought that they weren't even allowed in control rooms.

MR. CARROLL: We are talking about the difference between general public and --

MR. MICHELSON: You don't allow the general public in the control room.

MR. SCAROLA: These are VIP-types, this is not open to the public. I'm sorry.

MR. WARD: Not ACRS members.

[Laughter.]

MR. MICHELSON: Okay. That is not a visitors' gallery, then; that is part of the technical support center.

MR. SCAROLA: Thank you. I pointed out the large screen overview. That is what we call the integrated process status overview display. And I will show you what that looks like.

[Slide.]

MR. SCAROLA: This is basically a simplified graphic presentation that presents the highest level of information in the plant in a very simplified manner. The design basis for the display is, very simply, critical functions, those functions important to power production when you are producing power, and those functions that are important to safety when you are recovering from a reactor trip.

All of the critical function identifiers are on here and all of the system representations are laid out to support those critical functions.

Very simply, we look at all of the system parameters. There are about 10,000 points that are looked at in defining this display. These red symbols are basically that a system is on, and the green, which is washed out somewhat in this picture, is that a system is off. All of the yellow indicators are that systems have alarm conditions.

MR. MICHELSON: What kind of display is this?

MR. SCAROLA: We are using multiple video projectors. The video technology for the flexibility and the multiple units so we can basically gain adequate brightness.

Simple display symbols such as the down arrow, the minus sign, the indicator here that you have are a higher level than normal, are all things that are processed by the computer and then basically put up on the display to simplify the operator's overview comprehension of the plant.

The intent of this entire display is such that, number one, when an operator is lost in the details of diagnostics he does not lose the big picture.

Secondly, it's to give the entire staff one common mental model of the plant status.

MR. MICHELSON: Will this be seismically qualified?

MR. SCAROLA: No. This display is not seismically qualified.

MR. MICHELSON: So something I can write off without being needed for accident response?

MR. SCAROLA: Not being fully credited for accident response --

MR. MICHELSON: Not being credited at all, I assume, at least for anything you might get into in conjunction with a seismic event.

MR. SCAROLA: To the extent that the SPDS is, this is at existing plants so it means the same criteria.

MR. MICHELSON: Oh, yes, but SPDS doesn't -- isn't required to go through your emergency procedures.

MR. SCAROLA: Right, and this is not required.

MR. MICHELSON: So this is something that I can write off? I don't need it at all?

MR. SCAROLA: Yes, absolutely. It is not required.

MR. MICHELSON: You get into these fundamental arguments of course after you build these highly sophisticated crutches and then you take them away from the operator, how well can he do without them?

MR. SCAROLA: I think that's an important point. That's one of the reasons why when we look at what we have retained as fully qualified instrumentation I think you'll see that there is more than adequate information there for the operator to use.

MR. MICHELSON: Well, it's not a question of the amount of information but rather the manner in which it is projected to the operator.

MR. SCAROLA: Let me get right into that.

MR. WARD: Could you just say briefly though why? Is it really impossible to make that sort of a display, the whole system seismically qualified, whatever that means?

MR. SCAROLA: Well, there are two aspects to it.

One is, yes, you can make it seismically qualified.

The second aspect is there's a lot of data processing behind that and the data processing is basically a software task and to the extent that you would want to apply V and V to highly sophisticated software, yes, it can be made that way but it may not really be cost effective.

MR. WARD: It sounds like it is more of an issue of putting it through the QA ringer than it is structurally designing it to be seismically resistant.

MR. SCAROLA: It's a lot of things.

It's deterministic, performance. It's the sort of machine that is needed for the calculations. It's not a simple thing to say that that is going to meet all of the same criteria that you would meet inside class system.

MR. MICHELSON: How is software affected by a seismic event?

MR. SCAROLA: No, it's not.

MR. MICHELSON: If the hardware and all of the rest of the hardware better be good because it is the same hardware that's giving you the good information.

MR. WARD: That's why I say, it's more administrative or QA problem.

MR. MICHELSON: Everything up to the screen I think is safety grade, I would think -- isn't it?

MR. SCAROLA: No. The instrumentation is safety grade where it is required to be safety grade but then you have to take the information into computers, process the data, and then display the data.

From the points you process the data that is not safety grade at this point.

MR. MICHELSON: Now the hard stuff that the operator has access to that you tell me is all he really needs, that is all safety grade?

MR. SCAROLA: Yes. Let me go to that.

MR. MICHELSON: Okay.

MR. CARROLL: Is this consistent with your philosophy that the stuff he uses every day ought to be the stuff he has available and uses under accident conditions?

MR. SCAROLA: Yes. It is.

MR. CARROLL: Including a seismically induced accident?

MR. SCAROLA: I am not saying that everything that the operator has at his disposal will be at his disposal during an accident. That's not what I am saying.

It is exactly the opposite. I am saying the things that he needs during an accident he will use every day. It is a different situation.

I cannot design a control room where he uses everything and that's also available during an accident because it makes a very expensive control room design but it does work the other way around.

My next slide --

MR. WARD: Well, I didn't want to take a lot more time but this is -- if we are serious about where the threats are, at some plants, at some sites there are claims that a large seismic event is a major risk contributor -- you know, some numbers -- I don't know whether to believe them or not but some numbers show more than half of the risk. This is for the other half, I guess.

MR. SCAROLA: On my next slide I am going to show you --

MR. MICHELSON: The question is, what do you do? What do you do in a PRA with the human factors aspects of a PRA for the events wherein this good stuff is not available and he has to fall back on his fundamental instrumentation?

It certainly must change slightly the efficiency of the operation.

MR. CATTON: Increase the human factors error.

MR. MICHELSON: It's got to.

MR. CATTON: I wouldn't think it would decrease it. If it's a good system they ought to decrease it relative to what they use.

MR. MATZIE: This is Regis Matzie speaking. The other equipment is not backup. You've got the idea this is the stuff they normally use only and the other stuff is all backup.

As Ken gets into this you'll see they use both types of instrumentation continuously in their processing and that other type of instrumentation which he is going to describe has got all the standard parameters he needs to run the plant.

MR. MICHELSON: And those read off onto the main control panels?

MR. CARROLL: I guess this all started talking about SPDS. It looks to me like this integrated process status has a lot of the elements of a good SPDS in it.

Do the other instruments -- are they grouped and displayed so that there is one good place to look, and he is going to tell us that?

MR. SCAROLA: I think the answer is yes. I don't know -- okay.

Let me get into the design of the actual control panels and in my next slide I have photographs of this specific panel, which is the reactor coolant system panel.

[Slide.]

MR. SCAROLA: Now this panel is representative of all of the panels inside the control room.

On the panel there is a CRT that is basically the window into the data processing of the plant through the plant computer. Those are in essence 19 inch CRT displays that present a pictorial representation of the plant.

We also have spatially dedicated alarm tiles as well as spatially dedicated indicators. They are done on a very limited sense. There are very few of them as compared to existing control rooms and they are selected by the human factors specialists as those few instruments that are indicative of system performance, so again we go back to the critical function concept -- what are the few instruments you need to really indicate that the system is meeting its performance criteria?

MR. MICHELSON: Which readouts on that panel are seismically qualified?

MR. SCAROLA: This one, the alarm tiles and all of the indicators that you see over here.

MR. MICHELSON: But not the CRT?

MR. SCAROLA: Not the CRT display. The operator is going to use the CRT display as well as the indicators and the alarm tiles all of the time. For a seismic event he will be left with the alarm tiles and the indicators.

MR. MICHELSON: So you are using seismically qualified alarm systems then?

MR. SCAROLA: Yes, seismically qualified alarm as well as display systems, and they are fully qualified through all the software pedigrees.

[Slide.]

MR. SCAROLA: Now I have pictures of each one of those in somewhat more details.

These are the alarm tiles. This is -- it replicates what you would normally expect to see inside a control room -- spatially dedicated alarm tile for the major alarm areas.

The major difference is we have large groupings of alarms into functionally related groups so behind this tile there would be roughly eight to a dozen alarms that are all related to that specific area.

The alarm tile itself is dynamic in that right now it is showing through the box outline of what we call Priority 2 conditions. If there is a Priority 1 condition it goes to a full yellow display.

When the operator want to acknowledge that alarm he simply sticks his finger right on the tile.

[Slide.]

MR. SCAROLA: What he gets is again the representation of the tile, a listing of those things that are in alarm that he has acknowledged and those alarms that have cleared that he has now acknowledged.

If he wants to go further, he can simply make another touch.

[Slide.]

MR. SCAROLA: He gets a full listing of all of the alarms related to that tile.

MR. MICHELSON: That is only if the CRT is working.

MR. SCAROLA: No. This is functional all the time. In fact this is --

MR. MICHELSON: Where is this reading out on that other picture?

MR. SCAROLA: It's this panel right here.

MR. MICHELSON: Yes?

MR. SCAROLA: Okay, now what we have done is those slides that I showed you are these exact tiles.

MR. MICHELSON: Yes, yes.

MR. SCAROLA: And these are showing Priority 1 conditions in alarm and the lower ones are showing Priority 2 conditions but the tiles are dynamic.

MR. MICHELSON: Where is all this printout on the next slide showing up?

MR. SCAROLA: When the operator makes a touch, this screen now becomes the printout screen.

MR. MICHELSON: Oh, that's an LED type readout.

MR. SCAROLA: It is electro-luminescent technology, which is a phosphor-based black panel screen.

MR. MICHELSON: That's what I wasn't -- didn't realize.

MR. CARROLL: So while he is getting smart about what the one tile is saying, what is going on with the others?

MR. SCAROLA: Okay. What is happening on the main page is reflected here at all times in that this box, the alarm status box, is saying this is the activity on the main page and that box is going to show him his highest priority condition on the main page and we have a list of how priorities go.

Priority 1, not acknowledged; Priority 2, not acknowledged; Priority 3 -- et cetera.

The operator can return to the main page anytime.

He also in NUPLEX 80 there are only momentary audibles. A momentary audible comes in, beeps, says there is a new alarm.

If he has not done the acknowledgement within a minute, he gets a second tone that is a reminder, again momentary, okay?

So there is the flashing as well as the audible reminder that he has alarms.

The big screen we had, the big screen gives him a summary of the plant locations that have all the priority one conditions, okay, so he can see on the big screen as well as anyplace on any CRT that he has alarms going on. He doesn't lose any information.

[Slide.]

MR. WARD: Back to seismic again, some of these displays and instrumentations are apparently seismically qualified, but most risk analysis show that, you know, the risk from -- the risk there is from earthquakes is at ground accelerations in excess of the SSE and that in fact if you look at hazard curves, hazard curves per -- a lot of actual sites, you get numbers, you know, maybe twice or more of the SSE, you get return periods certainly with the ten to the minus, you know, a 100,000 years which is one of your design bases. Seismic PRAs generally show that good old piping is okay and a lot of other structures and pieces of equipment can at least survive up at accelerations in excess of the SSE. What about this stuff, what do you know about these instruments in the control systems.

MR. SCAROLA: The only thing I can tell you is what we have tested. All of these devices have been tested up to 25gs, that was the envelope that we looked for, we actually had over testing that went to 30gs by error just because we lost control of the table, but this stuff is very survivable.

MR. CARROLL: The temperature got above 104 degrees.

MR. MICHELSON: What is the power supply for a typical screen like we've been discussing?

MR. SCAROLA: Okay, depending upon the arrangement or with the particular one you're looking at, these are powered from the battery buses, the vital buses in the plant.

MR. MICHELSON: Now, some of the information is coming in through multiplexers to this device?

MR. SCAROLA: Correct, yes.

MR. MICHELSON: And the amount -- a certain amount of that information is coming from non-seismic, and 1E devices into the multiplexers and there the isolation is occurring, is that right?

MR. SCAROLA: Let me show you and I think I can elaborate a little bit on that.

MR. MICHELSON: All right.

MR. SCAROLA: Okay, these are the indicators. Let me go back here for one second, the indicators that are on the panel are down here, and let me show you what we're doing with indication. For all of the indicators we display what we call the process representation value, that's not a value from any specific sensor, but rather a computerized composite of a validated process representation value from all senses, so here we're looking at the hot leg RCS temperature, and on the 565 cold leg RCS temperatures. We have in the cold legs about 32 sensors, safety and non-safety, in the hot leg we have about 18 sensors, and we look at them, in the microprocessor, and we display what's called valid information, which is basically we look for sensor deviations, we throw out the bad ones. The operator can make a touch on this screen and he get to a second page where now he can make a touch on any particular sensor instrument tag number and he can get the read-out of that sensor.

[Slide.]

So, in essence what we're doing is we're looking at those non-safety sensors, we're looking at the safety sensors, and we are doing composite validations. The word PAMI here says not only is the data valid and that it meets all the acceptance criteria, but it also is within the tolerant of the Reg. Guide 197 sensors which are the fully qualified ones for the first accident environment.

MR. CARROLL: Where does PAMI come from?

MR. SCAROLA: Post Accident Monitoring Instrumentation, that's the term.

[Slide.]

So, we look at all of the sensors. Now, from here the operator can display any individual sensor, or he can return back to this display where we normally show an analog indication of the value of historical data trends that basically replaces the near-term usage of strip chart recorders, that is the real time usage. The historic usage of strip charts is inside the plant computer on optical disks, which is a permanent storage medium.

MR. MICHELSON: Will this be a safety grade computer now?

MR. SCAROLA: Yes.

MR. MICHELSON: Okay.

MR. SCAROLA: This is.

MR. MICHELSON: No, I'm talking about the process computer, you said you stored --

MR. SCAROLA: The one for the CRT displays is not a safety grade computer, that's where we draw the distinction.

MR. MICHELSON: No, but the historical data, you have said this is the display, but you're storing everything else in a computer.

MR. SCAROLA: Yes, that is non-safety grade.

MR. MICHELSON: That's a non-safety grade computer, so that's all lost under certain kinds of circumstances, like loss of power supply or whatever.

MR. SCAROLA: We're maintaining the real time information. Well, when you say it's lost, no, I don't want to say that. You never lose the data you have recorded because it goes onto the optical disks which is a permanent media, but from the point that you lose the computer, from there forward you will no longer retain historical data.

MR. MICHELSON: You no longer have it.

MR. CATTON: On your optical disk, if I attempt to restore on top of information that's already there, what happens?

MR. SCAROLA: Oh, if you attempt to rewrite, no, they're write once disks. You write once.

MR. CATTON: I hear you, but what if you write twice.

MR. SCAROLA: I'll look into it, I don't have the answer.

MR. CATTON: You know, I guess --

MR. SCAROLA: I don't think you can --

MR. CATTON: The reason I asked this is that I have a fancy hard disk in my computer that you're not supposed to do that to --

MR. SCAROLA: Yes.

MR. CATTON: -- but I had a program for backup that didn't know it, and now I don't have anything on my hard disk.

MR. SCAROLA: I think it's a valid question.

MR. CARROLL: We should point out that Dr. Catton is a klutz when it comes to mechanical things.

MR. CATTON: My son says the problem is I don't read any of the instructions and I don't even read the screen.

MR. MICHELSON: Let me go back a minute to the plant process computer. For present day plants is non-safety grade, generally, and not necessarily on good power supply, often out for maintenance, whatever, it's just not treated well because people don't seem to worry about it, so when an event comes along it turns out almost whenever you want it it's not there. Should this be the way we do future plants?

MR. SCAROLA: That's not the way we're doing this design. We have --

MR. MICHELSON: Maybe I misunderstood then.

MR. SCAROLA: We have a computer system that is a 100 percent redundant. It has a segmented architecture as well that allows you to take pieces of it out for maintenance and leave the rest of it in operation. If you look inside the control room picture there are about fifteen CRT displays inside the control room. So, there is a significant emphasis on the reliability of that plant computer.

MR. MICHELSON: Now, this is the plant process computer, the one that present day plants call non-safety?

MR. SCAROLA: Yes, it is a non-safety piece of gear, but we're not designing it to the same criteria.

MR. MICHELSON: Okay, how do you power it?

MR. SCAROLA: You power it off of battery bus, separate battery busses, there's a fully redundant computer system, we have a x-channel and a y-channnel, those are the non-safety designations, the x-power supply is independent of the y-power supply, and the x-computer is independent of the y-computer.

MR. MICHELSON: Are they both in the same cabinet then ultimately?

MR. SCAROLA: No, they're not in the same cabinet, they are in the same room, but the room is HVAC.

MR. MICHELSON: Okay, so, on a case of a power blackout even, are these battery backups coming from the qualified part of the system, qualified batteries or non-qualified.

MR. CATTON: Or does the computer have its own?

MR. MICHELSON: This computer does not have its own battery sources, no, it relies on the safety instrument battery buses.

MR. MICHELSON: It is using the station battery then, not the vital batteries.

MR. SCAROLA: It uses the non-vital instrument battery, right, and those batteries get recharged during a blackout from the gas turban generator.

MR. CATTON: Do these computers have an internal interrogation to see that they're upgrading properly?

MR. SCAROLA: Yes, not only that.

MR. CATTON: Is it automatic?

MR. SCAROLA: Yes, it's completely automatic. The other thing I'll point out is that this computer is doing its own dataprocessing, single validation alarm processing, etc., it's also continuously looking at the same calculations that are being performed by these computers, and then that main computer will enunciate that there are discrepancies if they exist, and the logic that goes into that is basically designed to tolerate a little bit of skewing and time because they will not be updating exactly simultaneously.

MR. MICHELSON: Let me pursue the battery a little further. Now, these are non-vital, it means it's non-1E battery banks that they're using, is that correct?

MR. SCAROLA: For the CRT, no --

MR. MICHELSON: So, therefore it's non-seismic and so forth, not necessarily physically separated from the fire viewpoint and sort of thing either since they're not in the set that you normally talk about for separation.

MR. SCAROLA: Not physically separated from each other, but definitely physically separated from the class 1E batteries.

MR. MICHELSON: Oh, yes, I hope so.

[Slide.]

MR. SCAROLA: The intent of the design, if I go back and look at the panel, is that the operator has all of this information both qualified and non-qualified at his disposal all the time and he will actually be using it all on a day to day basis. He'll be using his specially dedicated information very frequently because that's the simplest for him to access. The alarms are easy to get to, he looks up and he sees the indicator, he will be relying on those.

During an accident the operator will use whatever is in front of him. If the CRTs are working he will use them, but the indicators are the ones that are fully qualified and he will be familiar with them because he uses them every day.

That's basically the difference between the philosophy for this control room and the philosophy that we have inside existing control rooms where we have dedicated backup instrumentation that the operator really doesn't use on a day to day basis.

[Slide.]

MR. SCAROLA: Let me just show you the CRT displays, and I don't think I'm going to be able to show you much. There are --

MR. MICHELSON: Let me get a clarification on that panel again. If I've got a four-train system, do I have four separate tiles, one for each of the trains?

MR. SCAROLA: No. Let me show you. These are multi-channel sensors that are being looked at simultaneously by both computers, one computer that's operating the electro-luminescence displays, the second computer that's operating the CRT displays. All safety channels and non-safety channels are looked at together, and then the displays are completely independent and redundant.

MR. SCAROLA: Well, how about the electro-luminescent panels? How many of those are there -- one for each train, or --

MR. SCAROLA: For this particular parameter, which is RCS hot leg temperature --

MR. MICHELSON: Well, let's talk about safety.

MR. SCAROLA: Okay.

MR. MICHELSON: Things where you're monitoring safety situations.

MR. SCAROLA: There is a small set of parameters defined by Reg Guide 197 as Category I Parameters. For those, there is a second set of dedicated displays that look exactly like this that simply continuously display that handful of Reg Guide 197 Category I Parameters.

MR. MICHELSON: Is that on this same panel?

MR. SCAROLA: No. If I go back to the control room, it's in the back. It's in one of the auxiliary panels on the back left-side of the control room. It's what we call the safety monitoring panel.

MR. MICHELSON: You have t walk over there to look at it? Is that it?

[Slide.]

MR. SCAROLA: In the event that all of this information fails, the CRT fails --

MR. MICHELSON: Well, I'm just going to let the electro-luminescent panel fail, which I assume there are failure modes for it.

MR. SCAROLA: Okay. If the electro-luminescent panel fails, then the same exact information is accessible on the CRT from that exact panel.

MR. MICHELSON: Well,I don't know that. It depends on where the power is coming -- and that's a non-qualified CRT, so I don't know where its power is coming from.

MR. SCAROLA: I agree if they both fail, the third source is in the back of the control room.

MR. MICHELSON: So, I suspect there are single failures for which both the CRT goes and one of the panels?

MR. SCAROLA: No.

MR. MICHELSON: No?

MR. SCAROLA: No. No single failures. They are completely independent. All of the instrumentation that feeds --

MR. MICHELSON: They're powered from yet another source somehow?

MR. SCAROLA: Yes.

MR. MICHELSON: Okay.

MR. SCAROLA: These are powered by the vital batteries; these are powered by non-vital batteries.

MR. MICHELSON: Okay. Okay. So it would only be -- okay. Okay. But if it were, then there is this back-up for these few essential parameters?

MR. SCAROLA: Yes.

MR. MICHELSON: Is it located facing the operator, or is it on the back-side of a panel?

[Slide.]

MR. SCAROLA: No, it faces the operator. Let me get back to a picture so I can show it to you.

MR. MICHELSON: Okay. I'll take your word for it. That's okay. I take your word for it.

MR. SCAROLA: It's inside the horseshoe.

MR. MICHELSON: Okay, it's within the horseshoe.

MR. SCAROLA: Yes.

MR. MICHELSON: All right. Thank you.

MR. SCAROLA: Okay. So that CRT display that I was showing, which I don't think I'll be able to show because it's so dim, is a function-based CRT display. That one was designed to maintain the inventory control function. On that display, it's got --

MR. MICHELSON: That's this one?

MR. SCAROLA: Yes. It's got a minimum set of parameters that are indicative of the performance of that critical or the status of that function.

In addition, there are all of the systems, or what we call success paths, that are used in maintaining that critical function. There is one of those for the nine safety functions, and we've got those same nine as well as an additional three power production functions, and there are displays for each one of those.

Now, in addition, the operator can page down and get CRT mimic displays of every fluid system in the plant. So if, for example, the inventory control is supported by safety injection, he can page down and get a mimic of the safety injection system and get detailed status of every pump valve and instrument in that system.

MR. MICHELSON: Now, this control panel, this NUPLEX control panel, which you showed me some of the electro-luminescent panels also, there are control functions performed from there, and I guess that's all the little back-lit push-buttons at the bottom or something?

MR. SCAROLA: Yes. We have the philosophy to separate monitoring from controls. So all of the controls are on the desk section. There are two types.

MR. MICHELSON: But they are all at that location.

MR. SCAROLA: Yes. We use electro-luminescent again for the soft controls that you see there, which are the process loop continuous controls, what we used to call PID controllers, proportional integral derivative controllers, and the push-buttons are for the on/off, open/close functions.

MR. MICHELSON: Now, if I have a four-train system, then I have four electro-luminescent panels across?

MR. SCAROLA: Yes.

MR. MICHELSON: And there's a set of controls associated with each of those down on the desk?

MR. SCAROLA: Yes. We are maintaining electrical independence of all the channels inside the control room.

MR. MICHELSON: And there is some physical separation within the cabinet, or is that a requirement?

MR. SCAROLA: Physical separation to accommodate the voltage levels that we have, which are all low-voltage signals inside the panel. We are taking credit for the remote shutdown panel, which I'll show in the next set of slides, for catastrophic events such as fires.

MR. MICHELSON: Now, there's got to be some fair amount of power cabling within that cabinet, right, for that CRT and so forth?

MR. SCAROLA: When you say "power," you mean voltage level, that type of power?

MR. MICHELSON: Yes, and 15, 20, 30 amps circuit, that sort of power. Those CRTs are big and they require a fair --

MR. SCAROLA: Yes.

MR. MICHELSON: So you have an energetic source in there to ignite a fire within that cabinet?

MR. SCAROLA: Yes, that is true.

[Slide.]

MR. SCAROLA: Let me show you the physical separation and isolation that we have in the entire control complex. We talked extensively about the main control room and the technical support center. Supporting that, we have the computer room, we have the remote shutdown room, four safety-related equipment rooms, and one non-safety related equipment rooms.

All of these rooms are physically separated with fire barriers and separate security, and all of the data communication between the room is fiber optic interfaces.

MR. CARROLL: What's the fire barrier?

MR. SCAROLA: Three-hour fire barriers. What is it physically?

MR. CARROLL: Okay. So your use of the word "fire barrier" means the classical three-hour fire barrier?

MR. SCAROLA: Yes. Three-hour fire barriers. That's what we're using.

MR. MICHELSON: Three-hour fire doors and the works? All the electrical penetrations, as required, will be three-hour?

MR. SCAROLA: Certainly in the safety area. I would have to look a little bit more closely in the non-safety area.

MR. MICHELSON: Wait a minute. We're just trying to understand what you're trying to tell us. You know, say it right whatever it is.

MR. SCAROLA: Well, you're asking a level of detail that I don't --

MR. MICHELSON: When you say it's a three-hour barrier, do you mean three-hour electrical penetrations as well as ventilation penetrations and doors, the whole works? Is that what you mean, or do you just mean the wall is three-hours?

MR. SCAROLA: That's the intent. Whether or not that is fully carried through in the design, I have to look at it in more detail.

MR. MICHELSON: Okay. Because there may be a one-hour door on a three-hour wall, for instance.

MR. SCAROLA: Right. I would hope not. I hope not.

MR. MICHELSON: Well, it's not uncommon. People put concrete in for other reasons.

MR. CARROLL: Yes. There is also the issue of heat going through a three-hour barrier and effecting what's on the other side, and smoke and things like that.

MR. MICHELSON: We haven't gotten into the ventilation system at all. He didn't say they're going to ventilate all those from --

MR. SCAROLA: We talked earlier about the importance of verification and validation -- excuse me.

MR. KENNEDY: If I could, Mr. Chairman, we've got about 35 minutes left. How would you like to split the remaining time. Would you like to continue this discussion? I'm just looking a little -- we have some severe accident discussion and we have our PRA discussion. If you're interested, we can try to squeeze it in. If not, we can continue with the remaining time on I&C.

MR. MICHELSON: We have to hear the others, too.

MR. WYLIE: I don't know that we're going to gain a great deal by continuing with the I&C because we're going to have -- I mean, that's a lot of detail, it looks like to me.

MR. KENNEDY: I think we're going to spend some more time on this in the future, but I don't want to cut you off too soon if this is really of value to you.

MR. CARROLL: Well, I guess I agree with Charlie. Just to get a flavor of the whole thing, is there a couple of minutes you want to summarize in, and then we'll pick up the severe accidents, or tell us what you're going to talk about next time or something?

MR. SCAROLA: The only issues that we have not addressed, the ATWS issue, and I can say that we are meeting the criteria and we have extensive diversity in the design; and the other one is the station blackout criteria, and there, we talked already about the alternate AC source, which is a gas turbine generator.

MR. CARROLL: Yes. We're generally familiar with that.

MR. SCAROLA: So, I think that's it. We're all set.

MR. CARROLL: Okay. Be ready for some good V&V questions next time.

MR. SCAROLA: Thank you very much.

MR. TURK: I might point out that we do have working mark-ups of this material in Windsor, the panels that he showed in the 35 millimeter slides, and the staff will be visiting to look at that material, and certainly, if subcommittee members had occasion to be in Windsor and would like to see that, that could be arranged.

MR. CARROLL: Just one free comment. Don't make them white. They get too dirty in a control room.

[Slide.]

MR. TURK: I think 35 minutes for today is briefly acquaints you with the containment design, especially with regard to severe accident features, then Bob Jacquith will give a short run-down on the PRA results today, and then Ernie can summarize quickly.

[Slide.]

MR. TURK: As was pointed out earlier, the base design that we're using is the Cherokee/Perkins containment design, which is a steel spherical containment, not unlike the Yellow Creek containment. We spent a lot of time in that decision working with EPRI, as you may be aware. The EPRI base design is also a steel containment, but in a cylindrical geometry. Our feelings were that the increased access and maintenance room at the operating floor and several other reasons led us to that preference.

MR. CARROLL: I think most of us have heard a presentation on the containment.

MR. TURK: All right. That is true. That was part of the containment presentation. So, let me focus, then on severe accident-related features of that containment design.

[Slide.]

MR. TURK: They are basically inherent, first of all, in the large free-volume of the sphere, and the overall openness and venting of the sphere region. If you look at a cross-section of the containment and the structural walls within it, you can see that it's a relatively open containment that allows for fairly free natural circulation throughout the sphere. You can all see here the in-containment refueling water storage tank.

MR. CARROLL: Is it intended to use igniters anywhere in this containment?

MR. TURK: The current design would show that for the NRC criteria of, right now, 100 percent of the clad mixture and the 10 percent detonability limit, we would need igniters in the containment. Moving with, the EPRI criteria would be such that 75 percent and 13 percent would allow not using igniters.

MR. CARROLL: Well, you would probably need them in things like the refueling water storage tank, don't you?

MR. TURK: In the vent area, yes. The vents for in-containment refueling water sto:age tank.

MR. CATTON: Do you make any assumptions regarding where the hydrogen is, or do you assume that it's fully mixed throughout the volumes?

MR. TURK: Depending upon the event, yes, there are assumptions. It was pointed out, in a vent that resulted in the discharge to the in-containment refueling water storage tank, prior to any failure, the hydrogen would be generated in the tank, released as the coolant was released. I don't know; can you speak to the assumptions as far as the map code in hydrogen generation --

MR. CATTON: You don't have to. I know what the map code does. The assumption that the hydrogen is mixed within the volumes is not correct. You certainly are going to have stratification of hydrogen in your containment, and I think somehow you're going to have to come to grips with that.

MR. MATZIE: This is Regis Matzie again. There was a special study of the hydrogen mixing issue by the advanced reactor/severe accident program, probably now on the order of a year, year and a half ago, for this particular design. And. that study showed very good mixing within the major part of the containment, but that there was high concentrations in the area of the IRWST for those scenarios where you were venting into the IRWST, such as station black out. There is very good natural circulation, very open containment, so we would expect with the lower limits with the EPRI program has proposed, that overall containment would not need igniters, but there would be some requirement for localized igniters in the areas where the stuff would be concentrating because of the scenario.

MR. CATTON: Are you familiar with the study that was done for NRC by the National Academy?

MR. MATZIE: I personally am not.

MR. CATTON: It's interesting. It was a very good study, yet nobody seems to know about its existence. In any event, one of the first things that they note is that when you release a mixture of hydrogen and steam, hydrogen will stratify. It's not "it might" or "it could;" it will. Second, there is experimental data available through the HDR containment in Germany, which you guys probably know about, where they have measured significant stratification. Now, I know that NRC talks about it being mixed, and I have read what Fauske & Associates did for EPRI, but somehow they're avoiding the fact that the stuff's going to stratify. When it stratifies, it escapes very strongly.

They had circumstances where the hot air/steam/helium mixtures in the HDR facility got into the top of the building and it was days -- you could walk and reach up and stick your hand into the region where it was extremely hot, and yet you were comfortable down below. And that's how strong the stratification was. I just don't see anybody dealing with it and NRC not requiring it. And I'm gonna harass you forever about the stratification, unless there's something that really demonstrates it won't occur, some reason for it not occurring. I'm familiar with some of the testing that was done early on by EPRI, but it was in the kinds of chambers where you would expect there to be mixing. If you say you're always going to have your sprays on, sprays will keep it mixed, but by itself, it ain't gonna be mixed. You agree with that, don't you?

MR. CARROLL: I believe I do, Dr. Catton. I think somebody's hiding their head in the sand on some of this hydrogen issue myself.

MR. CATTON: Too many things have blown up. Not in the nuclear business.

MR. CARROLL: Including a couple of utility generators that have had hydrogen leaks that I've been familiar with.

MR. CATTON: Buoyancy driven flows are, generate very strong stratified flows. There is an example at Edison where they had, it was just the insulation was off a pipe and the heated plume went all the way up 20 or 30 feet without mixing with the surrounding air and cooked the cable tray. Any of the kinds of calculations that you guys might do would not show that.

MR. TURK: I think to quickly go through these prior to presenting the PRA results, the other aspects of the containment design that you may recall from having seen it before is the fact that the cavity design is such that a large floor area is provided to facilitate coolability. Again, we've used the guidelines that have been developed during the ALWR program of about .02 meters per megawatt. There's a flood capability from the in-containment refueling water storage tank to that cavity for coolability and there's also --

MR. CARROLL: How does that work? Does it flood it before the core's on the floor, or floods it after, or thermal fuses?

MR. TURK: The design we're working on, it is in the state of work, would allow for operator decision. It would not be an automatic flooding system. That's consistent with the current EPRI requirements. It is an issue as part of the DSER on the EPRI Chapter 5. So I think that is an open design issue right now.

MR. CATTON: Does this mean that you're going to let EPRI make the decision for you?

MR. TURK: No, I didn't mean that, but it means that we will be working with EPRI on the decision. We are part of the EPRI program. We are a contractor to EPRI on the EPRI program. So, we have been, I think, relatively successful in the EPRI program of reaching consensus decisions on most things; there have been a few exceptions where we have --

MR. CATTON: Well, there's the consensus on the hydrogen that I think the consensus is not right. And I'm a little concerned about this water, when you're going to put the water, because if you put it after, there's some question about the formation of crusting and everything else so that the water really doesn't do you any good. If you put the water before, can you stand the rapid steam generation, the rapid pressurization and maybe even the possibility of having steam explosions that might do some damage, not that the damage would be --

MR. TURK: And a factor in that is whether or not sprays are available in the containment when that's going on.

MR. CATTON: Right, so there's a whole lot of factors. There's the wind.

MR. TURK: Which leads us to the accident mitigation question that Mr. Ward brought up earlier, that this is an issue of, and as I say, the current design bases is that it's an issue of a vent condition that will probably have to be evaluated, and we're talking in terms of providing a capability that has to be directed.

MR. CATTON: Having, essentially, a steel sphere, are you concerned about the problem the Mark 1 has, the Mark 1 reactor, Mark 1 containment?

MR. TURK: The problem being?

MR. CATTON: The problem being that the molten core hits the liner.

MR. TURK: Bill, do you want to address? I'll put the picture up here for you to speak to.

MR. CATTON: I'm not familiar with layout in the building and where it is.

MR. TURK: This is the cavity area that we're talking about, and this being the floor area.

MR. CATTON: What is the blue?

MR. TURK: The blue is concrete. Okay, Bill?

MR. FOX: My name's Bill Fox, with Duke, working with CE on this design. The blue area shown is inside containment concrete. The cavity that's on the picture there is where the core would be disbursed into. As shown, going up the right hand side in the very laborious fashion, a vent path for the pressurized release. Also, on the right side just above the bottom of the cavity there is what we call a core debris chamber that entrains heavy core material back down into the bottom of the reactor vessel cavity while allowing the hot gases to go out. Once it releases out of the reactor cavity itself, it then goes into open containment and the crane wall is completely circumferential around the cavity and the steam generators which will, again, provide a separate protected area from containment contact.

MR. CATTON: All those surfaces are concrete?

MR. FOX: That is correct. Or, lined concrete with stainless steel. And the bottom, I believe, is 5 feet below the vessel of concrete cover before it gets to the containment, which is continuous through, and sandwiched in between the interior and exterior concrete.

MR. CATTON: What corrosion --

MR. FOX: With stainless steel plates, it's not a concern.

MR. CARROLL: You're thinking of the outside surface of the containment shell?

MR. CATTON: Yes. The containment shell is sandwiched in concrete.

MR. CARROLL: That's not a problem if you build it right. It's just looking at all your fancy arrows that one would almost assume that you knew what you were doing. The flow processes are very complicated.

MR. CARROLL: What he's accomplishing is, he's going to burn a vent in the top of the containment valve there.

MR. CATTON: At the tip of that arrow is where all of the hydrogen is going to be. You ought to think about that.

MR. TURK: I think the only remaining feature is the depressurization system which we did talk about earlier. So I'd like Bob Jacquith to just go through quickly the DRA results we have to date.

MR. CATTON: Is this anything like that Italian guy, Petrangeli's super system saver? Or are you familiar with that?

MR. CARROLL: Suppose the O2, -- I always get the units mixed up, meters squared per megawatt thermal isn't enough, do you have room?

MR. MATZIE: Regis Matzie. This was an integrated effort and that was an extension of the cavity quite a bit to get that floor area. It would be very difficult to get a substantially greater amount if that criteria was not acceptable.

MR. CATTON: I think that criteria leads to 30 centimeter deep pool of molten whatever on the floor.

MR. FOX: Phil Fox again with Duke. I believe the criteria for this particular design allows for a nine inch bed of core material with this particular surface area we allotted for.

MR. CATTON: What are you going to do if the criteria is not acceptable?

MR. CARROLL: Go to a cylindrical.

MR. CATTON: The criteria basically says that it's coolable, that you can flush it.

MR. FOX: We would have to go back and revisit that. It took a tremendous amount of iteration to get there and relaying all the requirements and coupling them together with all the accident issues to come up with that design. If that criteria is not accepted, we would have to go back and revisit and see what we can come up with.

[Slide.]

MR. JACQUITH: My name is Bob Jacquith and I'm supervisor of the reliability and risk assessment group. And I'm going to try to do the short version here.

We are still working on our PRA, the objectives of which were to comply with the severe accident policy statement to provide a level 3 PRA for a System 80+. As a part of that, we are demonstrating compliance with a 10 to minus five core belt objective, 10 to minus six large release objective, and demonstrate adequate containment performance reliability.

And moreover, as a part of the design process, PRA integrated pretty much into the design process.

[Slide.]

MR. JACQUITH: The approach that we used was to perform a baseline PRA per system 80. That was the CESSAR System 80 design. This being an evolutionary design, the design evolved from System 80 and the PRA did also in lock step with the PRA.

And again the design changes were evaluated using PRA and the ultimate product here for the PRA will be a level 3 PRA.

[Slide.]

MR. JACQUITH: Where we are as far as internal events goes for the PRA is that we have calculated that the core melt frequency is less than 10 to minus six for internal events and you can see here that we are dominated really by three things.

The vessel rupture which we consider to be conservatively large. We have just not worked to cut that down at all. ATWS is still an important contributor.

MR. CATTON: What did you do with the human factors in this? It's not in?

MR. JACQUITH: Pardon me? We modeled the human interaction the same --

MR. CATTON: Traditional approach. Seven times 10 to the minus seven is a pretty low number.

MR. JACQUITH: This is for internal events only. It is a very low number. That's right.

MR. CATTON: It's one of the lowest I think I've seen. It borders on the unbelievable.

MR. CARROLL: How about Seal LUCA? Why is that not a problem?

MR. JACQUITH: Seal LUCA --

MR. CARROLL: Is it encompassed by the small LUCA?

MR. JACQUITH: It is encompassed in the station blackout analysis.

MR. CARROLL: In the station blackout. Do you have a separate source of power for the seals, for seal cooling?

MR. JACQUITH: No, we don't, but, we've got an auxiliary AC power supply. I want to go on a little bit.

MR. MICHELSON: Let me ask, why is the vessel rupture a higher probability than a pipe break, even a small pipe break?

MR. CARROLL: A small LUCA doesn't lead to core damage.

MR. MICHELSON: These are just frequency of occurrence?

MR. CARROLL: No, no.

MR. JACQUITH: This is core damage, excuse me. This is core damage.

MR. MICHELSON: This is a core damage. All right. That could be right.

[Slide.]

MR. CATTON: Have you defended these numbers in front of the staff yet?

MR. JACQUITH: We have presented the Level I.

MR. CATTON: Those are the numbers you have up here?

MR. JACQUITH: Pardon me?

MR. CARROLL: The numbers you had. You have new numbers now. Do you believe them?

MR. SINGH: We just received the submittal a couple of months ago, and we just started looking at it.

MR. CATTON: I'd be very interesting in hearing what you have to say about numbers like ten-to-the-minus-ten.

MR. SINGH: Yes. Of course.

MR. MATZIE: Regis Matzie. I guess I should point out that we had the baseline System 80 PRA submitted quite a while ago, and it was reviewed I guess by Brookhaven National Laboratory in addition to the staff, and have fed back all their feedback in terms of the methodology and the results and incorporated it into the System 80+ PRA.

So, there has been a lot of scrutiny on methods and on approaches for the System 80 calculated numbers, and we have incorporated that into the System 80 plus.

MR. CATTON: I don't think people ever really questioned the methods used in PRA. The bottom line, if you put in the same numbers, you usually get the same answer. What people question is the numbers you put into it, and when you get numbers like ten-to-the-minus-ten, where in the hell did you get the input to get a number that's ten-to-the-minus-ten. I just don't believe it. It's too small unless there's something really unique about your system.

We're going to have some interesting explorations, I think, in the future with you guys.

MR. MICHELSON: These are interesting.

MR. CARROLL: They do not include the traditional sabotage or cognitive human error kind of stuff.

MR. JACQUITH: Excuse me?

MR. CARROLL: These numbers on the previous slide do not include sabotage or cognitive human error?

MR. JACQUITH: That's correct. Well, they do not include errors of commission, correct.

When we include the external events of seismic events and tornadoes, our core melt frequency is one-point-six times ten-to-the-minus six.

MR. CATTON: I haven't seen fire yet. I think that's supposed to be an external event.

MR. JACQUITH: Well, there is a footnote here that we have not explicitly modeled fire or flood --

MR. MICHELSON: Yet.

MR. JACQUITH: -- and that --

MR. CATTON: He didn't say yet; he just said he didn't do it.

MR. MICHELSON: Well, I assume you're going to do it.

MR. JACQUITH: We provided a position paper to the staff about a year and a half ago. Based on the fact that the new design requirements with regard to fire and flood are much more severe than they were ten years ago, and the specifics of our design, which are very unusual isolation between the quadrants under the containment, so that it was justified, we feel, that the frequency is so low that it need not be specifically --

MR. MICHELSON: I thought the licensing basis agreement said you were going to do it, but maybe I didn't read it carefully.

MR. CARROLL: Can we get a copy of the position paper? Can somebody send it to Med?

MR. JACQUITH: Yes.

MR. CARROLL: On both issues, because both of them are of interest to us.

MR. JACQUITH: Okay.

MR. CATTON: Is the heating ventilation system separate for each of these quadrants?

MR. JACQUITH: Yes, it is.

MR. CATTON: So you have four of them, four independent systems?

MR. JACQUITH: There are certainly two independent systems, and each of the -- the answer is yes, there are four.

MR. MICHELSON: And there is no common building ventilation that, for normal operation, ties the two together? That's really what he's asking, I think.

MR. CATTON: Yes. I think so, too.

MR. MICHELSON: Some people have come up with that. Some said, "No. We're going to keep ventilation totally separated, even the normal ventilation." You haven't said that either way yet.

MR. JACQUITH: I'm pretty sure that --

MR. KENNEDY: That's correct, we have not set it either way yet.

MR. MICHELSON: That issue is where you start worrying, then, about heat and smoke from fire going through the back way and heating up other rooms. There are a whole lot of issues that really haven't been addressed here at all yet, but we'll get to them.

MR. CATTON: Are you going to write that down on your list?

MR. MICHELSON: Well, certainly fire will be addressed. But I thought it was, and I'm just trying to find again in here why I got misled.

MR. CARROLL: Yes. I came away with the same impression you did.

MR. MICHELSON: Yes. I must have got misled when I read it, or I was sleeping probably.

MR. EL-ZEFTAWAY: Page 31.

MR. MICHELSON: Thirty-one.

[Slide.]

MR. JACQUITH: Additionally with regard to containment performance, one of the staff's issues is containment performance, and we are attempting to demonstrate the ruggedness of the containment design by predicting the reliability for severe accident sequences. The notion here is that the frequency of large releases ought to be on the order of attempt or less of the core melt frequency.

That is a goal that we probably can meet. Whether that's the right thing to do or not isn't quite decided yet. We aren't quite far enough along.

MR. CARROLL: What are the arguments pro and con since we're also wrestling with this question?

MR. JACQUITH: Well, one argument is, as you've already pointed out, our core melt frequency is very low, and there is a requirement -- you know, the inverse of the requirement is that the core melt frequency has to be at least ten times higher than large-release frequency, and we could cause that to happen, but we probably shouldn't.

There are some decisions to be made with regard to diverse containment heat removal capability. That is an issue that we're still wrestling with. Whether that's required or not -- it might be required in order to meet that ten-percent requirement, whereas to meet the ten-to-the-minus-six requirement, it probably is not required.

MR. CARROLL: If, instead of the tenth, you did your "or," what deterministic analysis do you think would be appropriate?

MR. JACQUITH: Well, we've already demonstrated, I believe, two things. One is that within the PRA, 97 percent of the core damage sequences, the containment holds together for at least 24 hours, okay. That's one.

MR. CARROLL: And why is 24 hours good enough?

MR. JACQUITH: I'm not saying it is. I just said that's a fact.

There's another. The NRC has proposed a requirement or a sort of a proof of principle here, maybe, that Level C stresses not be violated for 24 hours, and I believe that we're on the edge of demonstrating that right now.

MR. MATZIE: This is Regis Matzie. That alternate or "or" category of potential criteria was listed in the EPRI Chapter 5 draft SER from the staff, and we have been looking at whether that would be an acceptable alternative to the conditional failure probability. It looks as if that could be achieved, too.

MR. CARROLL: One in ten bothers me from the point of view that we're discouraging people from doing the right thing. If you think you got it bad, think of the poor high-temperature gas cool guys.

MR. MICHELSON: Let me point out why I got misled on fire, and I think I haven't -- I think you have not stated it correctly, or whoever wrote the licensing basis agreement.

On page 20, you talk about the PRA, and there it says that the System 80 probablistic risk assessment will be a Level III PRA which addresses both internal and external initiators of accident sequences which lead to core damage.

Now, you did take one exception further down the paragraph. You said sabotage would not be addressed. Nowhere did you take exception to fire not being addressed.

MR. MATZIE: In the middle of the paragraph, it says "External events [seismic events and tornado strikes only]."

MR. MICHELSON: Well, that's relative to the bounding plant site characteristics. On a site, sure, you worry about seismic and tornado and not fire, but on the plant itself, when you do the PRA, you worry about fire. I read that as something you did with the site only.

MR. JACQUITH: The fact is that we really did consider fire and flood and tsunami and sand slides and --

MR. MICHELSON: We're just interested in internal fires now.

MR. JACQUITH: No, I understand that.

MR. MICHELSON: Okay.

MR. JACQUITH: But you mentioned there, you quoted chapter and verse, that we were considering a whole bunch of external events. Well, we did consider them and we wrote a position paper that basically put some of them to rest.

MR. MICHELSON: I guess you should have taken fire as an exception, then, because you did take sabotage as an exception.

MR. KENNEDY: This is Ernie Kennedy. I agree I think we should clarify the LRB.

MR. MICHELSON: Yes.

MR. KENNEDY: Our intent was that fires would not be there, and if this is misleading, we ought to fix it.

MR. MICHELSON: Well, it sure doesn't say that fires aren't there because that's not a part of the bounding -- the bounding plant site characteristics -- sure, that's a different issue. That's external fires.

MR. CATTON: Did the NRC staff accept your position paper?

MR. SINGH: No, the staff has not accepted what is written in the LRB, and you will be seeing our comments.

MR. MICHELSON: I have not heard the staff ever say they can eliminate fire from a PRA yet.

MR. SINGH: That's right.

MR. CARROLL: What do we do for the last two minutes?

[Slide.]

MR. JACQUITH: Let me show one last slide here, which is the kind of improvements that we got going from system 80 to system 80+, and you can see that we've picked up two orders of magnitude of improvement, there are five slides in your handout that maybe you'll get a chance to look at on your own, and that basically identifies the features that make each one of these things go down, okay.

MR. CATTON: Somehow those things are incredible, you go from ten to the minus five to two times ten to the minus eight on transients.

MR. JACQUITH: Right.

MR. CATTON: That's going to be very difficult to --

MR. JACQUITH: No, I understand, I wish though that we had more time.

MR. CATTON: Well, we will, we will.

MR. JACQUITH: We really did overwhelm these problems with four trains of this, four trains of that, extra electricity, you know, all sorts of improvements, and --

MR. CATTON: But there's a bottom line on every one of the numbers there which is the human --

MR. CARROLL: Or the common mode failure kills you.

MR. JACQUITH: We've had common mode failure in the human model --

MR. CATTON: We are going to be very interested in seeing how you did that.

MR. MICHELSON: In the external event of fire it may kill you, too, because if we believe other people have studied it, it's about half the total contribution, and it's not even in here. So, you know --

MR. CATTON: I am just trying to sensitize you a little bit as to what it will be like next time.

MR. CARROLL: Yes, you didn't even have the mean guys here today.

MR. MICHELSON: We are just the good guys. I think at the next meeting we're going to discuss what completeness of design means also, because we will have to prepare some recommendations to the Commission after our next meeting and that's one of the issues I think the commissioners had better face up to.

MR. KENNEDY: Let me, if I could, just make two very brief closing comments. I put this slide up earlier on the purpose of the LRB. One comment I would like to make on this last bullet, as evidenced by today's meeting our LRB discussed a number of issues for which there's a potential for a lot of dialogue with both the ACRS and the staff. Our purpose in the LRB is to identify those issues and we believe they'll be resolved as part of the review of the application. We think if we use the LRB to resolve the issues then the approval of the LRB may be concurrent with the end of the review. So, we try to avoid trying to use the LRB specifically to resolve the issues, because we don't think we get there from here. We'd like to do that on the application.

MR. MICHELSON: Are you suggesting the LRB be approved at the end of the game instead of the beginning?

MR. KENNEDY: No, I'm suggesting it be approved at the beginning, but to do that you probably can't resolve the issue in the LRB, you have to identify it there, and the resolution comes as part of the technical review of the application.

MR. MICHELSON: What good is an LRB approval then if we leave all the really important things out because they haven't been resolved?

MR. CARROLL: It's the road map as to where you're going that you've agreed to up front. It's agreed that you've agreed that fire is a potential issue, Combustion's position is this, the staff has to come back and take a position.

MR. MICHELSON: Yes, I guess if you want to tabulate issue its purpose could be useful.

MR. CATTON: If it's for a road map it's clearly going to mark the points that you have to get over.

MR. MICHELSON: But having approved such a document and having found out later you left some things off the road map, what does the approval mean?

MR. CATTON: Your last point is that the above is not all inclusive.

MR. MICHELSON: Okay, then you're all right, that's a very good insulator.

MR. CATTON: I don't think approval has any meaning.

MR. MICHELSON: No, and I'm wondering if whether we'll even do it.

[Slide.]

MR. KENNEDY: I would also like to respond very briefly, I did say the end of the meeting I would talk a little bit about essentially complete plant. Let me do that very briefly and I'm sure we'll have to continue this discussion later.

MR. MICHELSON: Is this the slide we have?

MR. KENNEDY: No, this is backup slide, but this is quote from part 52, so it's nothing magic. The level of detail or essentially complete plant to us has two dimensions. First, the scope of the plant. I think we've made a pretty clear commitment that the scope of system 80+ is going to be a complete plant, and we heard some comments today that perhaps service water, portable water, to some extent should come within that definition. I think we can talk about that, but there's no doubt we've committed to the essentially complete as far as scope of plant.

With regard to level of detail, this slide is nothing more than a quote from part 52 on what part 52 says about the level of detail. The only point I want --

MR. MICHELSON: Which part of part 52 are you quoting from?

MR. KENNEDY: 52.47[a][2] I believe.

MR. CARROLL: You have seen those words before, Carl, we've had a lot of debate about them.

MR. MICHELSON: I just want to --

MR. KENNEDY: They're in 5247 somewhere.

MR. MICHELSON: Yes.

MR. KENNEDY: The point I wanted to make about this is the way the rule is constructed it distinguishes between the material which is presented to the staff and that which is made available for audit by the staff. It is our intention to present CESSAR-DC, all of the information that the staff will need to close out its safety review. Essentially that means since the staff used the application to the standard review plan, we have to present in the application the information necessary for the staff to make that review or make its finding. So, CESSAR-DC is going to look very much like what you're used to seeing in a FSAR, absent if you will procurement level and as-built data which obviously won't be in there to the extent it's in somebody's

FSAR.

MR. CARROLL: But will it be available for audit?

MR. KENNEDY: That's what I wanted to come to. Because this is an evolutionary plant design, we are fortunate in that much of the detailed design information in a lot of areas already exists in our files. For example, Rick Turk pointed out that within the reactor we have retained a lot of our previous design. All of that design information down to the equipment specs, performance specs, is there, is available for audit. So, we are fortunate that that information exists.

In areas where we have changed the design we are developing the information down to whatever level it's going to take to support the staff and we expect that to be a rather iterative effect, it will depend, I think, on the importance of that particular component, or the importance of that particular system to safety, and the information that we've got. We intend to develop that information to whatever level of detail it takes.

MR. MICHELSON: Will that be at the level that the regulation talks about when it says an essentially complete means of being able to write your procurement spec from it and so forth?

MR. KENNEDY: Yes, but it would be the information you would need to include in the procurement spec to specify the functional and performance requirements of that system for its safety functions. Now, what you might not find, and I say might not because some of it is there, what you might not find is some of our, if you will, commercial requirements which we would impose on that component.

MR. MICHELSON: Well, you don't find a boiler plate, no.

MR. KENNEDY: That's right, you wouldn't necessarily find that boiler plate. Now, in those areas where we have already developed you find that to. We wouldn't create a new document.

That, in a nutshell, is a brief discussion of the level of detail and I think it deserves some further discussion.

MR. CARROLL: ACRS had a lot of trouble with this language when part 52 was going through, and, you know, my problem is that I can take something that I've labelled procurements and I can buy a quality piece of hardware or I can buy a piece of junk, and I'm worried about a whole string of plants having that range of options on hardware.

MR. KENNEDY: Okay, we --

MR. MICHELSON: First of all, of course, there must be enough information with which to write a procurement spec and that's, I think you've agreed that amount of information will be there, and do you agree that that's the criteria one should look at in terms of judging the completeness of design then? Is there enough there to go out and buy the component?

Also, is there enough information to go out and construct the plant? That's the way it was defined originally, and I think that's the way EPRI is still defining it. Essentially complete and ready for design and construction.

MR. KENNEDY: Let me draw a distinction --

MR. MICHELSON: No, no, no, pardon me. Procurement and construction.

MR. MATZIE: Let me tell you my opinion. Regis Matzie. You certainly could not construct a plant based on the level of detail. You've got to do design detail for the items -- the construction level of detail has got to be still done for any of these plants that you're thinking of certifying. We don't think that's anywhere near the level of detail needed to certify the safety of the design, and you've got to have all the minute details to let a craftsman go do the construction. That's not needed to determine safety. There's one level above that, and that's -- we're all struggling with defining what that level is.

MR. MICHELSON: Yes. Do you need to know where the piping is, where the cable trays are to define safety, for instance?

MR. MATZIE: Certainly major allocations of space for important systems, I think that's the answer, for separation, sabotage, fire protection, all the kinds of things you've talked about, sort of, today, the issues you're going to ask to look into in more detail.il. But, you know the specific location of a pipe hanger, no. I mean, you don't need to know that.

MR. MICHELSON: You need to know where all these multi-plexars are located, for instance, around the plant, and where its wiring or its cabling goes from there to the main control room or to the instrument room or wherever. You need to know that in order to do a fire analysis.

MR. MATZIE: I think, in general, that's correct.

MR. MICHELSON: Okay. We're perhaps together.

MR. CARROLL: Okay. So, in order to let these guys go catch their airplane, you'll send Med your list and we'll look it over for completeness?

MR. KENNEDY: Yes. What we would like to do, I suppose, is we would kind of like to work with the committee and the staff to work out, if you will, a series of meetings so we can discuss like topics in a meeting and have the appropriate people here, and kind of look a little bit to the future as far as you'd like to look ahead.

MR. CARROLL: Okay. Well, Med would be the focal point on that.

MR. KENNEDY: Okay.

MR. CARROLL: We've established the same kind of relationship with GE and Westinghouse, so there's no reason we can't with you guys.

MR. KENNEDY: Well, it's good to be here today.

MR. CARROLL: All right. I will say that I thought the presentations today were very first-rate, and we learned a lot.

MR. KENNEDY: Thank you.

MR. CARROLL: Does anybody have anything else to say as they're walking out the door?

[Laughter.]

MR. MICHELSON: Let's talk about the next meeting, but we can do that off the record.

MR. CARROLL: All right. Adjourned.

[Whereupon, at 2:57 p.m., the hearing adjourned.]

REPORTER'S CERTIFICATE

This is to certify that the attached proceedings before the United States Nuclear Regulatory Commission

in the matter of:

NAME OF PROCEEDING: Subcommittee Meeting on Advanced Pressurized Water Reactors

DOCKET NUMBER:

PLACE OF PROCEEDING: Bethesda, Maryland

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

Marilynn Nations

Marilynn Nations
Official Reporter
Ann Riley & Associates, Ltd.

SYSTEM 80+ LRB DOCUMENT

MILESTONES	SCHEDULES
o REVISED INPUT FROM CE	1/22/90
o STAFF REVIEW	IN PROGRESS
o RECOMMENDATIONS TO ACRS/COMMISSION	
- COMMISSION PAPER	IN PREPARATION
o ACRS MEETING	TBD
o COMMISSION MEETING	TBD
o COMMISSION APPROVAL	TBD
o ISSUE FINAL LRB DOCUMENT	TBD

System 80+ ™ Standard Design Licensing Review Basis Document

Presentation To The ACRS Advanced PWR Subcommittee

April 3, 1990

ABB Combustion Engineering Nuclear Power

SYSTEM 80+ ™

E.H. Kennedy,

Manager

Nuclear Systems Licensing

AGENDA

o	INTRODUCTION TO LRB	E. H. KENNEDY
o	SYSTEM 80+ PROGRAM OVERVIEW	R. A. MATZIE
o	SYSTEM 80+ DESIGN & PRA: - TECHNICAL ISSUES DISCUSSED IN LRB - COMPARISON TO SYSTEM 80	R. S. TURK, W. A. FOX, K. SCAROLA R. E. JAQUITH
o	SUMMARY & CONCLUSIONS	E. H. KENNEDY

PURPOSE OF MEETING

- o ACRS Subcommittee Comments on System 80+ Licensing Review Basis Document (LRB)
- o Review System 80+ Design Features

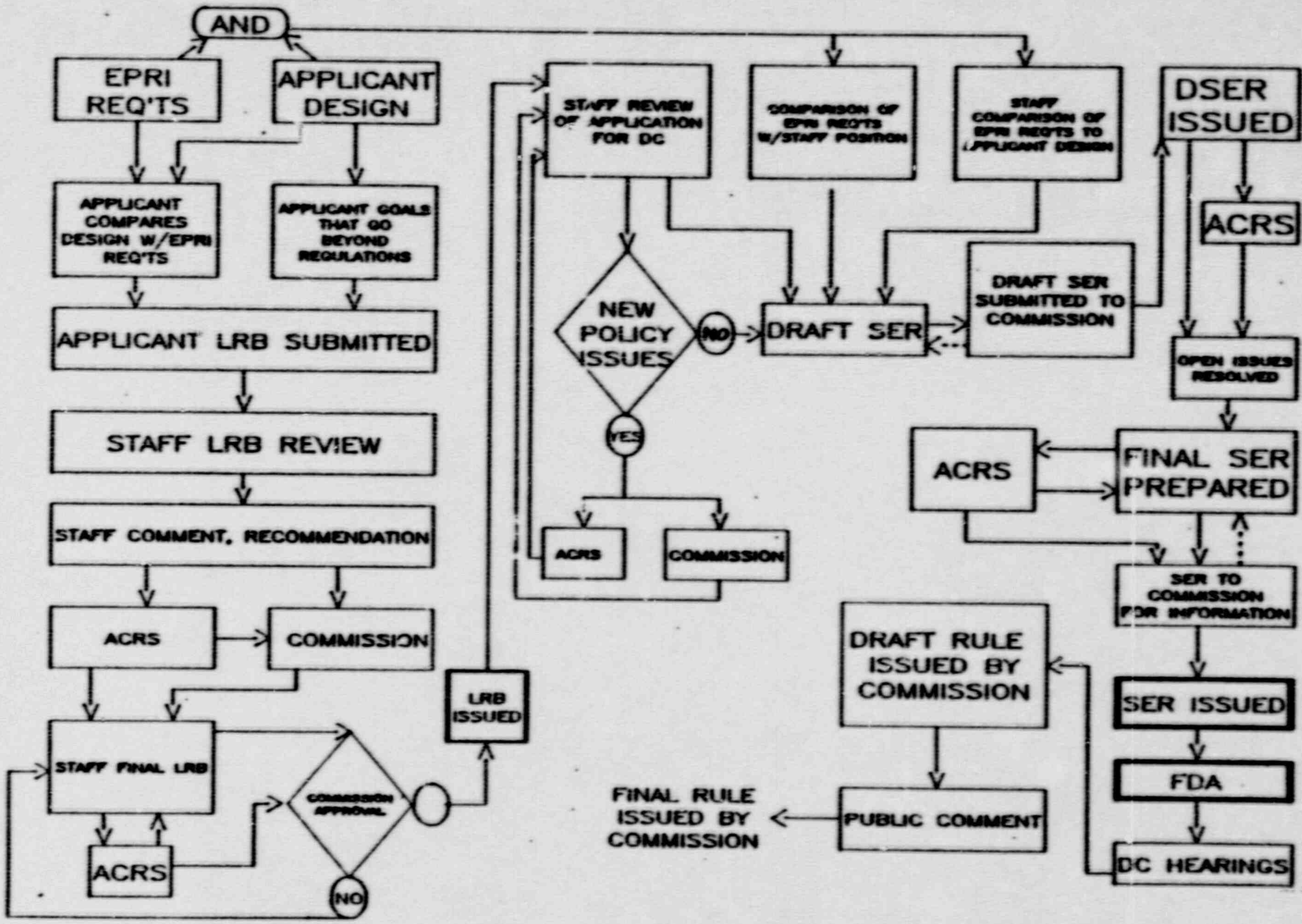
History of LRB

- First Proposed LRB: July 1987
- Several Revisions
  - Issuance of 10 CFR 52: April 1989
- Revised LRB. August 1989
  - Staff Requirements Memorandum: Dec. 1989
- Currently Proposed LRB: January 1990

PURPOSE OF LRB

- o IMPLEMENT PART 52 PROCESS
- o DEFINE SCHEDULE FOR SUBMITTAL/NRC REVIEW
- o IDENTIFY IMPORTANT ISSUES TO BE ADDRESSED DURING REVIEW OF APPLICATION.

DESIGN CERTIFICATION



CONTENT OF LRB

- o SCOPE OF SYSTEM 80+ DESIGN
  - COMPLETE PLANT
- o SCHEDULE FOR APPLICATION/REVIEW
  - COMPLETE APPLICATION 12/90
  - FDA 12/91
  - DC 12/92

8

SYSTEM 80+ APPLICATION FOR DESIGN CERTIFICATION

"CESSAR-DC"

COMBUSTION ENGINEERING STANDARD SAFETY ANALYSIS REPORT - DESIGN CERTIFICATION

SYSTEM 80+™

CESSAR-DC SUBMITTALS NOW COMPLETED:

NOVEMBER 1987 - GENERAL DESCRIPTION
- POWER CONVERSION SYSTEM

APRIL 1988 - REACTOR CORE & COOLANT SYSTEM
- CHEMICAL AND VOLUME CONTROL
- PROCESS SAMPLING

JUNE 1988 - SHUTDOWN COOLING
- SAFETY INJECTION
- EMERGENCY FEEDWATER

SEPTEMBER 1988 - SITE ENVELOPE
- SAFETY DEPRESSURIZATION
- EMERGENCY FEEDWATER

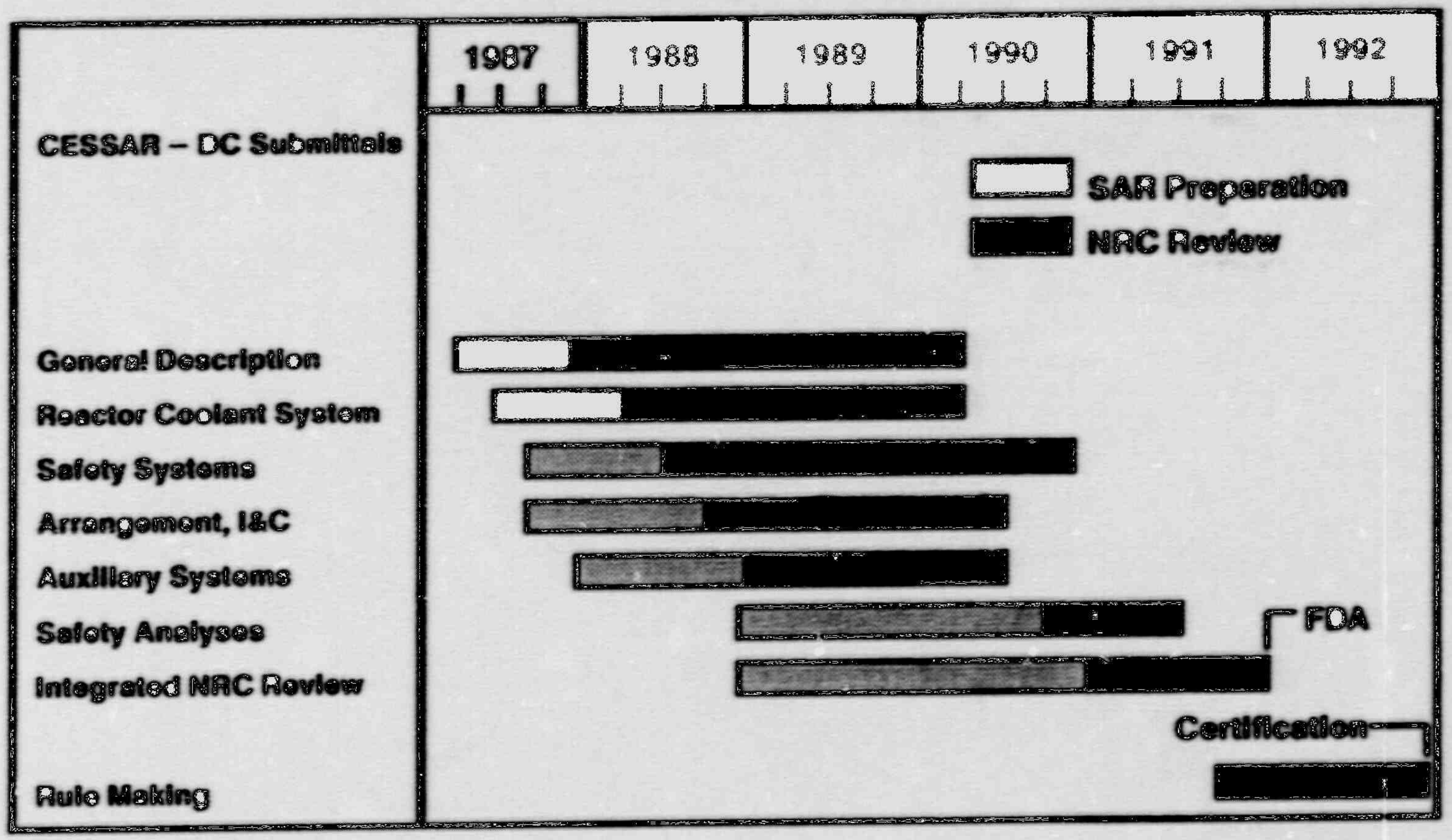
MARCH 1989 - LEAK-BEFORE-BREAK
- BALANCE OF PLANT SYSTEMS
- ELECTRICAL POWER DISTRIBUTION
- REACTOR PROTECTION SYSTEM
- FUEL HANDLING SYSTEM
- RADWASTE SYSTEM
- BUILDING AND SITE ARRANGEMENTS
- CONTAINMENT SYSTEMS
- SABOTAGE PROJECTION PROGRAM

DECEMBER 1989 - UPDATE FUEL METHODOLOGY DESCRIPTIONS
- RESOLUTION OF 64 USIs/GSIs
- PRA METHODOLOGY & LEVEL 1

REMAINING CESSAR-DC SUBMITTALS:

APRIL 1990	-	USI/GSI RESOLUTIONS (20)
	-	ECCS AND CONTAINMENT ANALYSES
AUGUST 1990	-	SAFETY ANALYSES
	-	PRA AND SEVERE ACCIDENT RESULTS
	-	SEISMIC METHODS
	-	BUILDING LAYOUTS
DECEMBER 1990	-	SEISMIC RESULTS
	-	TECHNICAL SPECIFICATIONS
	-	INSPECTIONS, TESTS, ANALYSES
	-	MAINTENANCE AND RELIABILITY GUIDELINES
	-	REMAINING USIs/GSIs

System 80+ Design Certification in the U.S. NRC Review Schedule



CONTENT OF LRB . . .

- o SEVERE ACCIDENT ISSUES:
  - USIs/GSIs
  - PRA
  - SEVERE ACCIDENT PERFORMANCE GOALS
    - -- CORE DAMAGE
    - -- LARGE RELEASE
    - -- CONTAINMENT PERFORMANCE

CONTENT OF LRB . . .

- Other Specific Issues:
  - Comparison with EPRI requirements
  - Physical security and sabotage
  - Site envelope
  - Completeness of design documentation
  - Quality assurance
  - Maintenance, surveillance & reliability
  - Safety goal policy statement
  - 60-year life
  - Fire protection
  - Station blackout
  - Leak-before-break
  - Source terms
  - OBE/SSE
  - Containment leak rate
  - Hydrogen generation
  - Containment vents
  - Mid-loop operation
  - Interfacing system LOCA
  - ATWS
  - Electrical system design
  - Degraded core behavior

15 "TECHNICAL" ISSUES

*1. Public Safety Goals
*2. Source Terms
*3. ATWS
*4. Mid-Loop Operation
*5. Station Blackout
*6. Fire Protection
*7. Intersystem LOCA
*8. Hydrogen Generation and Control
*9. Core-Concrete Interaction
*10. High-Pressure Core Melt Ejection
*11. Containment Performance
*12. "ABWR" Containment Vent
13. Equipment Survivability
*14. OBE/SSE
15. IST for Pumps and Valves

* Currently addressed in LRB

DETAILED AGENDA

9:00 - 9:30 INTRODUCTION E. H. KENNEDY

- PURPOSE OF MEETING
- HISTORY OF LRB
- CONTENTS OF LRB

9:30 - 9:50 PROGRAM OVERVIEW R. A. MATZIE

- DESIGN PROCESS
- PARTICIPANTS
- DESIGN OBJECTIVES
- DESIGN SCOPE

9:50 - 10:40 SYSTEM 80+ DESIGN R. S. TURK
(AND COMPARISON TO SYSTEM 80)

- RV, FUEL, INTERNALS
- REACTOR COOLANT SYSTEM
  - -- MID-LOOP
- SAFEGUARDS
  - -- IST PUMPS/VALVES
  - -- SOURCE TERMS
- AUXILIARY SYSTEMS
  - -- INTERSYSTEM LOCA
- COMPARISON TO EPRI REQUIREMENTS

10:40 - 10:50	BREAK	
10:50 - 11:20	INSTRUMENTATION AND ELECTRICAL SYSTEMS -- ATWS -- STATION BLACKOUT	K. SCAROLA
11:20 - 11:50	SYSTEM 80+ CONTAINMENT -- FIRE PROTECTION -- OBE/SSE	WM. A. FOX
11:50 - 12:20	SEVERE ACCIDENT FEATURES -- H_2 CONTROL -- CORE/CONCRETE INTERACTION -- HIGH PRESSURE CORE MELT EJECTION -- "ABWR" VENT -- EQUIPMENT SURVIVABILITY	R. S. TURK
12:20 - 12:50	PRA - OBJECTIVES - STATUS -- SAFETY GOALS -- CONTAINMENT PERFORMANCE - RESULTS (LEVEL I)	R. E. JAQUITH
12:50 - 1:00	SUMMARY AND CONCLUSIONS	E. H. KENNEDY

R. A. Matzie,

Director

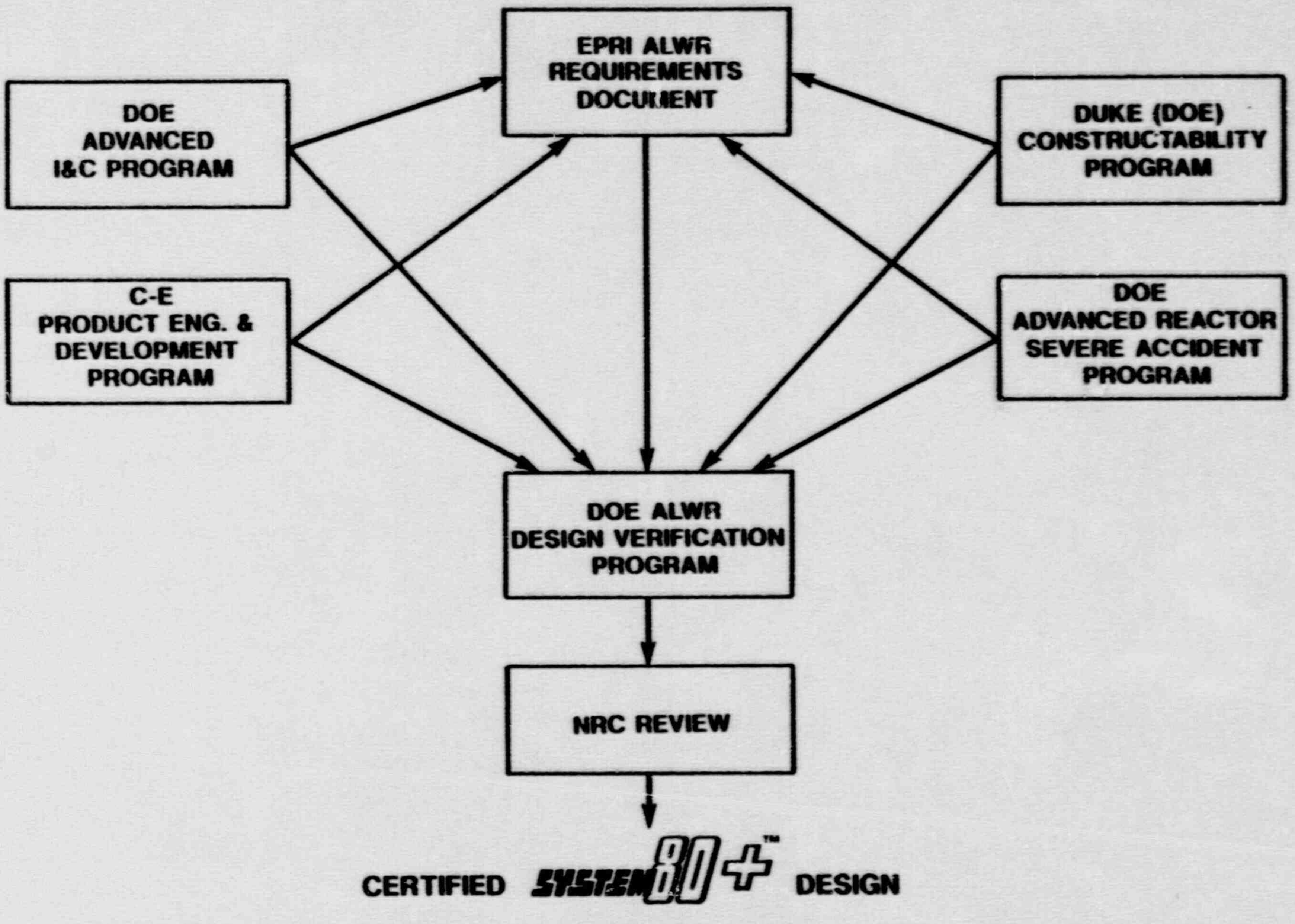
Advanced Water Reactor Projects

SYSTEM 80+ PROGRAM OBJECTIVES

- o DEVELOP AN ADVANCED PWR DESIGN WITH:
  - ENHANCED SAFETY
  - INCREASED MARGINS
  - IMPROVED OPERABILITY AND MAINTAINABILITY
  - REDUCED COST
  - PROVEN TECHNOLOGY

- o OBTAIN NRC CERTIFICATION OF THE ADVANCED DESIGN TO:
  - REDUCE LICENSING RISK
  - RETAIN NUCLEAR AS A VIABLE OPTION

C-E EVOLUTIONARY ALWR PROGRAM



APPROACH FOR DEVELOPING SYSTEM 80+ STANDARD DESIGN

- o Start with Current System 80 (CESSAR-F) and Duke Power's Cherokee/Perkins BOP
- o Consider Changes Due to
  - EPRI ALWR Requirements
  - NRC Mandated Changes (Primarily to Address Severe Accidents)
  - C-E Desired Changes (as a Result of Operational Feedback)
- o Assess Impact of Changes on
  - Safety
  - Performance
  - Operability
  - Maintainability
  - Cost
- o Incorporate Changes Using
  - PRA
  - Cost/Benefit
- o Revise Standard Design (System 80+/CESSAR-DC)

SYSTEM 80 IS A MAJOR PORTION OF A NUCLEAR PLANT

- NSSS
- PLANT PROTECTION AND MONITORING SYSTEMS
- SUPPLEMENTARY PROTECTION SYSTEM
- SHUTDOWN COOLING SYSTEM
- SAFETY INJECTION SYSTEM
- CHEMICAL AND VOLUME CONTROL SYSTEM
- WATER CHEMISTRY
- FUEL HANDLING SYSTEM

SYSTEM 80+ IS A COMPLETE NUCLEAR POWER PLANT

- o REACTOR SYSTEMS
- o SAFEGUARDS SYSTEMS
- o STEAM AND POWER CONVERSION SYSTEMS
- o TURBINE GENERATOR SYSTEMS
- o WASTE MANAGEMENT SYSTEMS
- o ONSITE POWER SYSTEM
- o CONTAINMENT STRUCTURE AND SUPPORT SYSTEMS
- o COOLING WATER SYSTEMS
- o SUPPORT SYSTEMS
- o CONTROL BUILDINGS
- o OTHER BUILDINGS (FUEL, DIESEL GENERATOR, ETC.)

STRUCTURES SYSTEMS, AND COMPONENTS FOR WHICH A CONCEPTUAL DESIGN WILL BE PROVIDED

- Offsite Power Systems
- Training and Support Facilities
- Heat Sinks and Intake Structures
- Potable and Sanitary Water

SYSTEM 80+ ASSURED CONSTRUCTABILITY & COSTS

- o CONSTRUCTION SCHEDULE:
  - 48 MONTHS (FIRST CONCRETE TO FUEL LOAD)
  - 6 MONTHS (START-UP)
- o PLANT COSTS:
  - CAPITAL <$1150/KWE
  - FUEL <0.8¢/KWH
  - O&M <1.2¢/KWH
  - TOTAL LIFE CYCLE COSTS <5.8 ¢/KWH
- o CONFIDENCE IN SCHEDULE AND COSTS IS VERY HIGH, SINCE EXISTING CONSTRUCTION TECHNIQUES ARE USED AND DESIGN DETAILS ARE ALREADY KNOWN

SYSTEM 80+
IMPROVED OPERATION

- o 60-Year Design Life
- o Availability >87%
- o Outage Time
  - <30 Days/Year
  - Including Refueling Time, <50 Days/Fuel Cycle
- o Unplanned Trips <1/Yr
- o Personnel Exposure <100 Man-Rem/Yr
- o Improvement Maintainability:
  - Self-Testing Features
  - Reduced ISI
  - Increased Work Space
  - Separation of Safety/Non-Safety Systems

SYSTEM 80+ SAFETY GOALS

- Core Damage Frequency $<10^{-5}$ Events/Yr
- Severe Accident Release $<10^{-6}$ Events/Yr for Occurrence of Doses Greater than 25 Rem at Site Boundary

SYSTEM 80+™

SYSTEM 80+/SYSTEM 80 DESIGN COMPARISON

AREA	DESIGN OBJECTIVES	CHANGES FROM SYSTEM 80
REACTOR	- MAINTAIN PROVEN DESIGN - MEET UTILITY PERFORMANCE NEEDS	- VERY FEW CHANGES - PART-STRENGTH RODS FOR LOAD FOLLOW
REACTOR COOLANT SYSTEM	IMPROVE PLANT MARGINS	- LOWER OPERATING TEMPERATURES - INCREASED SYSTEM VOLUMES - IMPROVED MATERIALS
SAFEGUARDS SYSTEMS	REDUCE CORE MELT FREQUENCY	- REDESIGN IN VERY CLOSE CONFORMANCE WITH EPRI ALWR REQUIREMENTS - ADDED SAFETY DEPRESSURIZATION SYSTEM

SYSTEM 80+™

SYSTEM 80+/SYSTEM 80 DESIGN COMPARISON . . .

AREA	DESIGN OBJECTIVES	CHANGES FROM SYSTEM 80
AUXILIARY SYSTEMS	SIMPLIFICATION	NON-SAFETY CVCS
CONTAINMENT	- ADDRESS SEVERE ACCIDENTS MEET UTILITY MAINTENANCE NEEDS	USE DUAL, SPHERICAL STEEL DESIGN
INSTRUMENTATION AND CONTROL	PROVIDE STATE OF THE ART, HUMAN FACTORS ENGINEERED CONTROL COMPLEX	NUPLEX 80+
ELECTRICAL DISTRIBUTION AND SUPPORT SYSTEMS	IMPROVE RELIABILITY CONSISTENT WITH SAFEGUARDS SYSTEMS	GREATER REDUNDANCE AND DIVERSITY

DIFFERENCES FROM EPRI DESIGN REQUIREMENTS

- o DEGREE OF COMPLIANCE IS HIGH (>95%)
- o DIFFERENCES RELATED TO PLANT PERFORMANCE, NOT REGULATORY REQUIREMENTS.
- o LIST OF DIFFERENCES MAY CHANGE DUE TO COMPLETION OF:
  - EPRI ALWR DESIGN REQUIREMENTS
  - SYSTEM 80+ DESIGN

SPECIFIC DIFFERENCES FROM EPRI ALWR DESIGN REQUIREMENTS

- HOT LEG TEMPERATURE, 615°F (S-80+) VS. 600°F
- SG SUPPORTS, SKIRT (S-80+) VS. PEDESTAL OR OPEN FRAME
- SG HANDHOLES, BOTTOM TUBESHEET (S-80+) VS. EVERY TUBE SUPPORT ELEVATION
- CEA ANTI-EJECTION LATCHES, SYSTEM 80+ DOES NOT INCLUDE THEM.
- EFW CROSS-CONNECT, SYSTEM 80+ HAS A NORMALLY-CLOSED CROSS-CONNECT
- FW ISOLATION VALVES, REDUNDANT (S-80+) VS. FWIV & CONTROL VALVE
- MAIN FW PUMPS, TURBINE-DRIVEN (S-80+) VS. MOTOR-DRIVEN
- MAIN STEAM ISOLATION, NOT INITIATED FOR S-80+ ON PRESSURE RATE-OF-CHANGE
- CABLE FAILURE DETECT/REPAIR CRITERION MAY NOT BE MET

SPECIFIC DIFFERENCES FROM EPRI ALWR DESIGN REQUIREMENTS . . .

- SOME PVC AND NEOPRENE INSULATION MAY BE USED
- ALTERNATE AC SOURCE WILL NOT MEET IEEE 387 (DGs)
- SYSTEM 80+ RETAINS THE RVLMS
- DIESELS WILL NOT BE AUTOMATICALLY LOADED WITHOUT TG TRIP
- DUAL CONTAINMENT, SPHERICAL (S-80+) VS. CYLINDRICAL
- NSSS OFFSET IN CONTAINMENT, NO OFFSET (S-80+) VS. 15-20 FOOT OFFSET
- EQUIPMENT HATCH, OPERATING FLOOR LEVEL (S-80+) VS. GRADE LEVEL

R. S. Turk,

Project Manager

System 80+ Development

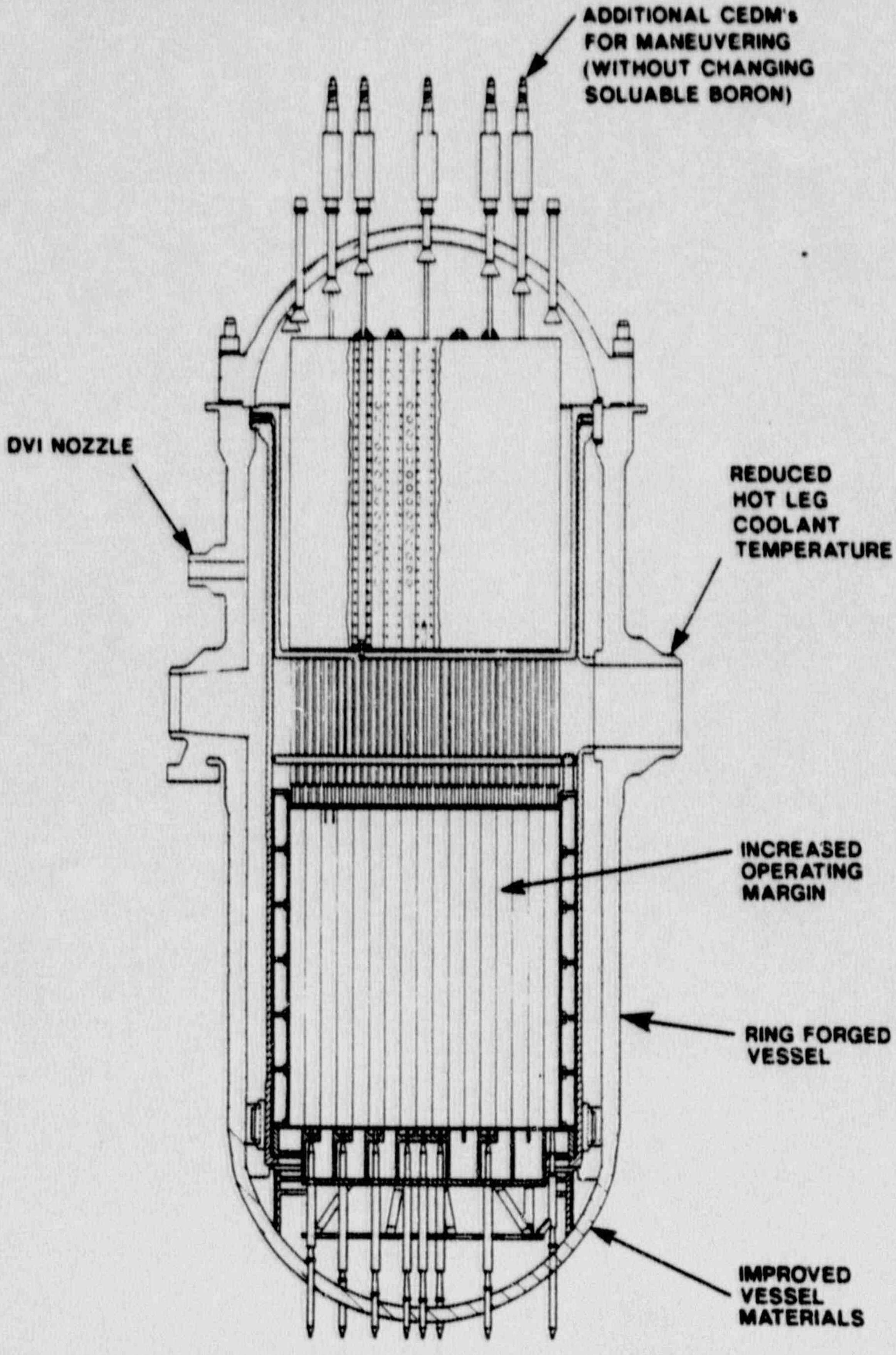
SYSTEM 80+ DESIGN FEATURES

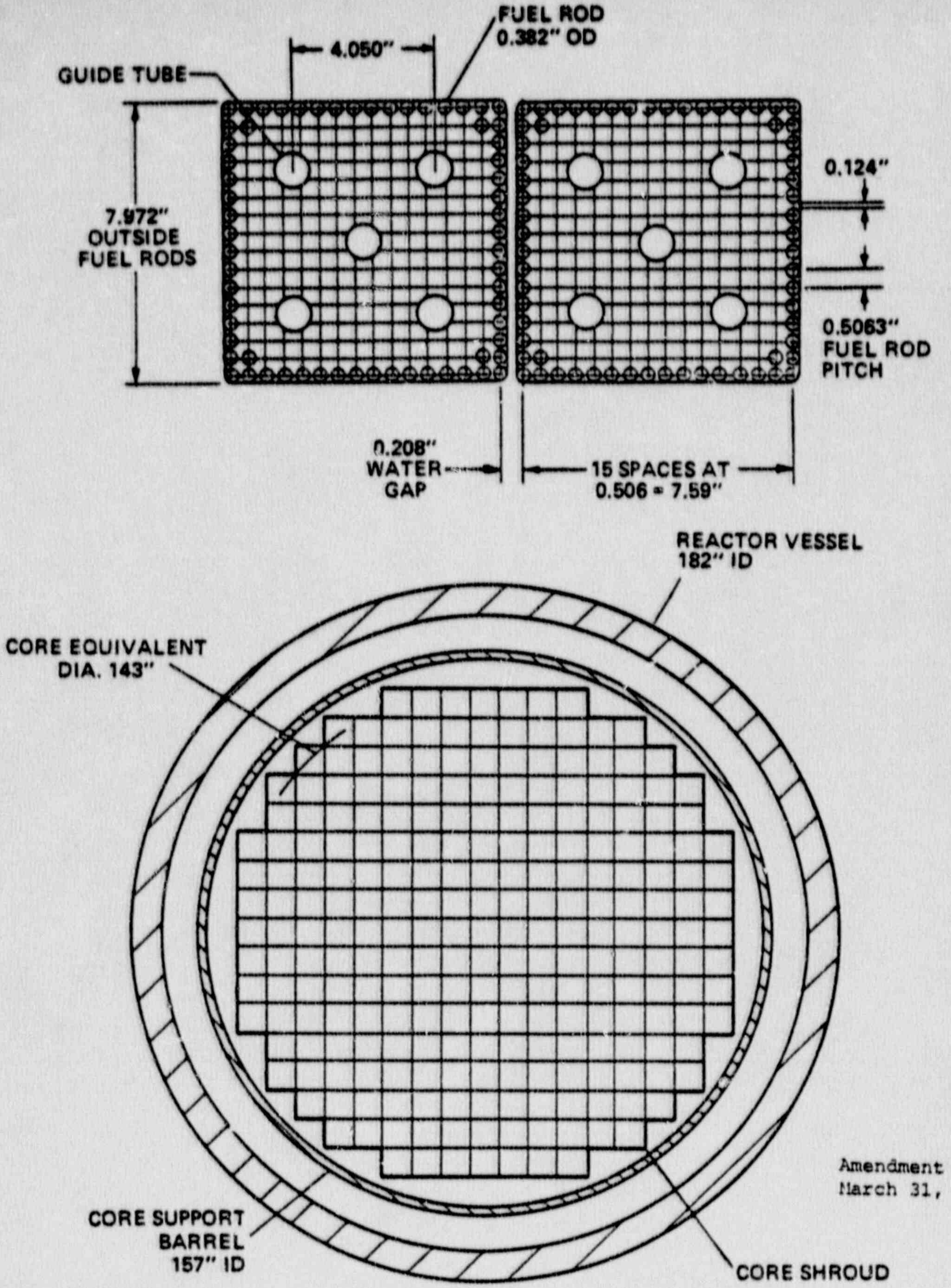
o REACTOR*

- INCREASED OVERPOWER MARGIN
- MANEUVERING CONTROL WITHOUT SOLUBLE BORON
- RING FORGED REACTOR VESSEL
- LONG-LIFE CONTROL RODS

* DESIGN CHANGES ARE RELATIVE TO SYSTEM 80

System 80+ Reactor Enhancements





Amendment B
March 31, 1988

SYSTEM 80+™	REACTOR CORE CROSS SECTION 241 FUEL ASSEMBLIES	Figure 4.1-2

DESIGN CHANGES TO INCREASE THERMAL MARGIN

CHANGE	APPROX. GAIN
LOWER COOLANT TEMPERATURE (^{O}F)	3%
HIGHER CORE FLOW RATE (2%)	2%
COLSS/CPC IMPROVEMENTS	4%
ADVANCED INTEGRAL B.P. (OPTIONAL)	2%
	9-11%

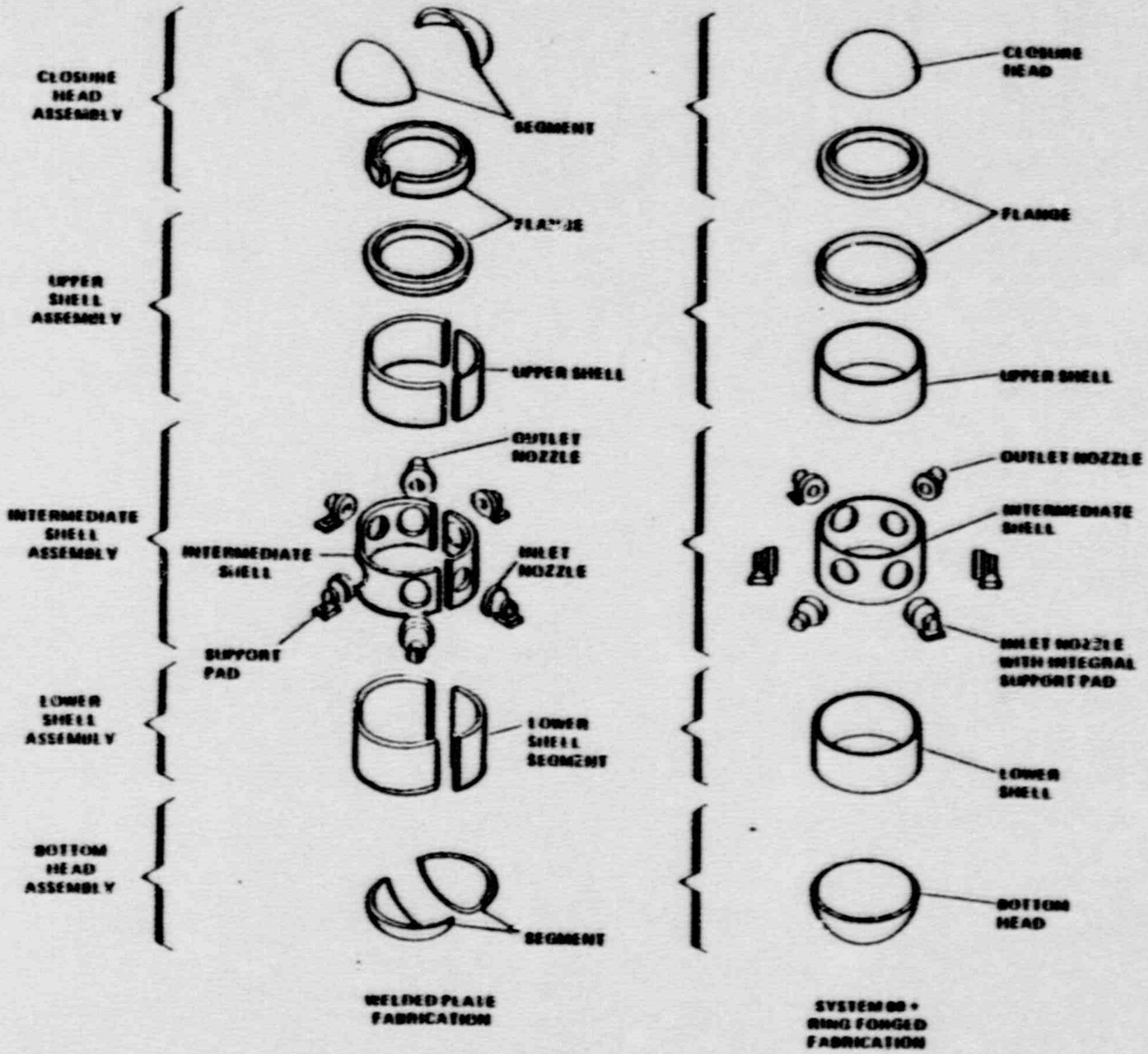
NET THERMAL MARGIN FOR SYSTEM 80+ (TYPICAL)

INITIAL CORE	18 - 20%
RELOAD CORES	15 - 17%

CONTROL ELEMENT ASSEMBLY DESIGN CHANGE COMPARISON

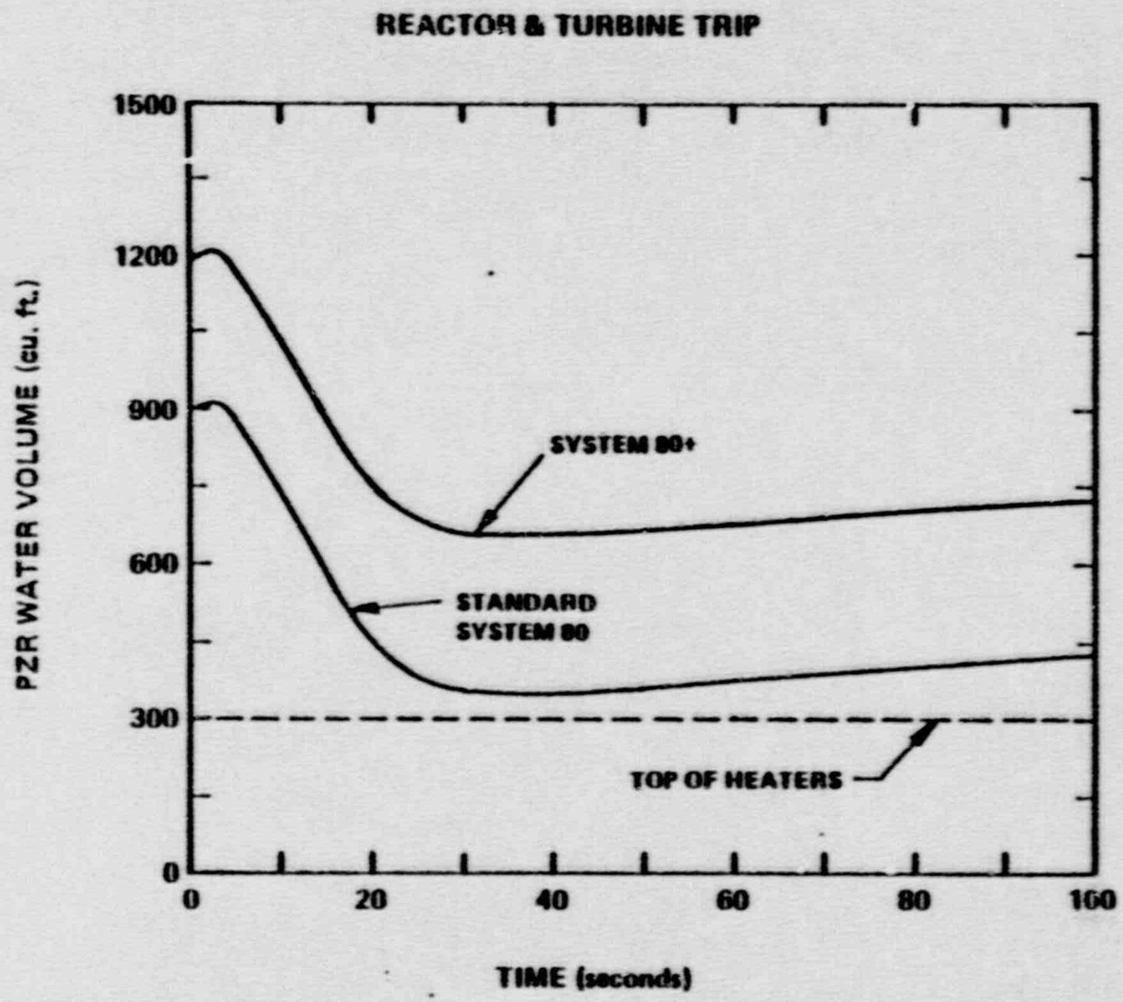
	System 80		System 80+	
CEA Type	Number	Absorber	Number	Absorber
Full Strength (12-Finger)	48	B_4C	48	B_4C
Full Strength (4-Finger)	28	B_4C	20	AG-IN-CD
Part-Length (4-Finger)	13	B_4C	--	--
Part-Strength (4-Finger)	--	---	25	INCONEL
Total	89	10-Year Life	93	20-Year Life

SYSTEM 80 REACTOR VESSEL COMPARISON



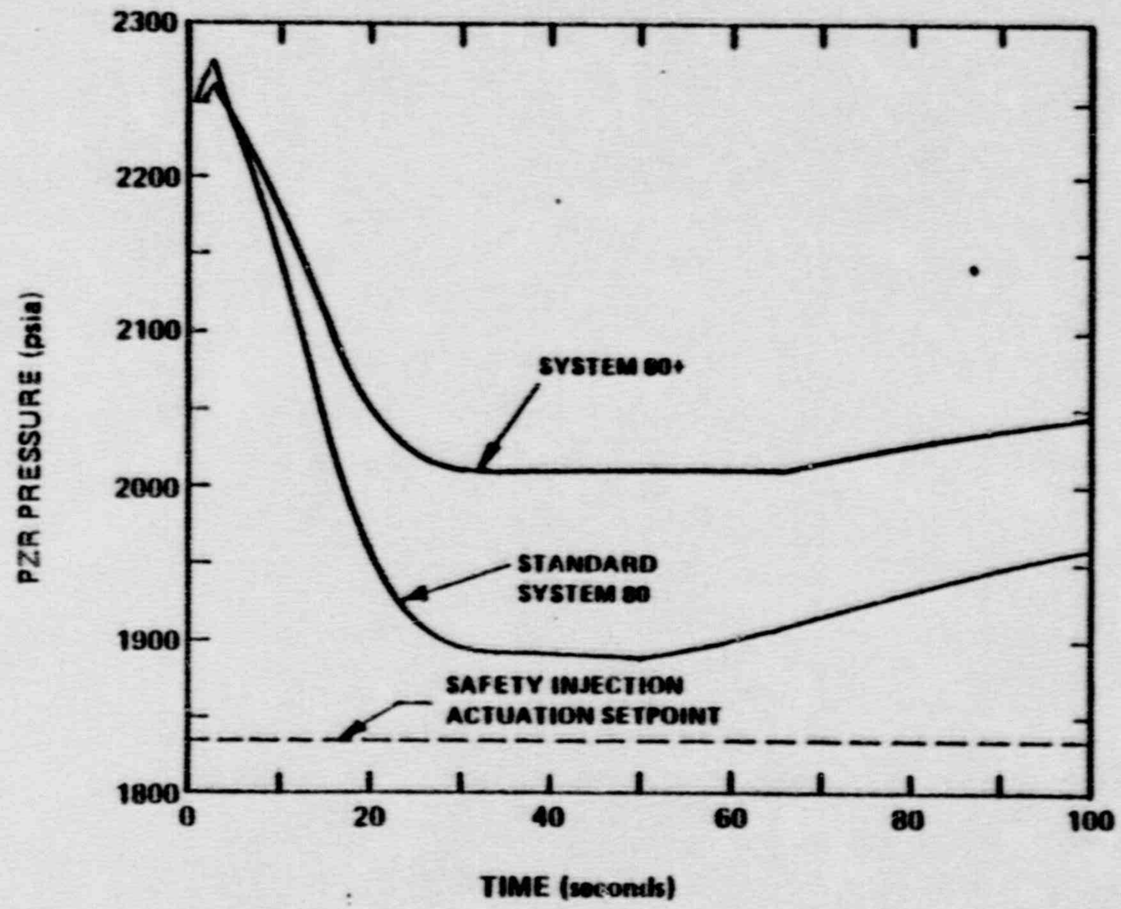
SYSTEM 80+ DESIGN FEATURES...

- o REACTOR COOLANT SYSTEM:
  - 33% LARGER PRESSURIZER
  - 10% SG TUBE PLUGGING MARGIN AND 10% MORE HEAT TRANSFER AREA
  - 25% LARGER SECONDARY INVENTORY
  - MORE CORROSION RESISTANT SG TUBES (INCONEL 690)
  - SG DESIGNED FOR EASE OF MAINTENANCE (LARGER MANWAYS)
  - 6°F LOWER HOT LEG TEMPERATURE (T_H)
  - REDUCED VIBRATION IN SG ECONOMIZER REGION
  - LOWERED FW DISTRIBUTION RING
  - IMPROVED STEAM DRYERS
  - SECONDARY SIDE PRESSURE REDUCED 70 PSIA TO 1000 PSIA

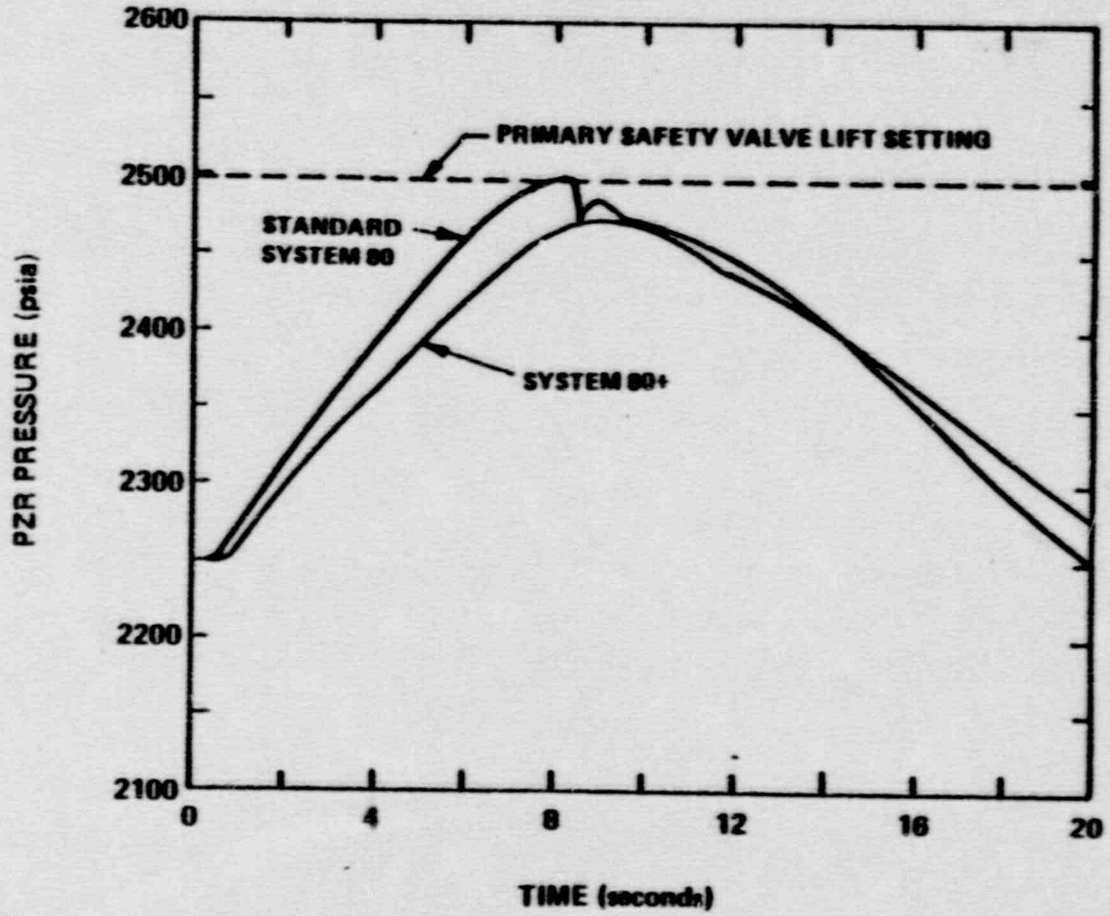

REACTOR & TURBINE TRIP
PZR WATER VOLUME (cu. ft.)
1500
1200
900
600
300
0
0
20
40
60
80
100
TIME (seconds)
SYSTEM 80+
STANDARD
SYSTEM 80
TOP OF HEATERS

SYSTEM 80+™

REACTOR & TURBINE TRIP

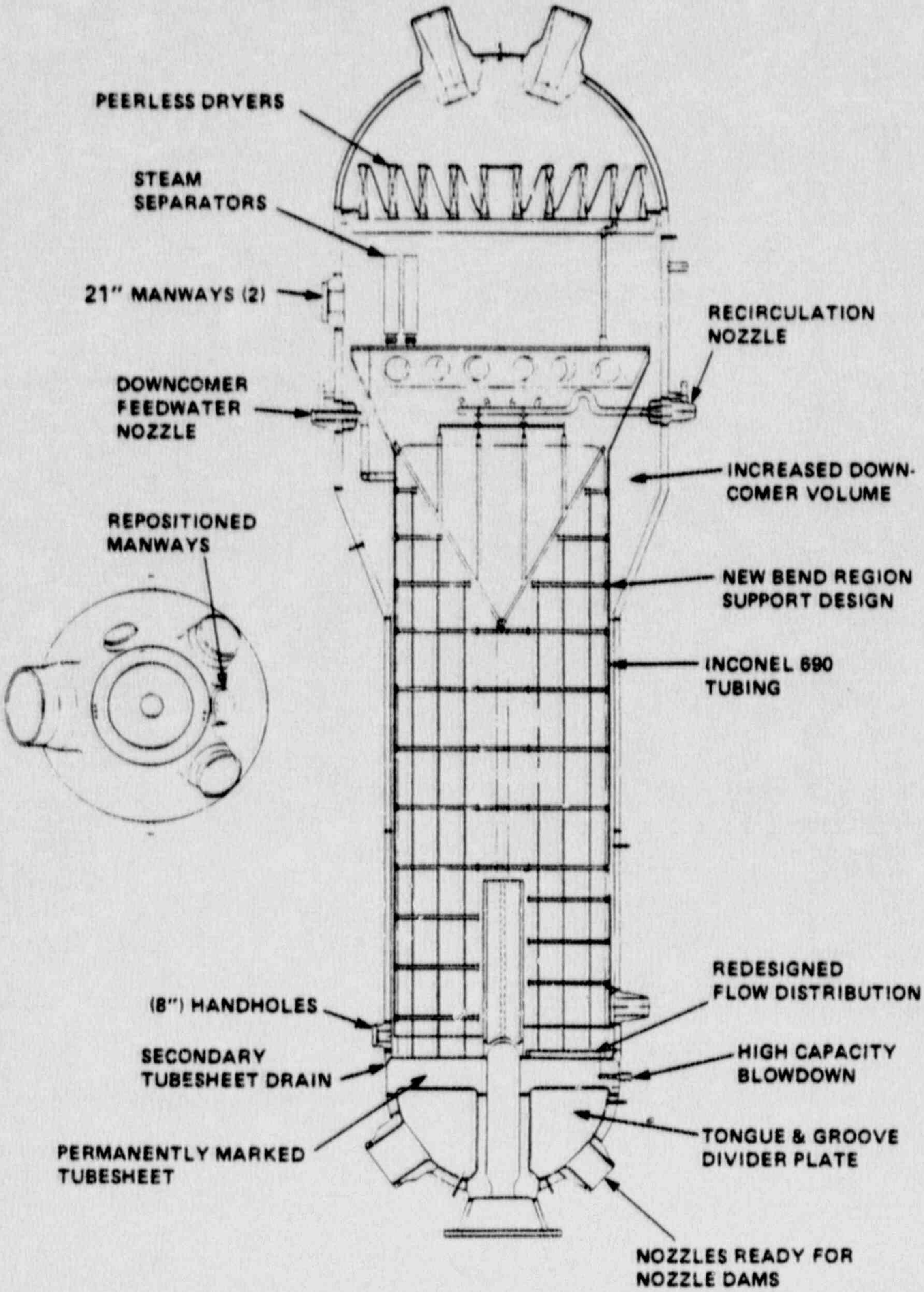


LOSS OF CONDENSER VACUUM



SYSTEM 80+™

SYSTEM 80+ STEAM GENERATOR ENHANCEMENTS



SYSTEM 80+ DESIGN FEATURES...

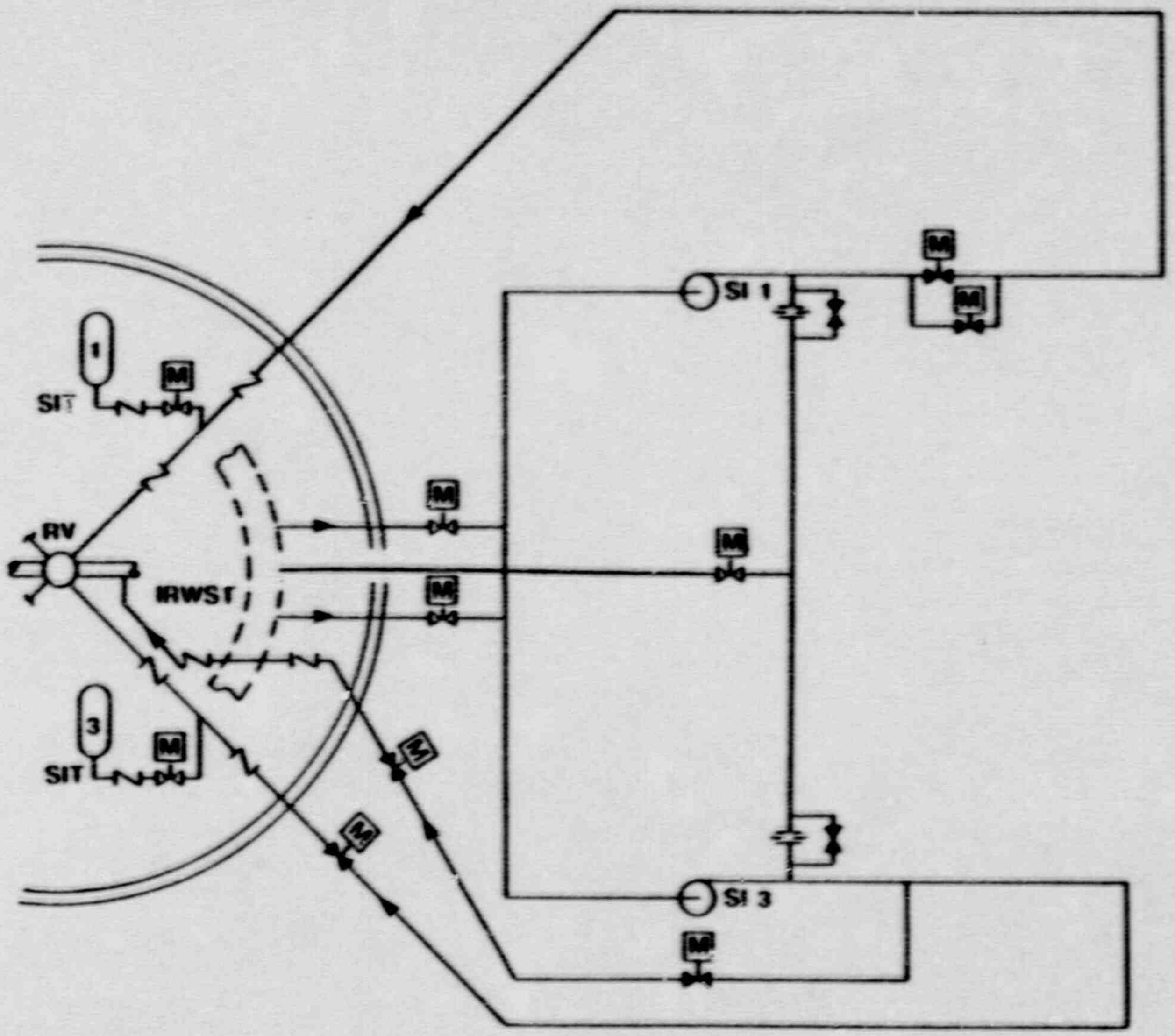
o SAFEGUARD SYSTEMS:

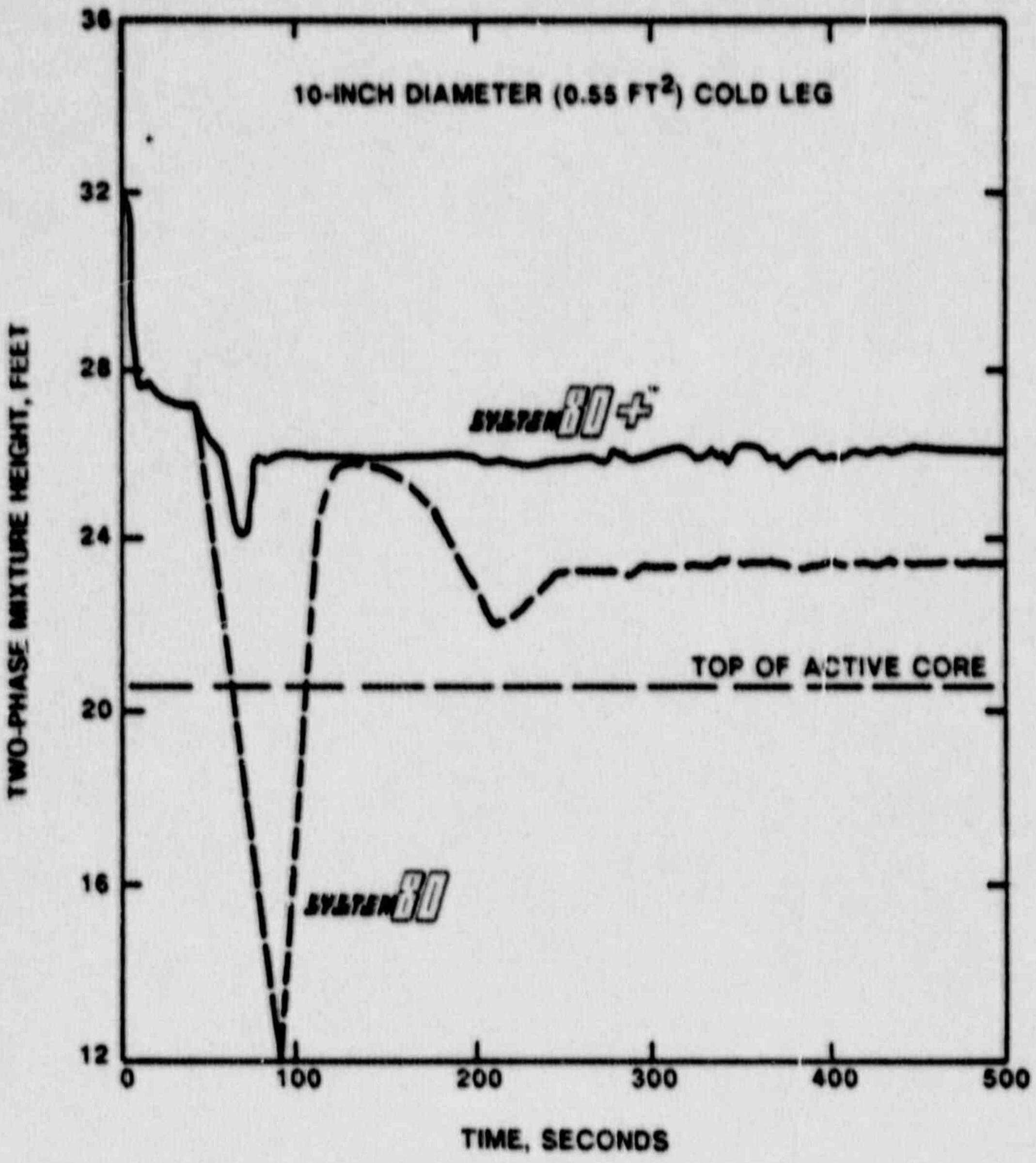
- FOUR-TRAIN SAFETY INJECTION SYSTEM,
- SHUTDOWN COOLING AND CONTAINMENT SPRAY SYSTEMS
- SAFETY DEPRESSURIZATION SYSTEM
- IN-CONTAINMENT REFUELING WATER STORAGE TANK
- FOUR-TRAIN EMERGENCY FEEDWATER SYSTEM

SYSTEM 80+ DESIGN FEATURES...

- SAFETY INJECTION SYSTEM:
  - -- SEGREGATED SYSTEM INTO QUADRANTS
  - -- INJECT DIRECTLY INTO REACTOR VESSEL
  - -- FOUR 100% CAPACITY PUMPS (HIGH PRESSURE)
  - -- ELIMINATION OF NEED FOR LOW PRESSURE PUMPS
  - -- SUCTION FROM IRWST (ELIMINATION OF SWITCHOVER FROM EXTERNAL WATER SUPPLY)
  - -- ON-LINE FULL FLOW TEST CAPABILITY
  - -- PERFORMS BORON INJECTION ACCIDENT MITIGATION FUNCTION

ENGINEERED SAFETY FEATURES SYSTEM
(Safety Injection System)





SMALL BREAK LOSS OF COOLANT ACCIDENT
(SYSTEM 80 vs SYSTEM 80+)

SYSTEM 80+ DESIGN FEATURES...

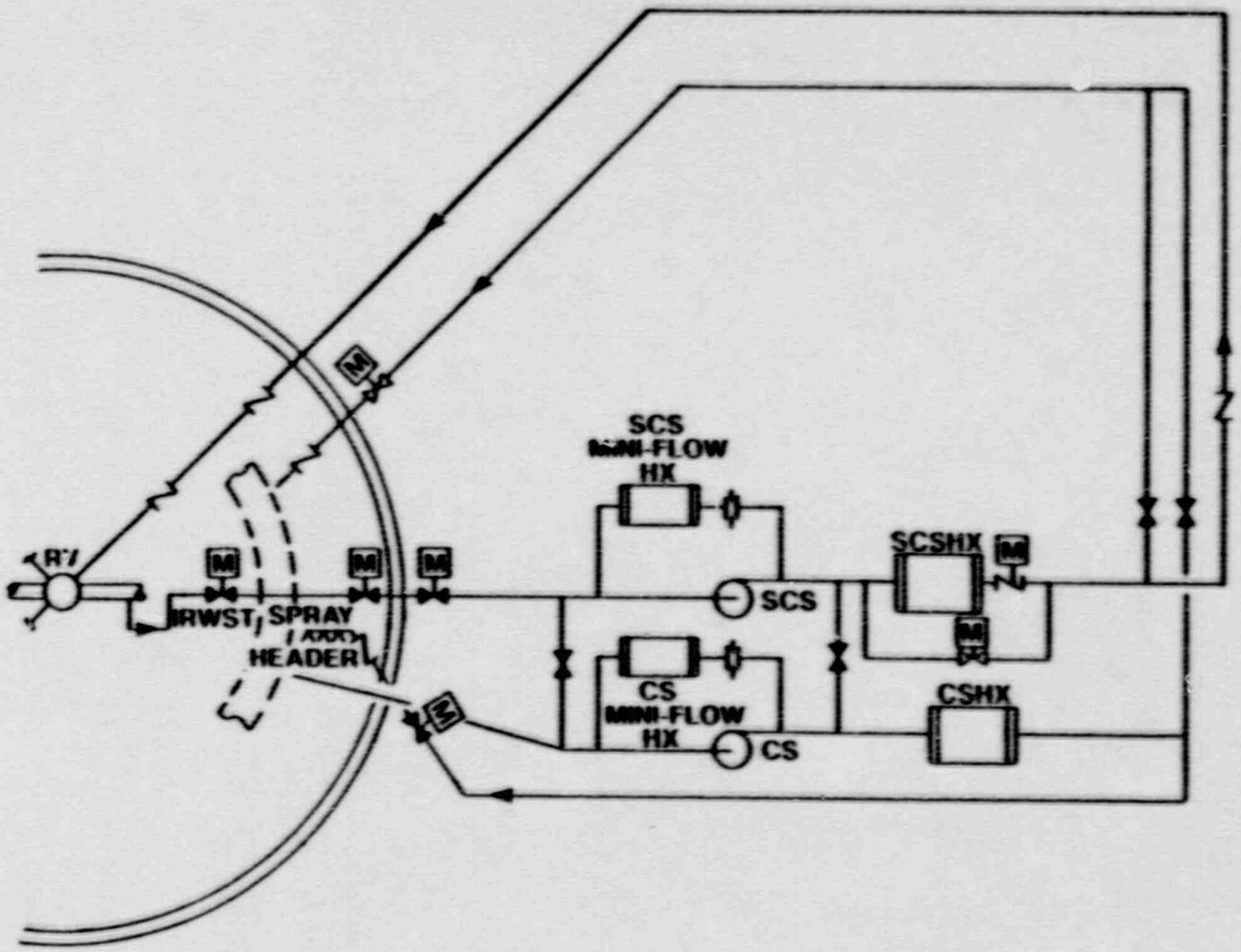
- SHUTDOWN COOLING AND CONTAINMENT SPRAY SYSTEMS:
  - -- INCREASED PRESSURE (900 PSIA) OF SHUTDOWN COOLING SYSTEM
  - -- INDEPENDENT BUT INTERCHANGEABLE SHUTDOWN COOLING AND CONTAINMENT SPRAY
  - -- ON-LINE FULL-FLOW TEST CAPABILITY
  - -- HIGHER CAPACITY CONTAINMENT SPRAY

INTERSYSTEM LOCA (ISSUE 7)

- DESIGN BASES: MINIMIZE PROBABILITY OF INTERSYSTEM LOCA
- KEY DESIGN FEATURES:
  - ELIMINATION OF LOW PRESSURE SAFETY INJECTION
  - SCS DESIGN PRESSURE INCREASED TO 900 PSIA
  - TRIPLE PRESSURE ISOLATION VALVES (PIV) (I.E., CHECK VALVES OR MOV'S) FOR SCS
  - FOR SIS, CVCS AND SAMPLING SYSTEM; ONE OR MORE OF THE FOLLOWING APPLY:

    ...SYSTEM PIPING ULTIMATE RUPTURE STRENGTH IS EQUAL TO NORMAL RCS PRESSURE,
    ...CHARGING PUMPS CAN MAKEUP LOST INVENTORY,
    ...BREAK IS ASSUMED TO OCCUR INSIDE CONTAINMENT,
    ...FLOW PATH CONTAINS NORMALLY OPEN VALVES WHICH CAN ISOLATE THE BREAK.
  - MEAN FREQUENCY OF ISL IS 3.0E-9 EVENTS PER YEAR.

ENGINEERED SAFETY FEATURES SYSTEM (Shutdown Cooling & Containment Spray System)



MID-LOOP OPERATION (ISSUE 4)

- o DESIGN BASIS: MINIMIZE THE PROBABILITY OF LOSING DECAY HEAT REMOVAL CAPABILITY DURING MID-LOOP OPERATION.

- o DESIGN FEATURES:

  - DEDICATED, PERMANENT, SAFETY GRADE INSTRUMENTATION

    -- LEVEL DETECTION TO BOTTOM OF HL

    -- CORE EXIT TEMPERATURE AVAILABLE DURING SHUTDOWN

  - FAVORABLE RCS LAYOUT

    -- SUCTION PIPING CONNECTED TO BOTTOM OF HL

    -- SUCTION PIPING ORIENTED VERTICALLY

    -- SCS PUMP LOCATED IN SUBSPHERE

  - ONE OF FOUR HPSI PUMPS CAN BE AVAILABLE

  - SCS AUTO CLOSURE LOGIC REMOVED

  - CONSIDERING DESIGN CHANGE TO DECREASE VORTEXING (VORTEX BREAKER)

  - OPERATIONAL GUIDELINES WILL ADDRESS MID-LOOP OPERATION (E.G., PRESSURIZER MANWAY VENT)

INSERVICE TESTING OF PUMPS AND VALVES (ISSUE 15)

- o DESIGN BASES:
  - EPRI ALWR REQUIREMENTS
  - 10 CFR 50.55,
  - NRC GENERIC LETTERS 89-04 AND 89-10,
  - ASME CODE, SECTION XI.
- o DESIGN FEATURES;
  - FULL FLOW TEST CAPABILITY FOR SCS PUMPS.
  - COMPLIANCE WITH EPRI ALWR REQUIREMENTS ON SAFETY-RELATED PUMP AND VALVE TESTING.
  - TESTING OF SAFETY-RELATED PUMPS AND VALVES UNDER DESIGN CONDITIONS.
  - ADDRESS ANY EXCEPTIONS OF PVNGS PROGRAM
  - ALARMS FOR LEAKAGE INTO (OVER-PRESSURIZATION) OF LOW-PRESSURE SYSTEMS.

SOURCE TERMS (ISSUE 2)

- o DESIGN BASIS:
  - Meet current NRC regulations and guidance
  - Implement EPRI ALWR Requirements to extent practicable
- o DESIGN APPROACH:
  - Currently approved methodology (TID 14844, Reg. Guides, SRP) is being used for the design basis safety analysis. Requirements of 10 CFR 100 will be met.
  - A more realistic source term will be used for severe accident evaluations. Specific revisions to be finalized during NRC staff review. [A reduction in the EPZ based on more realistic source terms is outside the scope of our design certification program.]

- Safety Depressurization System:

  -- Safety Grade Venting of Non-condensible Gases from Pressurizer and Reactor Vessel

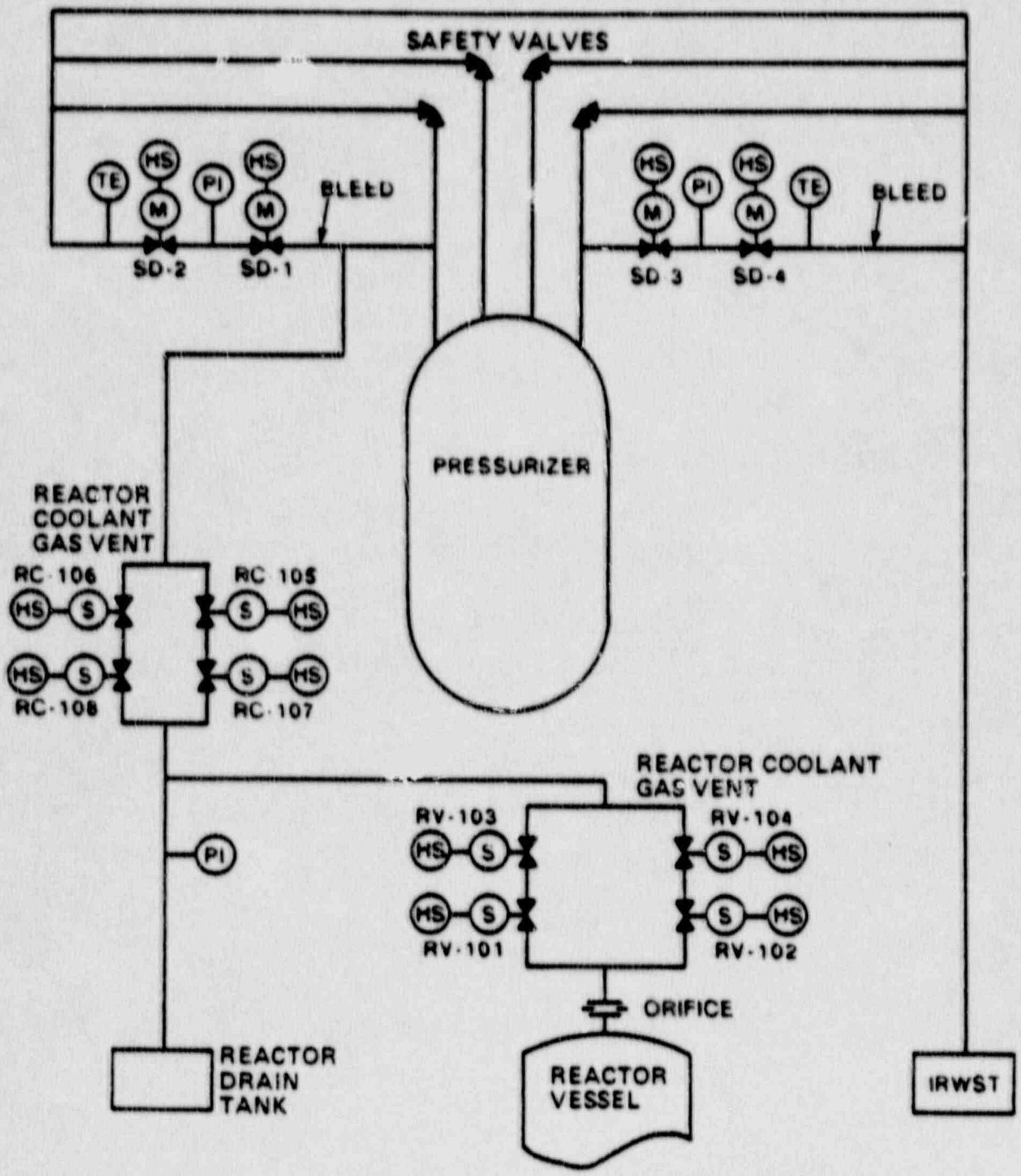
  -- Safety Grade RCS Depressurization and Cooldown if Normal Pressurizer Sprays are not Available

  -- RCS Depressurization to Initiate Bleed and Feed Flow in Unlikely Event of Total Loss of Feedwater Flow

  -- RCS Depressurization During a Severe Accident Scenario

  -- Manual Control from the Control Room

SAFETY DEPRESSURIZATION AND VENT SYSTEM



- EMERGENCY FEEDWATER SYSTEM FEATURES:

  -- DEDICATED SAFETY SYSTEM (NO OPERATING FUNCTIONS FOR NORMAL PLANT OPERATION)

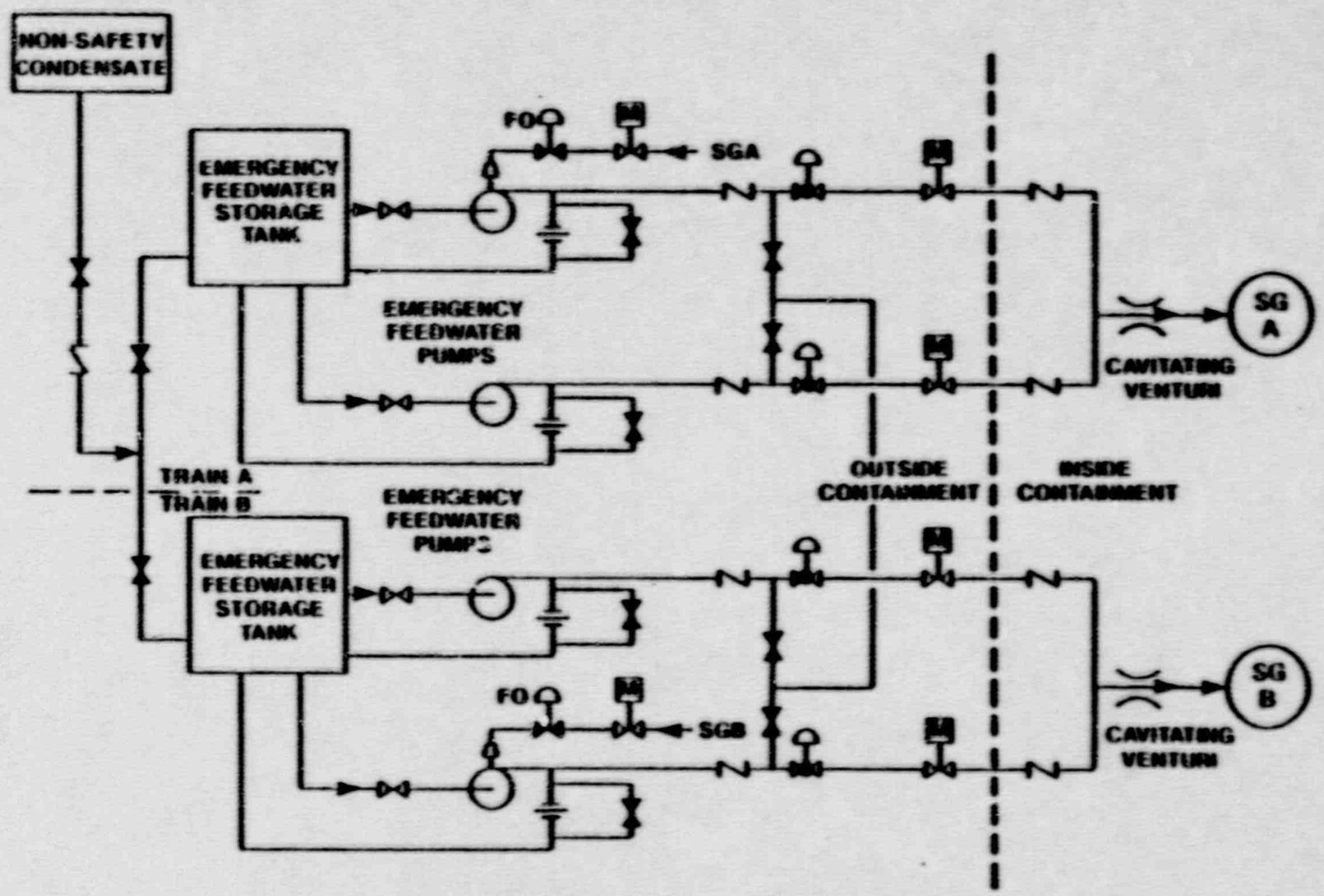
  -- FOUR-TRAIN SYSTEM:

  FOR EACH STEAM GENERATOR;

  A. ONE 100% CAPACITY MOTOR-DRIVEN PUMP TRAIN
  B. ONE 100% CAPACITY TURBINE-DRIVEN PUMP TRAIN
  C. ONE EMERGENCY FEEDWATER STORAGE TANK
  D. ONE CAVITATING VENTURI

  -- FOUR-CHANNEL CONTROL SCHEME TO PRECLUDE INADVERTENT ACTUATION DUE TO SINGLE FAILURE

  -- MANUAL CROSS CONNECTION CAPABILITY BETWEEN TRAINS



EMERGENCY FEEDWATER SYSTEM

SYSTEM 80+™

SYSTEM 80+ DESIGN FEATURES...

- o AUXILIARY SYSTEM DESIGN:
  - NON-SAFETY GRADE CHEMICAL AND VOLUME CONTROL SYSTEM
  - SIMPLIFIED RCS CHARGING AND AUXILIARY SPRAY PIPING
  - HIGHER LETDOWN EXCHANGER DESIGN PRESSURE
  - LETDOWN FLOW VALVE WITH FIXED ORIFICE
  - CENTRIFUGAL CHARGING PUMPS
  - ELIMINATION OF EXTENSIVE HEAT TRACING

Wm. A. Fox, III

Duke Engineering Services, Inc.

SYSTEM 80+ CONTAINMENT

CONTAINMENT SELECTION PROCESS:

- o SPHERICAL STEEL CONTAINMENT VESSEL (SSCV)

CONTAINMENT DESCRIPTION:

- o TECHNICAL DATA
- o SECTIONS & PLANS

CONTAINMENT FEATURES:

- o IRWST
- o SEVERE ACCIDENTS

"TECHNICAL" ISSUES:

- o FIRE PROTECTION
- o SEISMIC DESIGN

SYSTEM 80+ CONTAINMENT...

CONTAINMENT SELECTION PROCESS:

- o REVIEWED DECISION FOR SELECTION OF P-81 CONTAINMENT

- o DEVELOPED INDEPENDENT CONSIDERATIONS AND CONCERNS FOR CONTAINMENT TYPE SELECTION

  - DESIGN
  - CONSTRUCTION
  - OPERATION, MAINTENANCE AND TESTING
  - DESIGN BASIS EVENTS & SEVERE ACCIDENT

- o CLOSELY FOLLOWED WORK ON DOE DESIGN FOR CONSTRUCTABILITY PROGRAM (INDEPENDENT FROM SYSTEM 80+)

  - COMPARATIVE CONSTRUCTABILITY EVALUATIONS OF 4 DIFFERENT PWR CONTAINMENT TYPES

- o FACTORS FOR SELECTION OF SSCV

SYSTEM 80+ CONTAINMENT...

FACTORS FOR SELECTION OF SSCV:

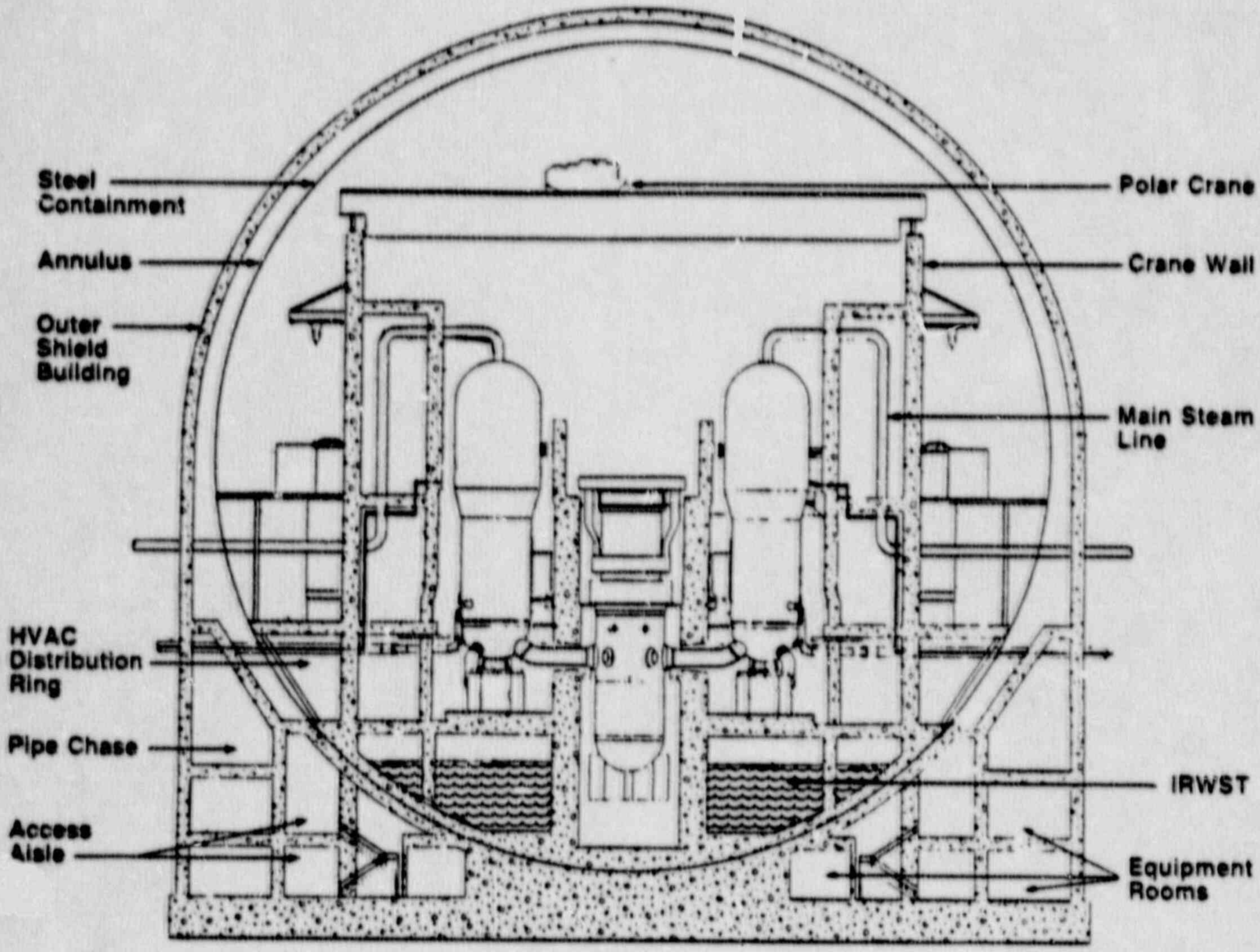
- o SPHERE IS TECHNICALLY SUPERIOR HOWEVER LACKS U.S. EXPERIENCE
- o ECONOMICALLY COMPETITIVE WHEN CONSIDERING:
  - OPERABILITY/MAINTAINABILITY
  - RELIABILITY/AVAILABILITY
  - SAFETY MARGINS AND ACCIDENT RECOVERABILITY
  - CONSTRUCTION IMPACT COSTS
  - INVESTMENT PROTECTION (MINIMIZE VULNERABILITY)
- o MEETS EPRI ALWR FUNCTIONAL REQUIREMENTS
- o BENEFITS

SYSTEM 80+ DESIGN CONTAINMENT...

o LARGE, STEEL SPHERICAL CONTAINMENT:

- DUAL CONTAINMENT
- 200 FT. DIAMETER
- INCREASED SPACE FOR MAINTENANCE & ACCESS
- DESIGNED TO MITIGATE SEVERE CORE DAMAGE
- SHADOW AREA HOUSES SAFEGUARD SYSTEMS

Containment Building — Elevation View



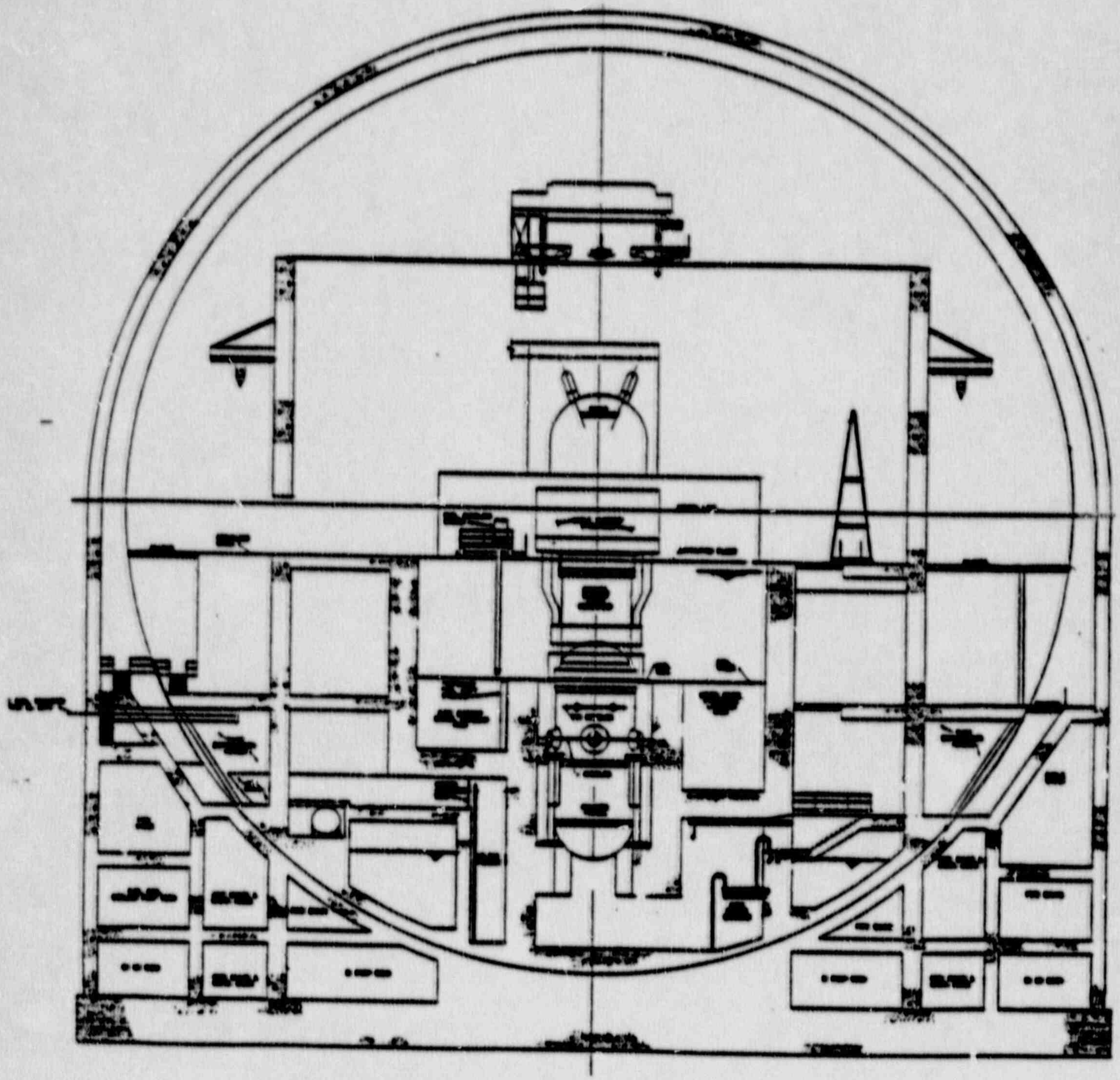
TECHNICAL DATA

CONTAINMENT:

Containment Type	Steel Sphere
Steel Type	SA-537 Cl. 2
Internal Diameter	200 feet
Wall Thickness	1.75 in.
Free Volume	3.4×10^6 cu. ft.
Design Pressure	49 psig

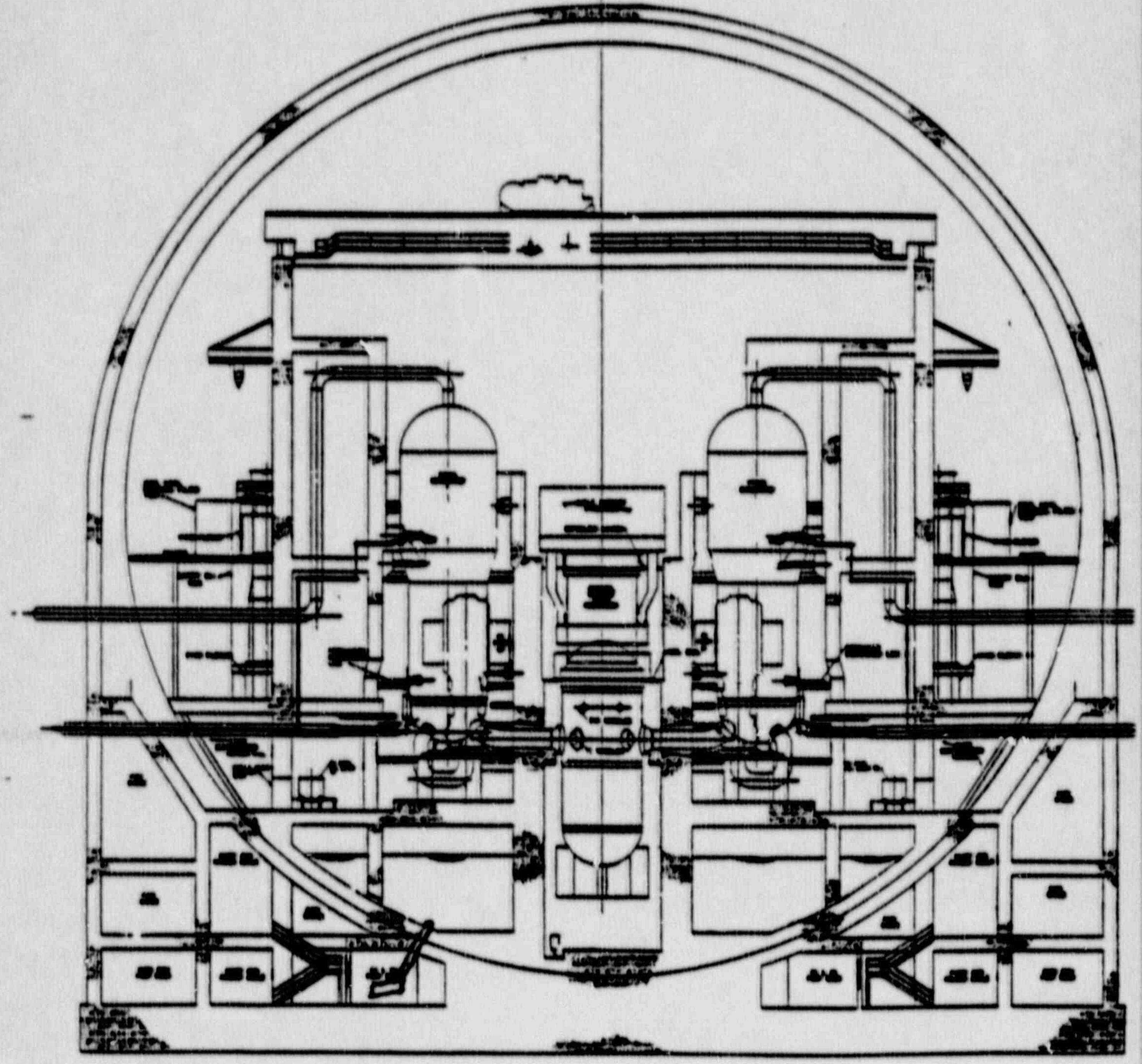
SHIELD BUILDING:

Type	Concrete
Internal Diameter	210 feet
Wall Thickness	3 feet

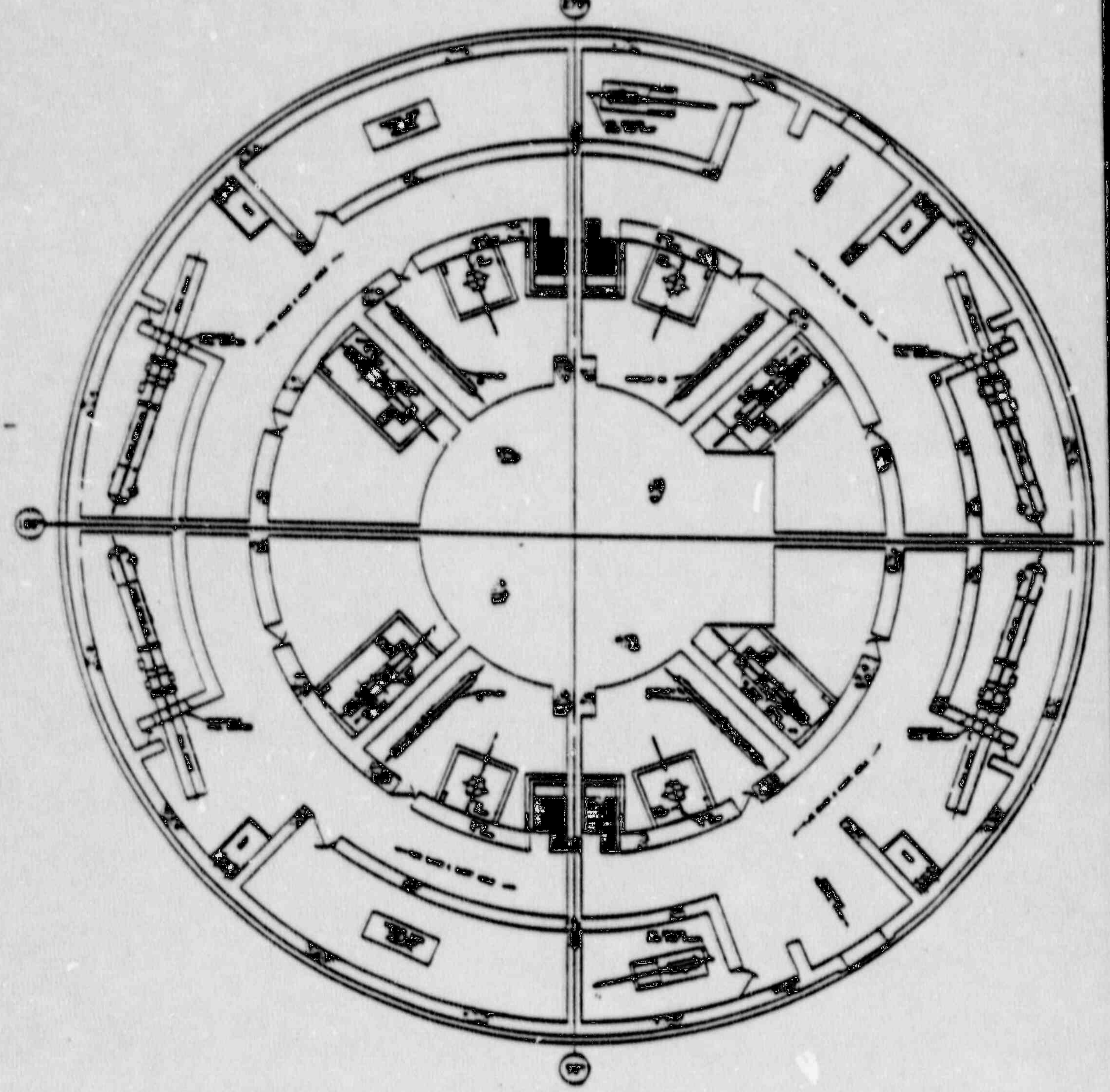


SECTION VIEW 0 - 180

SYSTEM 80+



SECTION VIEW 90 - 270
SYSTEM 80+

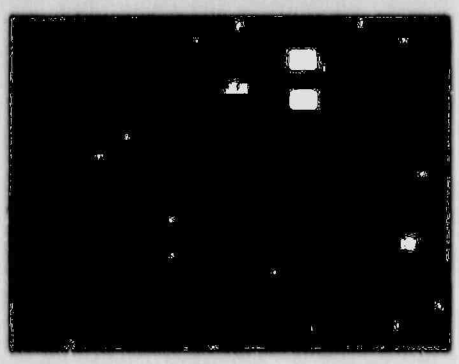


BASEMAT PLAN SUBSPHERE
SYSTEM 80+

SYSTEM 80+ CONTAINMENT...

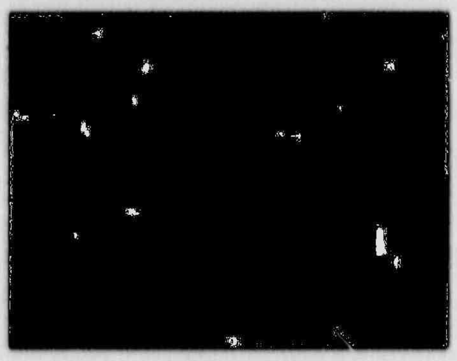
- In-containment Refueling Water Storage Tank (IRWST)
  - Structural Characteristics
    - -- Toroidal, Using Containment Internal Structure as Boundary
    - -- Located Low in Containment for Optimal Space Utilization and Improved Water Return Path
  - Functional Characteristics
    - -- Capacity in Excess of 500,000 Gallons
    - -- Provide Water for Emergency Core Cooling and Refueling
    - -- Provide Energy Sink for Safety Depressurization System
    - -- Eliminates Need for Recirculation Mode of Emergency Core Cooling
    - -- Provide Source of Water for Reactor Cavity Flooding
    - -- Scrubs Radioactive Material from Discharge of Pressurizer Safety Valves and Safety Depressurization System

Nuplex 80 + CRT Displays



Integrated Process Status Overview Display

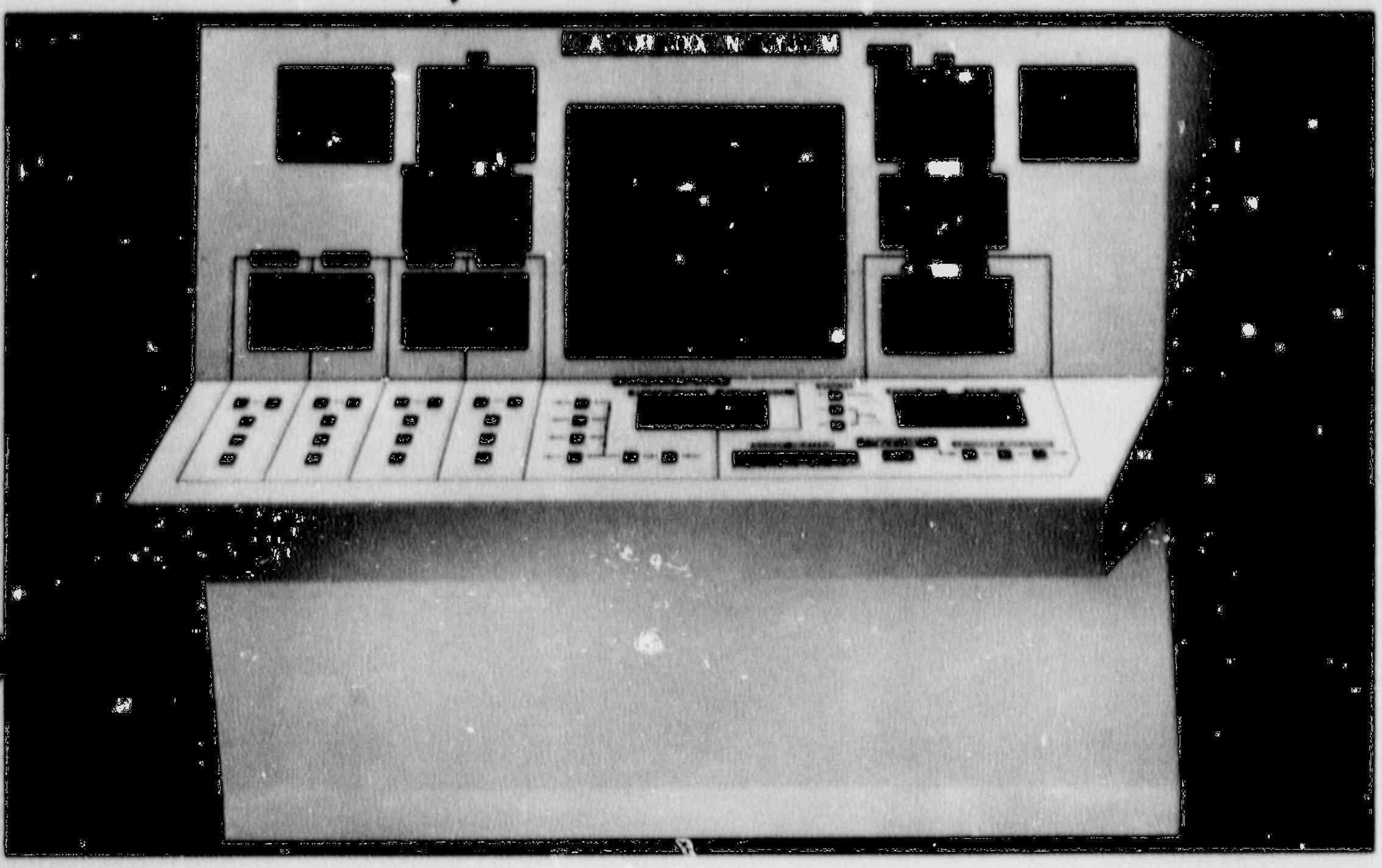
Second Level Critical Function Display



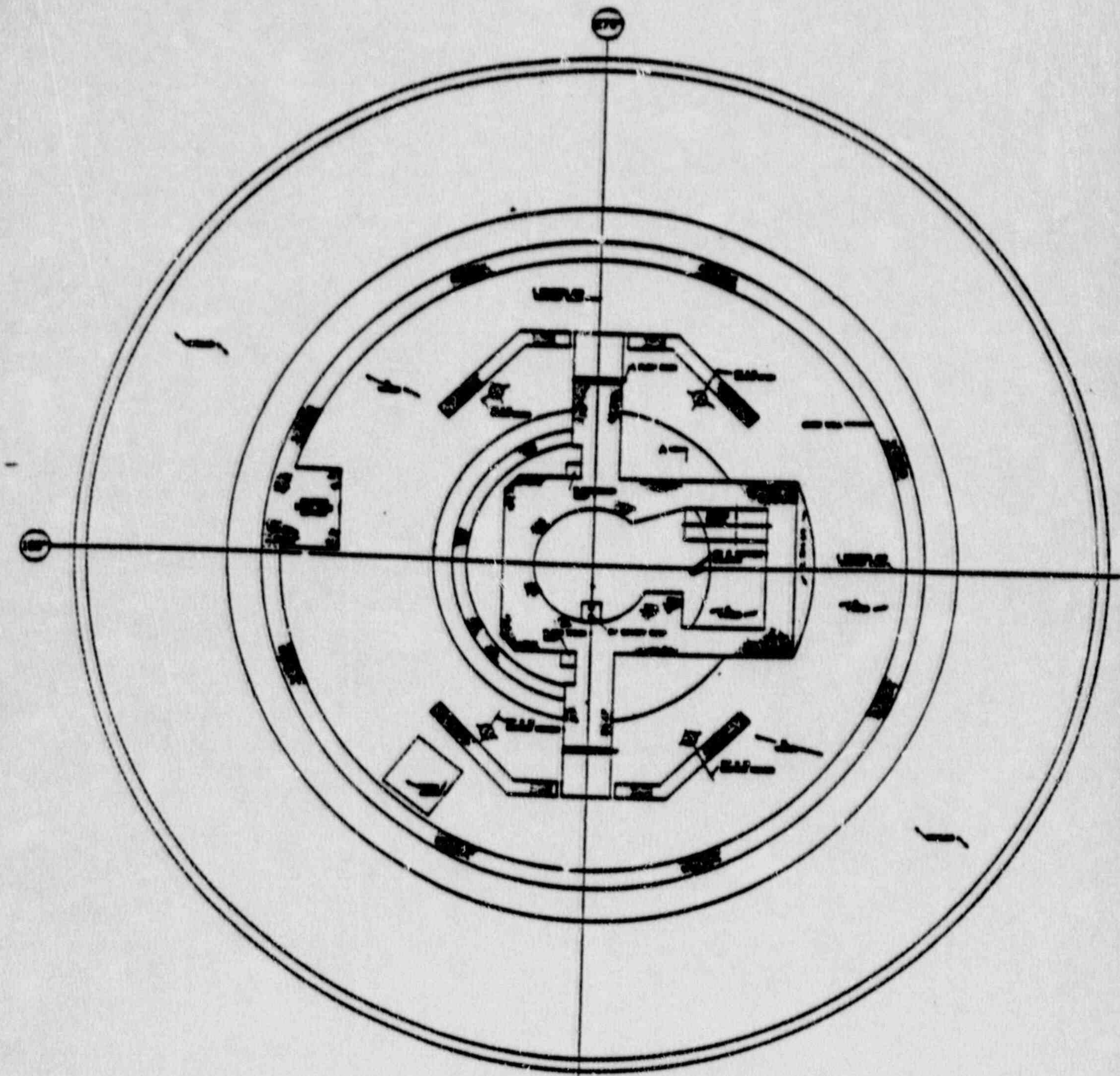
Third Level Diagnostic Display

Third Level Success Path Display

Nuplex 80 + Control Panel



Combustion Engineering, Inc.
1000 Prospect Hill Road
Windsor, Connecticut 06095

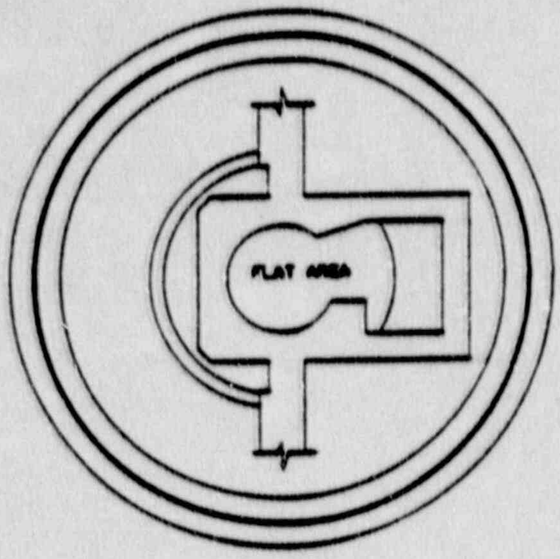


IRWST PLAN
SYSTEM 80+

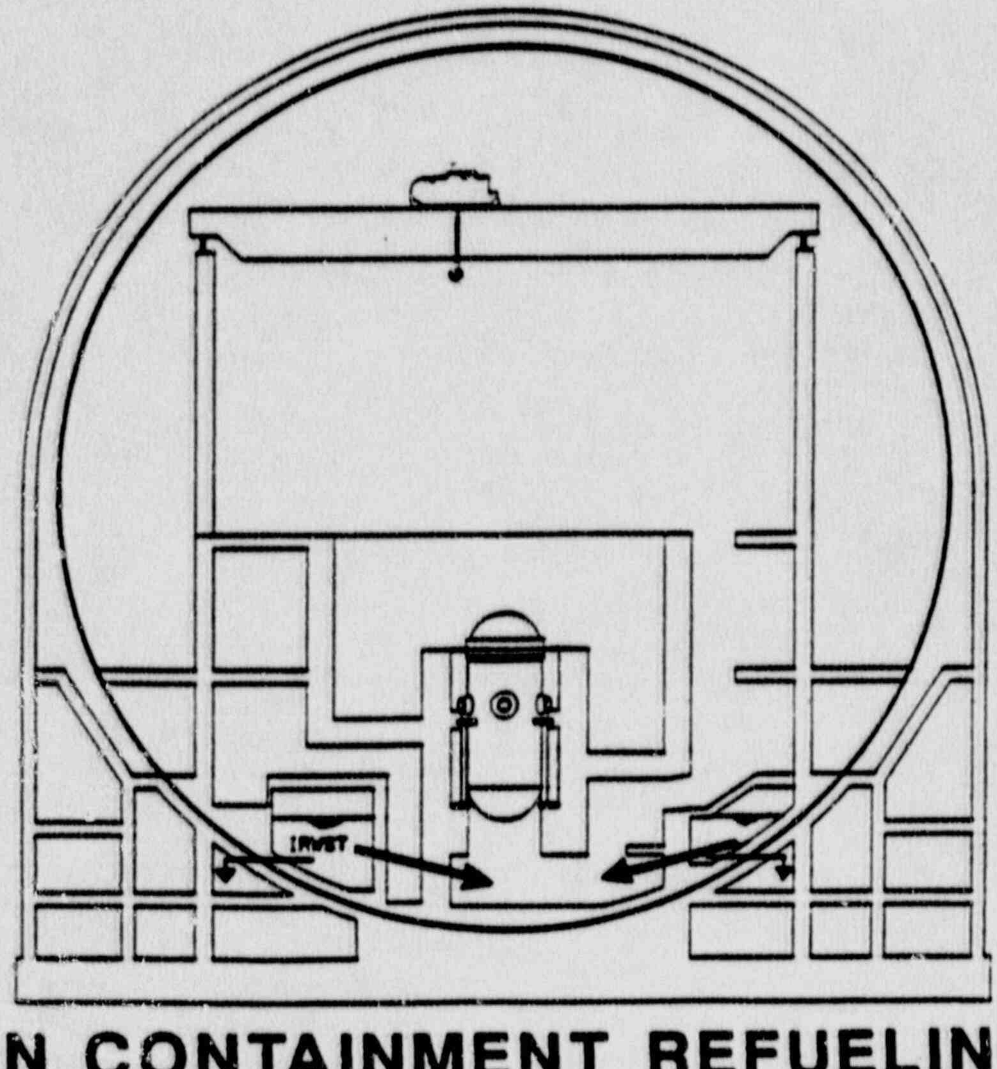
SYSTEM 80+ CONTAINMENT...

DESIGN CHARACTERISTICS FOR SEVERE ACCIDENTS:

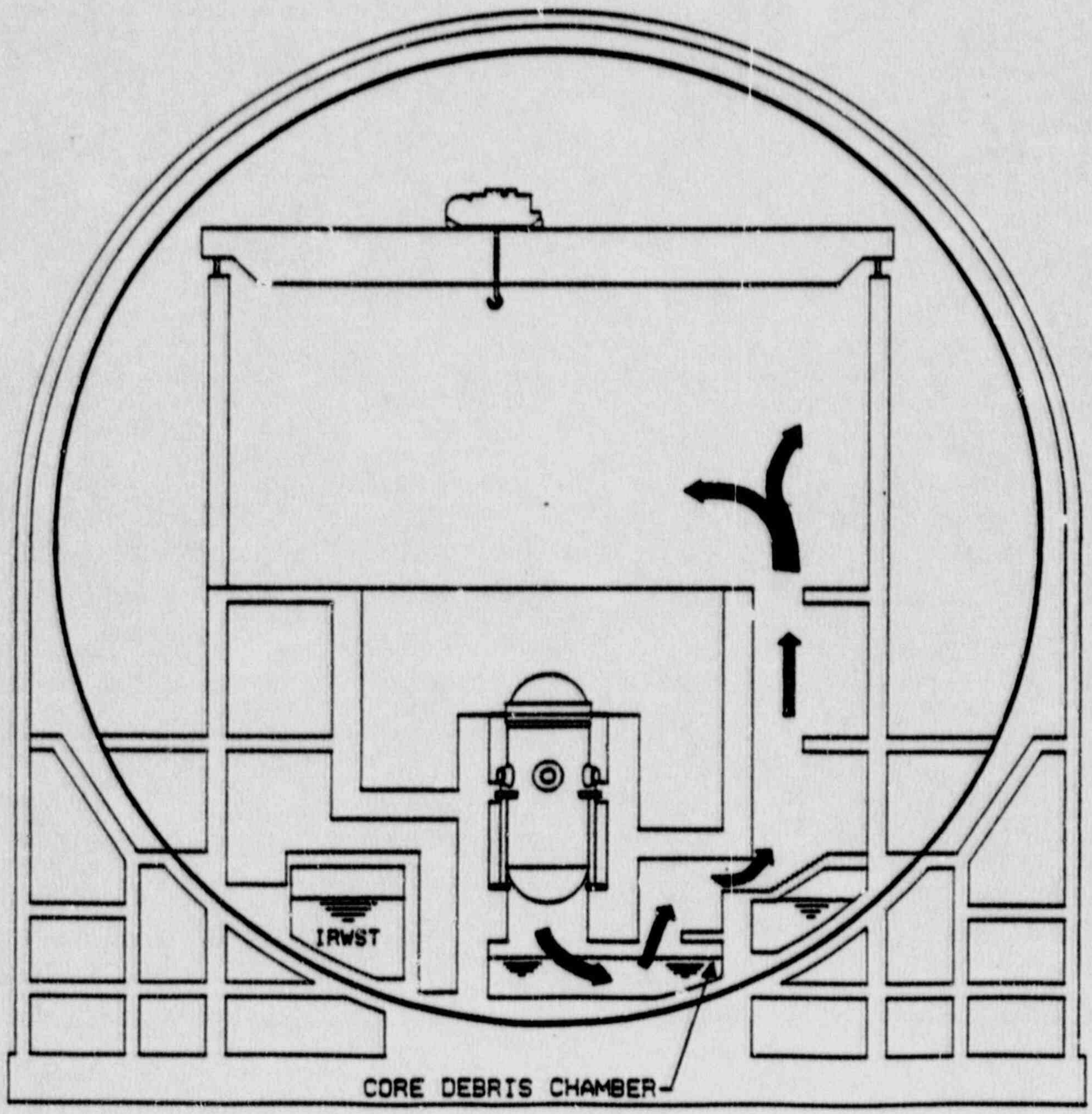
- o LARGE REACTOR VESSEL CAVITY FLOOR AREA FOR DEBRIS COOLABILITY
- o ABILITY TO FLOOD CAVITY FROM IRWST FOR DEBRIS QUENCHING
- o FEATURES TO RETAIN CORE DEBRIS IN REACTOR VESSEL CAVITY TO MINIMIZE DIRECT CONTAINMENT HEATING (TWICE CORE VOLUME)
- o LABORIOUS BUT OPEN AND FREE EXITWAY OUT OF REACTOR VESSEL CAVITY
- o VENT PATHS TO FACILITATE CONTAINMENT ATMOSPHERE MIXING AND HYDROGEN DILUTION



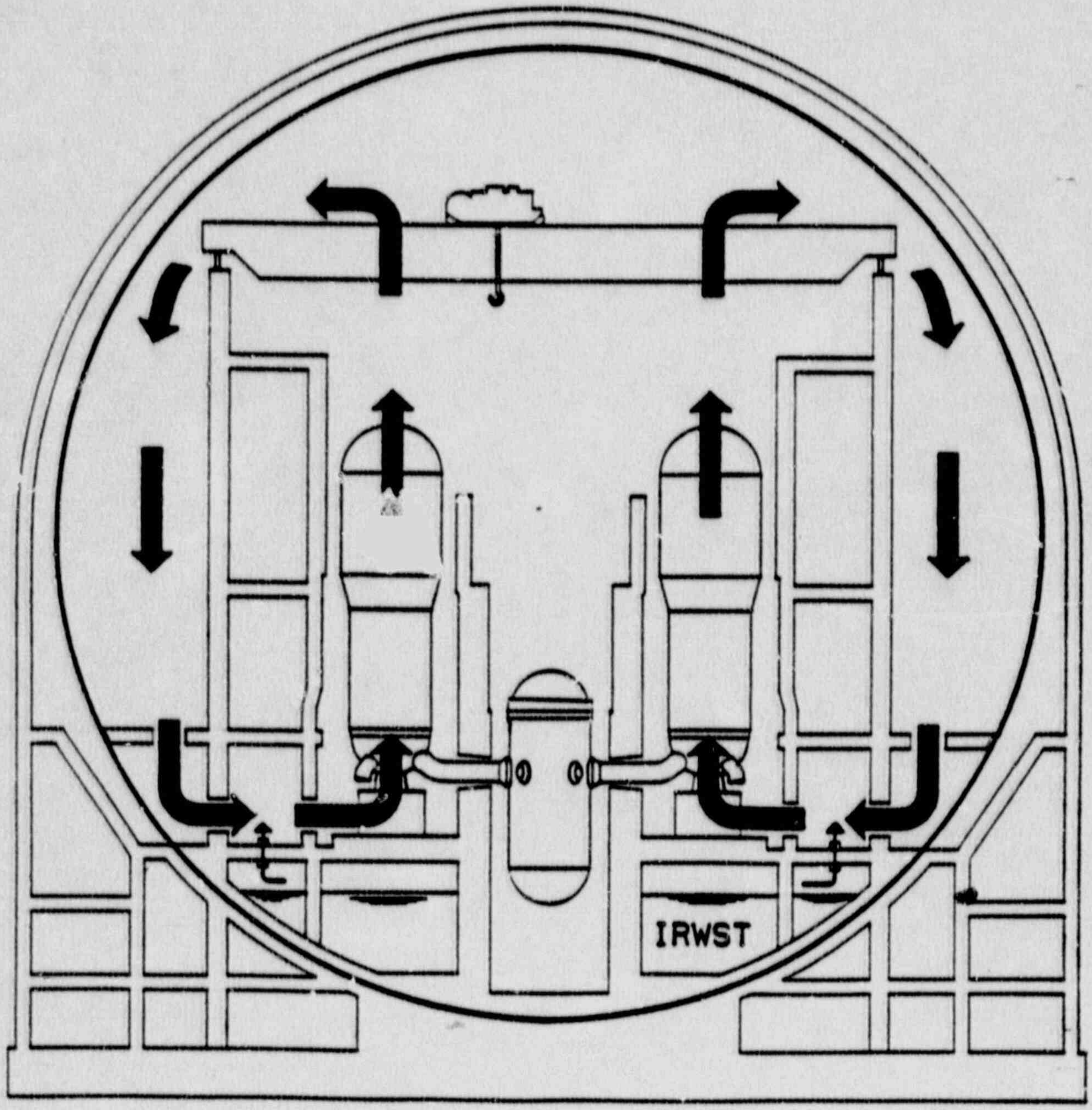
SECTION



IN CONTAINMENT REFUELING WATER STORAGE TANK



SEVERE ACCIDENT MITIGATION



POST-ACCIDENT VENTILATION

FIRE PROTECTION (ISSUE 6):

- o APPROACH:
  - FIRES ARE ADDRESSED SEPARATELY FROM THE DESIGN BASIS AND SEVERE ACCIDENT ANALYSES
  - FIRE ANALYSIS WILL INCLUDE PREVENTION, DETECTION, SUPPRESSION AND CONTAINMENT FEATURES
  - ACCEPTANCE CRITERIA:
    - -- SAFE SHUTDOWN CAN BE ACHIEVED ASSUMING ALL EQUIPMENT ON ANY ONE FIRE AREA IS RENDERED INOPERABLE AND RE-ENTRY FOR OPERATOR ACTION IS NOT POSSIBLE. THE CONTROL ROOM IS EXCLUDED, PROVIDED THAT AN INDEPENDENT, ALTERNATE SHUTDOWN CAPABILITY IS PROVIDED.
    - -- PROTECTION MUST BE PROVIDED FOR REDUNDANT SHUTDOWN SYSTEMS IN CONTAINMENT TO ENSURE TO EXTENT PRACTICAL THAT ONE DIVISION WILL REMAIN FREE OF DAMAGE.
    - -- SMOKE, HOT GASES, AND FIRE SUPPRESSANT WILL NOT MIGRATE TO OTHER AREAS TO ADVERSELY AFFECT SHUTDOWN CAPABILITY.

FIRE PROTECTION . . .

- o DESIGN FEATURES:
  - PLANT ARRANGEMENTS PROVIDE FOR PHYSICAL SEPARATION
    - -- REDUNDANT EQUIPMENT IN SEPARATE ROOMS WITH CLEAR PHYSICAL BARRIERS (FIREWALLS) NOT ONLY BETWEEN DIVISIONS BUT ALSO BETWEEN TRAINS WITHIN EACH DIVISION
    - -- SEPARATE AND DEDICATED PLANT SHUTDOWN CAPABILITY FOR CONTROL ROOM FIRE
  - DETAILED FIRE ANALYSIS WILL BE PROVIDED

OBE/SSE(ISSUE 14):

- DESIGN BASIS:
  - OBE DECOUPLED FROM SSE AND ESTABLISHED INDEPENDENTLY, BASED UPON INVESTMENT PROTECTION.
  - SEISMIC DESIGN SPECTRA INCLUDES LATEST TECHNOLOGICAL DEVELOPMENTS INCLUDING HIGHER AMPLITUDES AT HIGHER FREQUENCY RANGES ALONG WITH AN ENVELOPING SOIL-STRUCTURE INTERACTION ANALYSES
- DESIGN FEATURES:
  - SAFE SHUTDOWN EARTHQUAKE (SSE) PEAK GROUND ACCELERATIONS OF 0.3G.
  - DESIGN BASIS OBE GROUND ACCELERATION OF 0.1G
  - OBE OF 0.1G WILL STILL CONTROL THE DESIGN OF PLANT STRUCTURES AND SOME PIPING SYSTEMS COMPONENTS

SYSTEM 80+ CONTAINMENT...

BENEFITS OF SPHERICAL STEEL CONTAINMENT VESSEL:

- ANALYSIS CONSIDERATIONS
- CONCRETE SHIELD BUILDING
- LARGE SUBSPHERE AREA
- EFFICIENT UTILIZATION OF VOLUME AND SPACE
- UTILIZATION OF INTERIOR STRUCTURAL COMPONENTS
  - CRANE WALL
  - IRWST IN LOWER CONTAINMENT
  - RV CAVITY DESIGN FOR ACCIDENT MITIGATION
  - CONTAINMENT VENTILATION
- SAFETY CONSIDERATIONS
- CONSTRUCTION SCHEDULE IMPROVEMENTS
- OPERATIONS AND MAINTENANCE ADVANTAGES

SYSTEM 80+ CONTAINMENT...

SUMMARY:

- SPHERE BETTER SATISFIES THE FUTURE NUCLEAR PLANT REQUIREMENTS FOR THE SYSTEM 80+™
- MORE POTENTIAL SOLUTIONS FOR SEVERE ACCIDENTS REQUIREMENTS AND SAFETY ISSUES
- OPEN CONTAINMENT MINIMIZES CONGESTION AND EASES OPERATIONS AND MAINTENANCE ACTIVITIES
- PARALLEL PATH CONSTRUCTION ADVANTAGES THUS REDUCING CONSTRUCTION SCHEDULES
- OVER OPERATING LIFE, PROVIDES A MAJOR ADVANTAGE IN EFFICIENCY AND COST

K. Scarola,

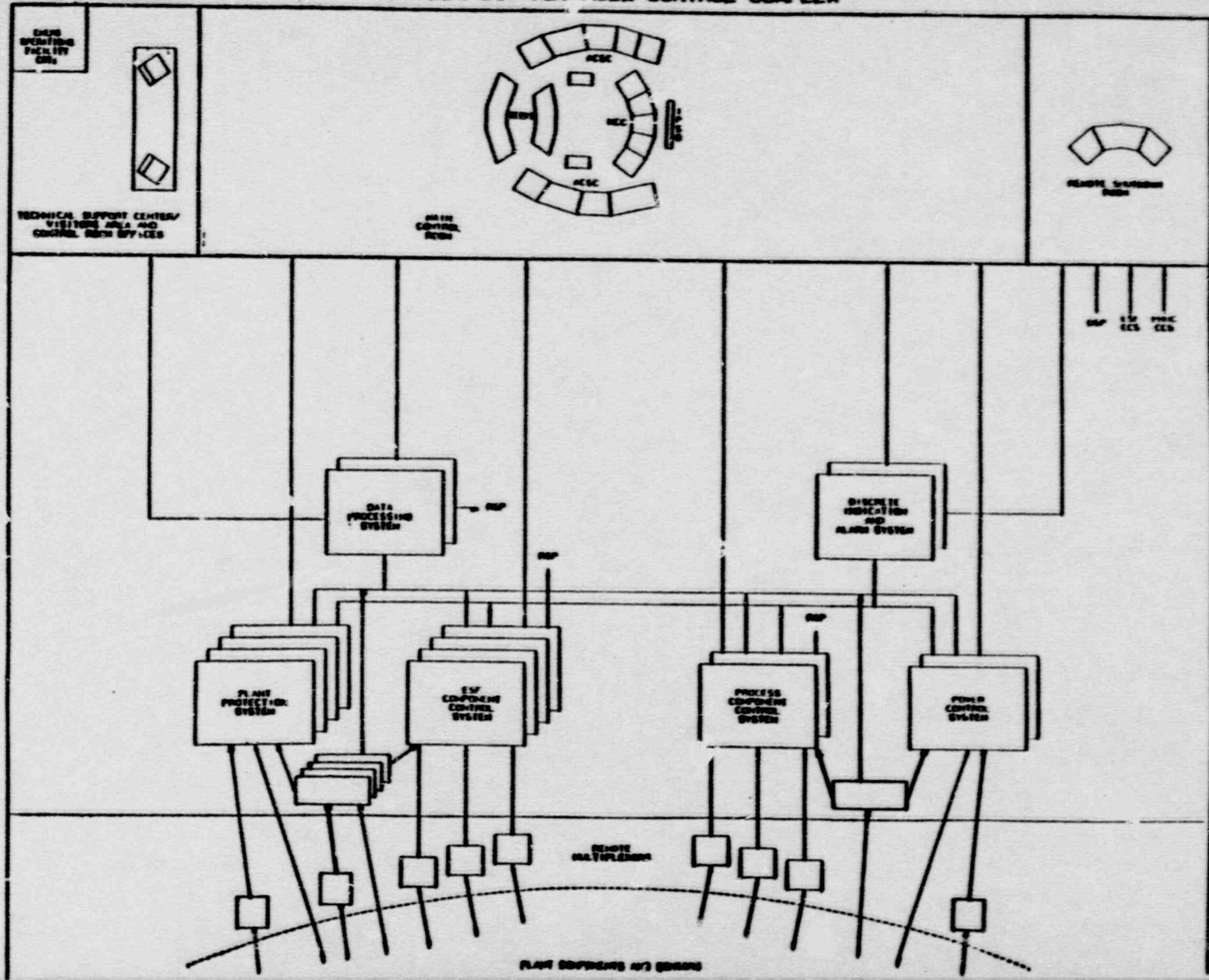
Supervisor

Advanced Instrumentation Design

NUPLEX 80+ DESIGN BASES

- o Meet all Current Regulatory and Industry Requirements for Instrumentation and Controls:
  - Post-TMI Action Plan
  - Human Factors Engineering
  - Fire Protection and Sabotage
  - Verification and Validation
  - PRA
- o To Improve Plant Safety:
  - Digital Protection Systems with Continuous Automatic Testing
  - Four-Train ESFAS
  - Improved Man-Machine Interface
- o To Improve Plant Availability:
  - Fault Tolerant Control Systems
  - Pre-Trip Control Actions
  - Power Dependent Protection Limits
  - Improved Man-Machine Interface
- o To Improve the Cost Effectiveness of Nuclear Power Generation:
  - Lower Construction Costs
  - Shorter Design and Construction Schedules
  - Lower Operation and Maintenance Costs

NUPLEX 80+ ADVANCED CONTROL COMPLEX

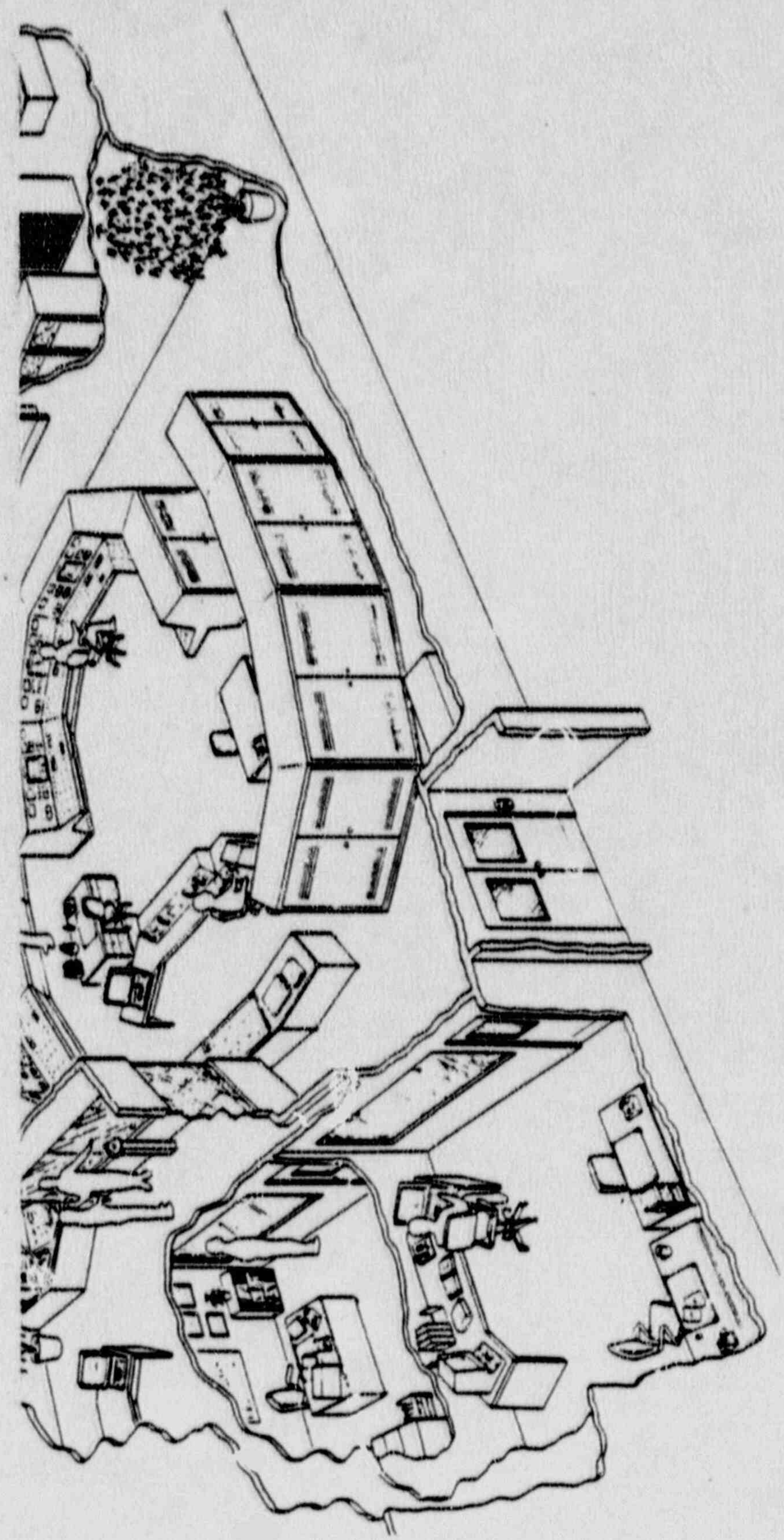


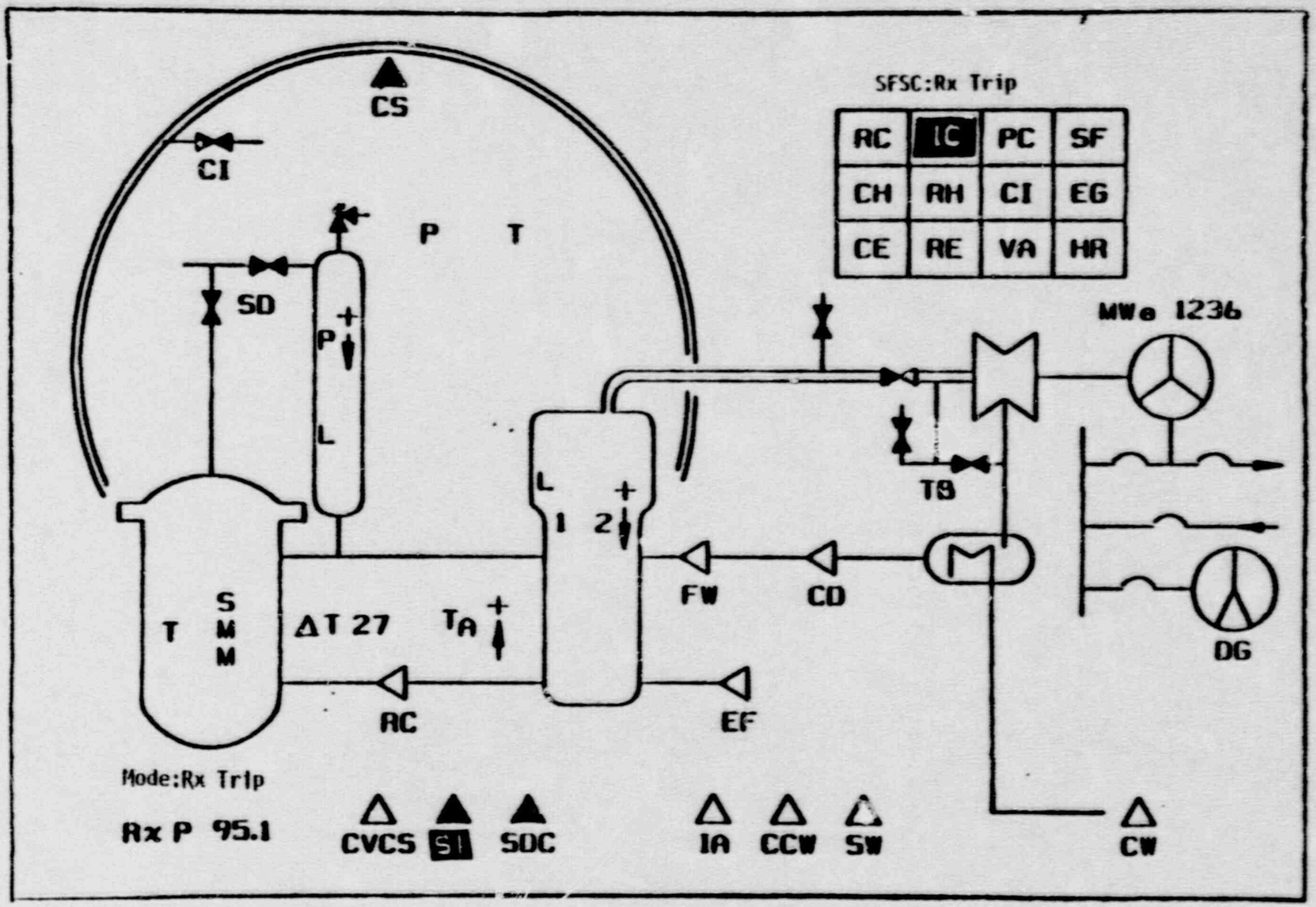
NUPLEX 80+ HUMAN FACTORS APPROACH

- ESTABLISH A MULTIDISCIPLINARY DESIGN AND INDEPENDENT REVIEW TEAM
  - HF SPECIALIST
  - REACTOR OPERATORS
  - NUCLEAR SYSTEM ENGINEERS
  - INSTRUMENT AND CONTROLS ENGINEERS
- PERFORM TOP DOWN INDEPENDENT SYSTEM ANALYSIS
  - FUNCTION ALLOCATION EVALUATION
  - IDENTIFY INFORMATION AND CONTROLS REQUIREMENTS

ATWS (ISSUE 3)

- o DESIGN BASES: 10 CFR 50.62
- o DESIGN FEATURES:
  - DIVERSITY IN NUPLEX 80+ PROVIDES DEFENSE-IN-DEPTH TO PROTECT AGAINST COMMON MODE FAILURES
  - CLASS 1E PLANT PROTECTION SYSTEM
    - -- RPS AND ESFAS
    - -- 4 CHANNELS
    - -- DUAL PROCESSORS IN EACH CHANNEL PROCESSING PRIMARY AND SECONDARY TRIPS FOR EACH EVENT
  - NON-CLASS 1E ALTERNATE PROTECTION SYSTEM
    - -- REACTOR TRIP AND EMERGENCY FEEDWATER ACTUATION
    - -- DIVERSE FROM PPS
  - NON-CLASS 1E TURBINE TRIP
    - -- INDEPENDENT OF AND DIVERSE FROM PLANT PROTECTION SYSTEM




CS
CI
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SFSC:Rx Trip
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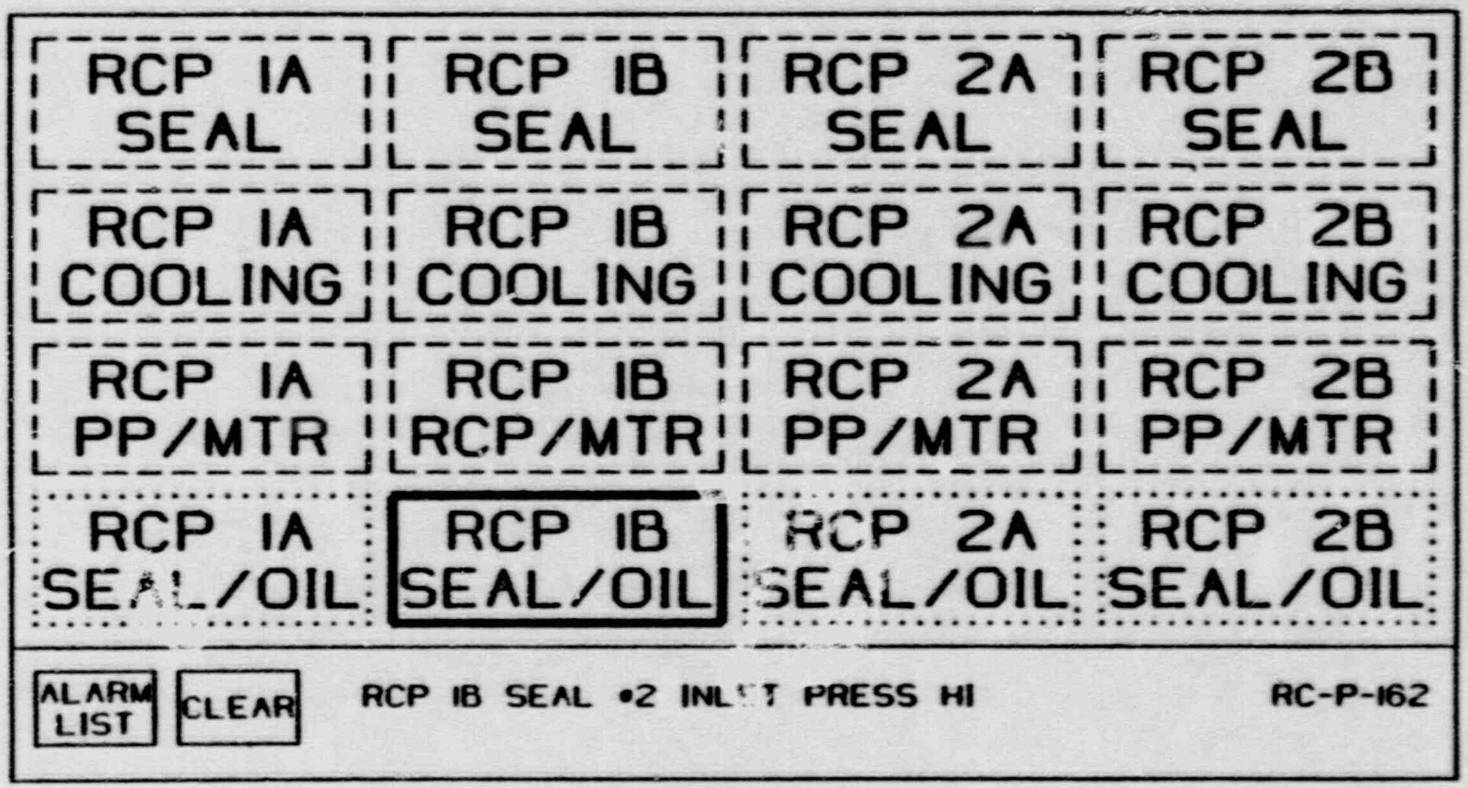


RCP ALARM TILES (DEECO)

CALMA FILE:
I.CI.GONYNORIRCPDWG

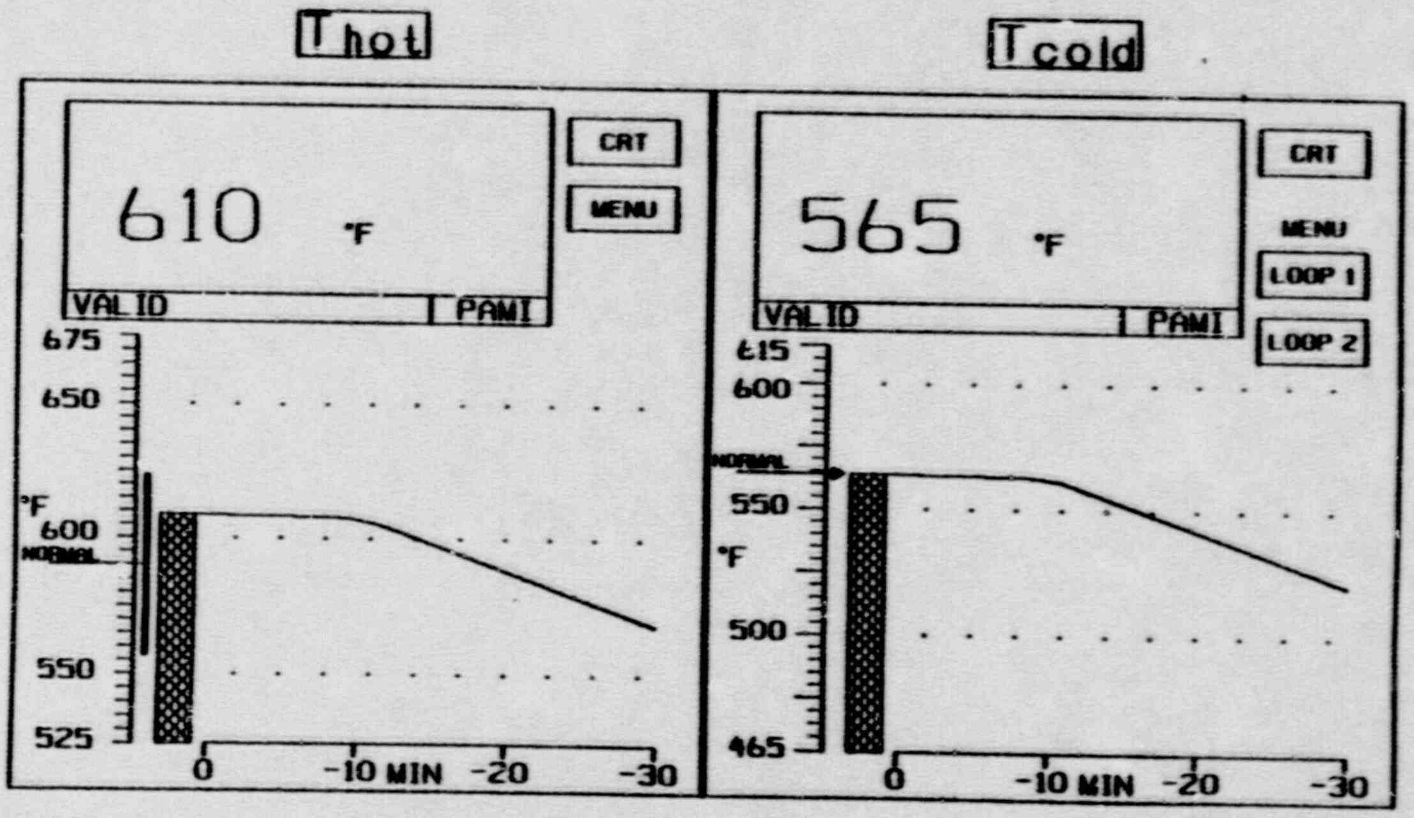
TILE	STATUS	ALARM DESCRIPTION	POINT ID
RCP IB SEAL/OIL		RCP IB SEAL #1 INLET PRESS LO	RC-P-161
	■	RCP IB SEAL #2 INLET PRESS HI	RC-P-162
		RCP IB SEAL #3 INLET PRESS HI	RC-P-163
		RCP IB PP BRG OIL RSVR LVL LO	RC-L-117
		RCP IB MTR LWR OIL RSVR LVL HI	RC-L-118
		RCP IB MTR LWR OIL RSVR LVL LO	RC-L-118
		RCP IB MTR UPR OIL RSVR LVL HI	RC-L-119
		RCP IB MTR UPR OIL RSVR LVL LO	RC-L-119
	■	RCP IB OIL LIFT TANK LVL HI	RC-L-141
		RCP IB OIL LIFT TANK LVL LO	RC-L-141
		RCP IB OIL LIFT PUMP FLOW LO	RC-Y-FRCPIB
		RCP IB OIL LIFT PUMP OUT PRESS LO	RC-Y-PRCPIB

ALARM STATUS

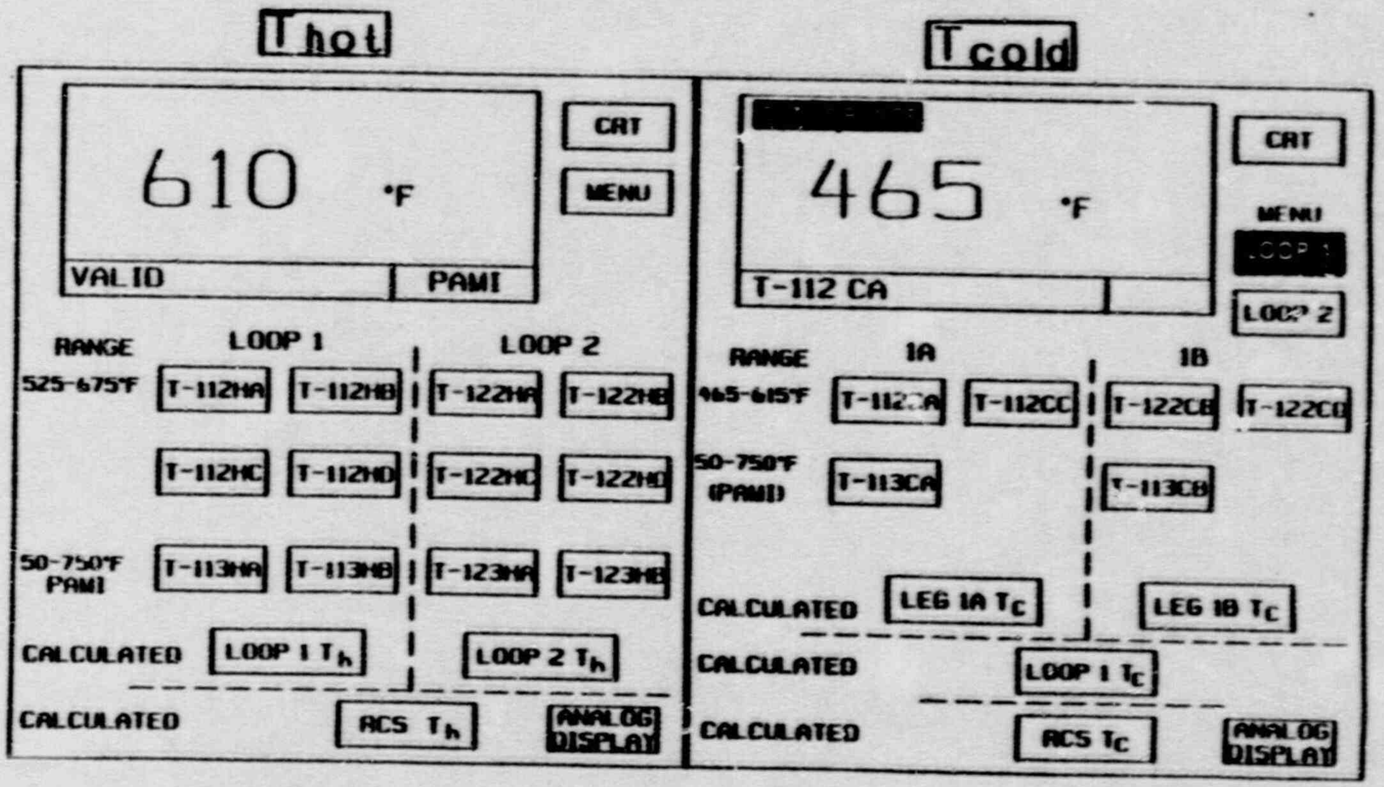
ALARM LIST | CLEAR

RCP IB SEAL/OIL ALARM STATUS PAGE

CALMA FILE:
[.CLGONYNOR]RCPDWG



NPS-PANELFRONTS(SHT1)



NPS-PANELFRONTS(SHT12)

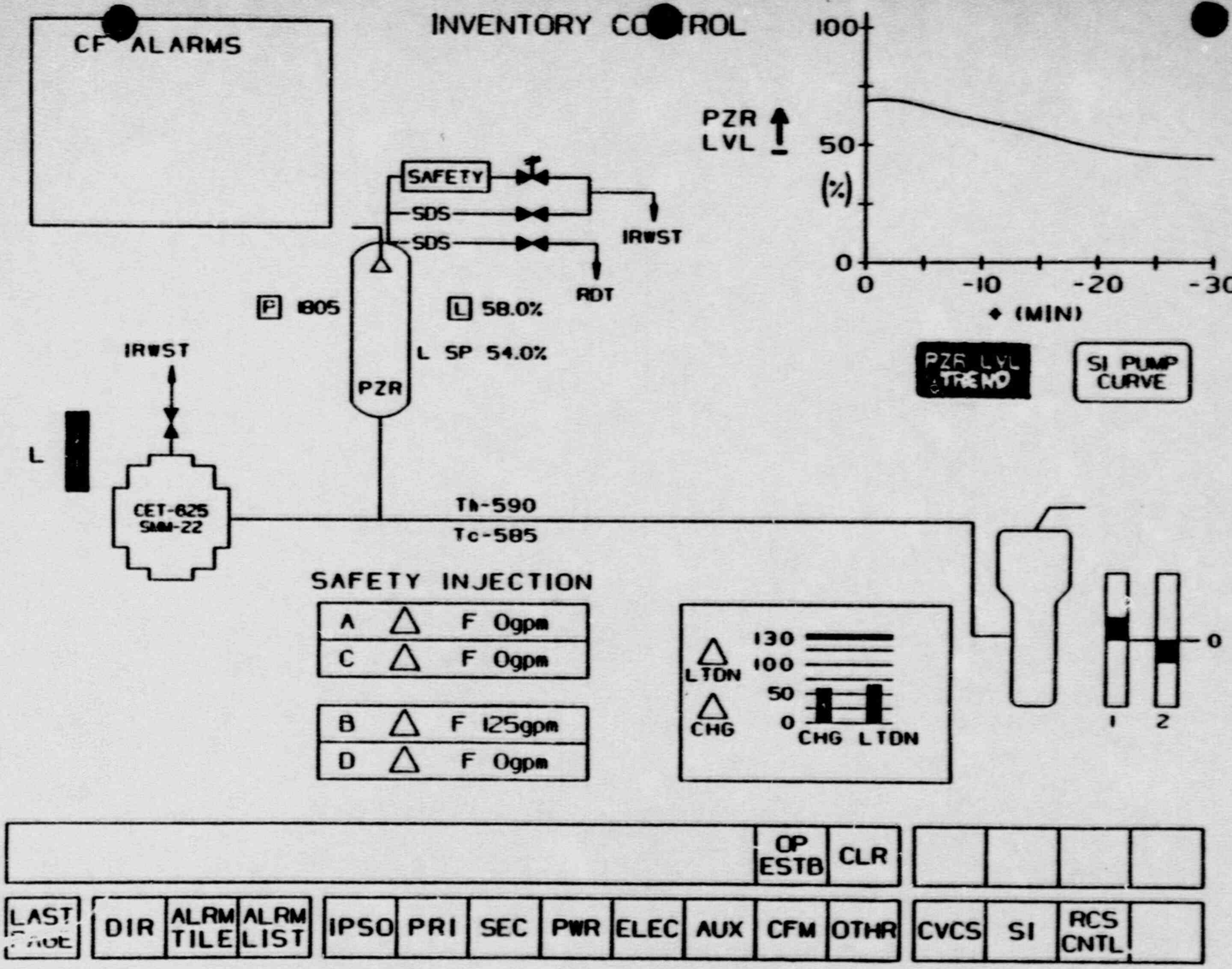
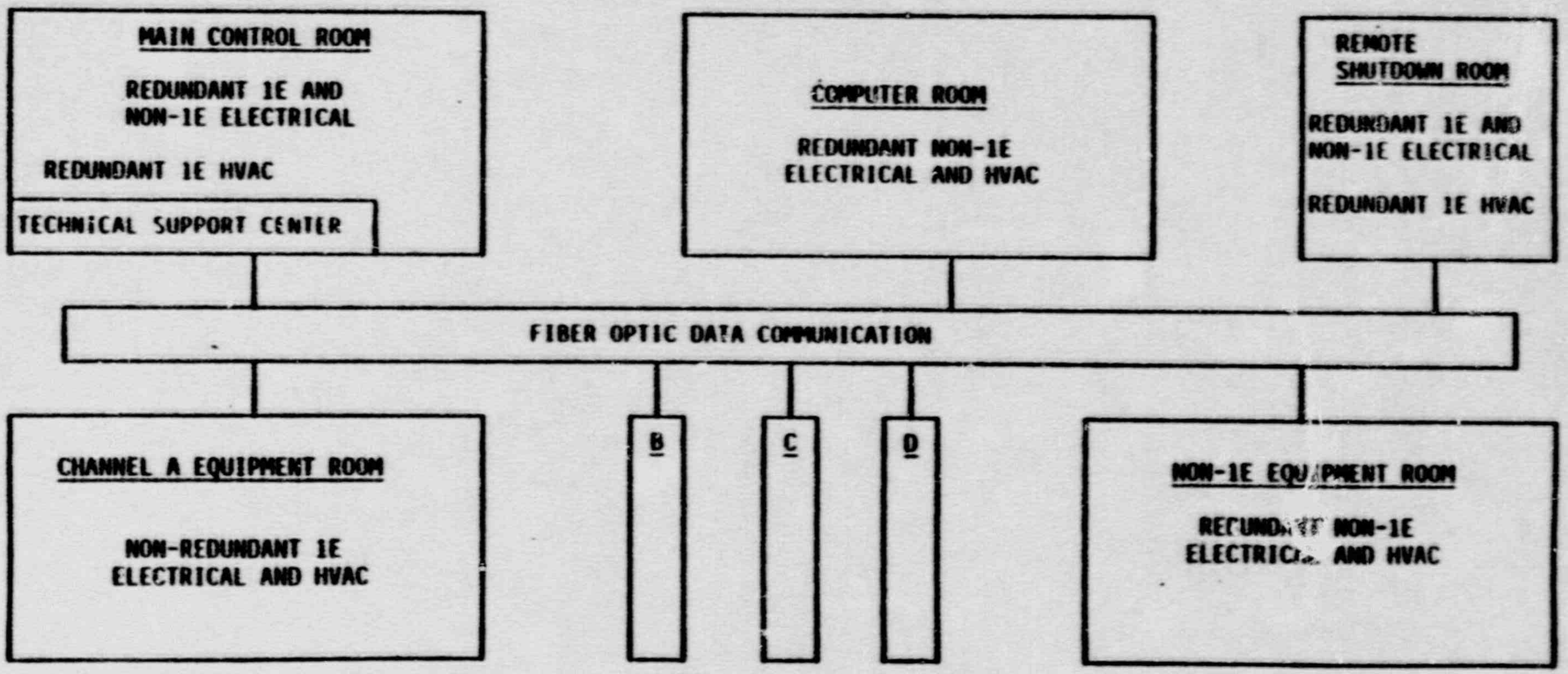


FIGURE 10 INVENTORY CONTROL
TYPICAL 2ND LEVEL CRITICAL FUNCTION DISPLAY PAGE

SLIDE169.DOC

NUPLEX 80+ SEPARATION AND ISOLATION



NUPLEX 80+ DIVERSITY

- NUPLEX 80+ MAXIMIZES STANDARDIZATION WHILE MAINTAINING DIVERSITY IN KEY AREAS TO ENSURE THAT THE DEFENSE IN-DEPTH CONCEPT IS NOT COMPROMISED

- NUPLEX 80+ DIVERSITY:

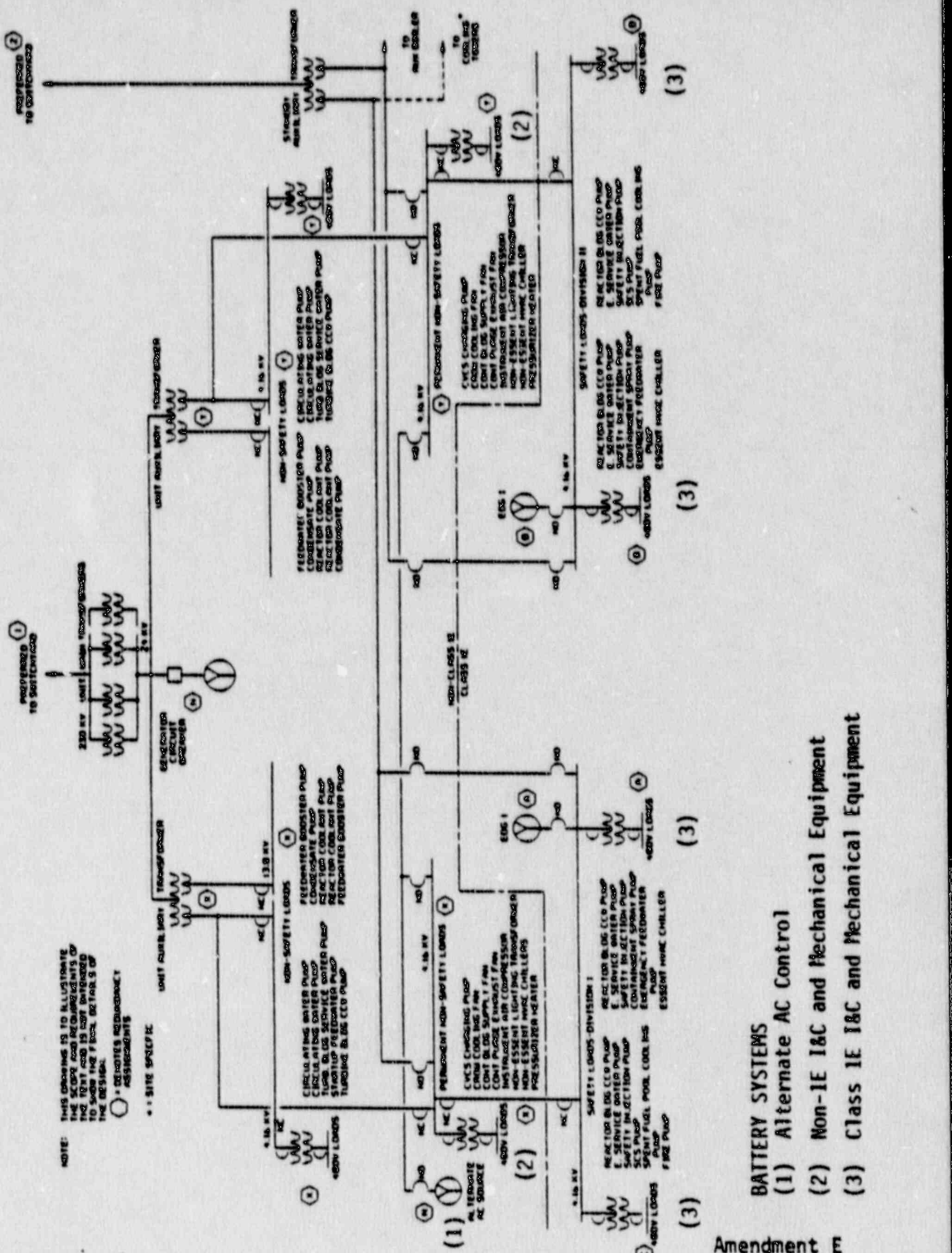
FUNCTION	DESIGN TYPE 1	DESIGN TYPE 2
REACTOR TRIP	PLANT PROTECTION SYSTEM	ALTERNATE REACTOR TRIP WITHIN PROCESS-CCS
FLUID SYSTEM CONTROLS	EMERGENCY SUCCESS PATHS (E.G., EMERGENCY FEEDWATER) VIA ESF-CCS	NORMAL SUCCESS PATHS (E.G., MAIN FEEDWATER) VIA PROCESS-CCS
REACTIVITY CONTROLS	EMERGENCY BORATION VIA ESF-CCS	NORMAL CEA CONTROL - VIA POWER CONTROL SYSTEM
ALARM AND INDICATION	ALARM TILES AND DISCRETE INDICATORS - VIA DIAS	CRT DISPLAYS - VIA DPS
POWER	DIESEL	GAS TURBINE

STATION BLACKOUT (ISSUE 5)

- o DESIGN BASIS: 10 CFR 50.63 AND REGULATORY GUIDE 1.155
- o DESIGN FEATURES:
  - REDUNDANT CLASS 1E DIESEL GENERATORS
  - NON-CLASS 1E GAS TURBINE
  - 8 HOUR BATTERIES
  - REDUNDANT STEAM DRIVEN EMERGENCY FEEDWATER PUMPS

SYSTEM 80+ STATION BLACKOUT PREVENTION

- o NORMAL AC - MAIN GENERATOR
  - PREFERRED GRID
  - ALTERNATE GRID
- o EMERGENCY AC
  - DIESEL GENERATOR I (CLASS 1E)
  - DIESEL GENERATOR II (CLASS 1E)
  - GAS TURBINE GENERATOR (NON-1E)
- o EMERGENCY AC STARTED ON LOSS OF 2-OUT-OF-3 NORMAL AC OR ESFAS
- o RELAXED EMERGENCY AC LOADING DEMANDS
  - DG: 20 SEC
  - GTG: 10 MIN
  - EVENT BASED SEQUENCER MINIMIZES LOAD GROUP SIZE
- o GTG SIZED TO ACCOMMODATE ONE CLASS 1E DIVISION FOR DG FAILURE OR OUT-OF-SERVICE



Amendment E
December 30, 1988

SYSTEM 80+™	TYPICAL UNIT MAIN POWER SYSTEM ONE-LINE	Figure 8.3.1-1

ADDITIONAL NUPLEX 80+ SAFETY IMPROVEMENTS

- PLANT PROTECTION SYSTEM PROVIDES CONTINUOUS SOFTWARE EXECUTION TO VERIFY TRIP LOGIC FUNCTIONALITY
- DPS PROVIDES COMPUTER ASSISTED LOGGING AND VERIFICATION FOR PERIODIC COMPONENT SURVEILLANCE TESTS
- PLANT PROTECTION SYSTEM PROVIDES EVENT BASED SEGMENTATION WITHIN EACH CHANNEL
- PLANT PROTECTION SYSTEM INITIATES PRE-TRIP CONTROL ACTIONS SUCH AS RPC
- MEGAWATT DEMAND SETTER KEEPS PLANT WITHIN OPERATING LIMITS

SUMMARY

- o NUPLEX 80+ ADVANCED CONTROL COMPLEX:
  - LARGE-SCREEN PLANT OVERVIEW DISPLAY
  - TOUCH-SENSITIVE CRT & EL DISPLAYS
  - INTEGRATION OF ACCIDENT AND NORMAL DISPLAYS
  - COMPUTER-PROCESSED DATA REDUCTION AND VALIDATION
  - HIERARCHY OF DEDICATED AND SELECTABLE DISPLAYS
  - PRIORITIZED, MODE DEPENDENT ALARMS
  - MULTIPLEXING
  - OFF-THE-SHELF, FIELD-PROVEN EQUIPMENT AND SOFTWARE
  - AUTOMATIC SELF-TESTING

R. S. TURK

SYSTEM 80+ DEGRADED CORE DESIGN FEATURES

- o Steel Spherical Containment
  - Large Free Volume for Hydrogen Control Under Severe Accident Conditions
  - Vent Paths for Proper Hydrogen Mixing
- o Reactor Cavity
  - Designed to Retain Core Debris and Prevent Direct Containment Heating
  - Large Floor Area to Facilitate Debris Coolability
- o Safety Depressurization Capability of the RCS
- o In-containment Refueling Water Storage Tank
  - Provides Water Supply for Safety Injection and Containment Spray Systems
  - Provides Inventory for the Cavity Flooding System
  - Ability for Self-Cooling Through Any Available Pump/Heat Exchanger Combination
  - Eliminates the Need for Recirculation from the Containment Sump
  - Hydrogen Igniters Can Be Added if Necessary

SYSTEM 80+ DEGRADED CORE DESIGN FEATURES...

- SAFETY DEPRESSURIZATION SYSTEM TO PREVENT VESSEL FAILURE AT HIGH PRESSURE
  - 2500 PSIA TO 400 PSIA WITHIN 1 TO 2 HOURS.
- REACTOR CAVITY CONFIGURATION TO PREVENT DEBRIS TRANSPORT AND PROVIDE COOLABILITY
  - EXIT AREA GREATER THAN AREA AROUND VESSEL
  - COLLECTION VOLUME TWICE CORE VOLUME
  - FLOOR AREA GREATER THAN 0.02 M^2/MWT
  - FLOOD CAPABILITY FROM IRWST
- LARGE CONTAINMENT WITH NATURAL CIRCULATION TO PREVENT H_2 BUILDUP
  - METAL WATER REACTION BASED ON 75% OF CORE METAL
  - 13% LIMIT ON H_2 CONCENTRATION

HYDROGEN GENERATION AND CONTROL (ISSUE 8)

- DESIGN BASIS - EPRI ALWR REQUIREMENTS:
  - HYDROGEN GENERATION EQUIVALENT TO 75% METAL-WATER REACTION OF THE ACTIVE FUEL CLADDING WILL NOT CAUSE THE UNIFORM HYDROGEN CONCENTRATION IN CONTAINMENT TO EXCEED 13 PERCENT BY VOLUME
  - CONTAINMENT DESIGN WILL PROMOTE A MIXED ATMOSPHERE WHICH MAKES THE LOCAL DETONATION OF HYDROGEN UNLIKELY
  - HYDROGEN BURNING WILL NOT RESULT IN FAILURE OF EQUIPMENT NECESSARY TO MAINTAIN CONTAINMENT INTEGRITY
- DESIGN FEATURES:
  - THE SYSTEM 80+ SPHERICAL CONTAINMENT, WITH A FREE VOLUME OF 3.4E+6 FT3, MEETS THE EPRI REQUIREMENTS.
  - USE OF IGNITERS IS NECESSARY FOR HYDROGEN CONTROL ASSUMING 100% METAL-WATER REACTION AND A DETONABILITY LIMIT OF 10%

CORE-CONCRETE INTERACTION/DEBRIS COOLABILITY (ISSUE 9)

- o DESIGN BASIS - EPRI ALWR REQUIREMENTS:
  - ALWRs SHALL PROVIDE SUFFICIENT CAVITY FLOOR SPACE TO ENHANCE CORE DEBRIS SPREADING
  - ALWRs SHALL PROVIDE FOR QUENCHING DEBRIS IN THE REACTOR CAVITY
  - THE STEEL CONTAINMENT (PRESSURE BOUNDARY) SHALL BE PROTECTED FROM CORE DEBRIS BY AT LEAST 3 FEET OF CONCRETE
- o DESIGN FEATURES:
  - TO PROMOTE LONG TERM DEBRIS COOLABILITY, THE SYSTEM 80+ CAVITY FLOOR PROVIDES A MINIMUM OF 0.02 M^2/MWT
  - SYSTEM 80+ CONTAINS AN IN-CONTAINMENT REFUELING WATER STORAGE TANK TO PROVIDE WATER DIRECTLY TO THE CAVITY (METHOD OF DELIVERING WATER TO CAVITY NOT YET FINALIZED).
  - THE CONCRETE BASEMAT THAT LIES BETWEEN THE CAVITY FLOOR AND THE STEEL PRESSURE BOUNDARY HAS A MINIMUM THICKNESS OF THREE FEET AND A THICKNESS OF FIVE FEET DIRECTLY BENEATH THE CAVITY FLOOR (NEAR ITS CENTER).

HIGH PRESSURE CORE MELT EJECTION (ISSUE 10)

- o DESIGN BASIS - EPRI ALWR REQUIREMENTS:
  - PREVENTION; ALWR DESIGNS SHALL INCLUDE A DEPRESSURIZATION SYSTEM FOR THE REACTOR COOLANT SYSTEM TO MINIMIZE THE POSSIBILITY OF A HIGH PRESSURE CORE MELT EJECTION.
  - MITIGATION: ALWR DESIGNS SHALL INCLUDE A REACTOR CAVITY ARRANGEMENT SUCH THAT DEBRIS FROM A HIGH PRESSURE EJECTION IS NOT LIKELY TO EXIT THE CAVITY.
- o DESIGN FEATURES:
  - THE SYSTEM 80+ DESIGN INCLUDES A SAFETY-GRADE DEPRESSURIZATION SYSTEM.
  - THE SYSTEM 80+ CAVITY DESIGN INCLUDES A CORE DEBRIS CHAMBER AND LABYRINTHINE VENT PATH FOR DISENTRAINMENT OF MOLTEN DEBRIS.

"ABWR" CONTAINMENT VENT (ISSUE 12)

- o DESIGN BASIS:

  NONE

- o DESIGN FEATURE:

  A VENT CAN BE ADDED TO THE DESIGN IN THE FUTURE, IF NECESSARY.

EQUIPMENT SURVIVABILITY (ISSUE 13)

- o DESIGN BASIS:
  - ENSURE THAT SYSTEMS AND EQUIPMENT REQUIRED TO MITIGATE SEVERE ACCIDENTS ARE AVAILABLE TO PERFORM THEIR INTENDED FUNCTION.
  - SYSTEMS AND EQUIPMENT REQUIRED ONLY FOR SEVERE ACCIDENT PREVENTION AND MITIGATION NEED NOT BE SUBJECT TO 10 CFR 50.49 ENVIRONMENTAL QUALIFICATION REQUIREMENTS, 10 CFR PART 50, APPENDIX B QUALITY ASSURANCE REQUIREMENTS AND 10 CFR PART 50, APPENDIX A REDUNDANCY/DIVERSITY REQUIREMENTS.
- o DESIGN FEATURES:
  - REASONABLE ASSURANCE WILL BE PROVIDED THAT EQUIPMENT REQUIRED TO COPE WITH SEVERE ACCIDENTS WILL OPERATE IN THE ENVIRONMENT AND TIME SPAN FOR WHICH IT IS NEEDED.
    - -- RUGGED, BEST-ESTIMATE DESIGN REQUIREMENTS
    - -- REALISTIC EVALUATION
    - -- SUPPLEMENTAL PHYSICAL PROTECTION (E.G., COVERS, BARRIERS)

R. E. Jaquith,

Supervisor

Reliability Systems

PROBABILISTIC RISK ASSESSMENT

OBJECTIVES:

- o COMPLY WITH SEVERE ACCIDENT POLICY STATEMENT PROVIDING A LEVEL III PRA FOR THE SYSTEM 80+ DESIGN.
- o DEMONSTRATE COMPLIANCE WITH EPRI ALWR MEAN CORE DAMAGE FREQUENCY GOAL OF 1.0E-5 EVENTS/YEAR.
- o DEMONSTRATE COMPLIANCE WITH LARGE RELEASE GOAL OF 1.0E-6 EVENTS/YEAR.
- o DEMONSTRATE CONTAINMENT PERFORMANCE/ RELIABILITY.
- o SUPPORT EVALUATION OF DESIGN CHANGES AND DEMONSTRATION THAT SYSTEM 80+ PROVIDES AN INCREASED LEVEL OF SAFETY.

PROBABILISTIC RISK ASSESSMENT

APPROACH:

- o Establish Baseline PRA for System 80
- o Use PRA as Evaluation Tool for Assessment of Design Changes
- o Prepare Level III PRA For System 80+

SYSTEM 80+ PRA
CORE DAMAGE FREQUENCY (INTERNAL EVENTS)

INITIATING EVENT	CORE DAMAGE FREQUENCY (WITH RECOVERY) (MEAN/YEAR)
LARGE LOCA	3.54E-8
MEDIUM LOCA	8.62E-8
SMALL LOCA	4.31E-8
LOSS OF FEEDWATER	5.84E-9
OTHER TRANSIENTS	4.64E-9
STEAMLINE BREAKS	2.74E-10
S.G. TUBE RUPTURE	1.38E-7
LOSS OF OFFSITE POWER + SBO	9.14E-8
ATWS	1.97E-7
LOSS OF CCW/SSW	1.25E-8
LOSS OF 4.16KV BUS	2.75E-11
LOSS OF 125 VDC BUS	2.61E-12
INTERFACING SYSTEM LOCA	3.01E-9
VESSEL RUPTURE	1.00E-7
TOTAL	7.17E-7

CORE DAMAGE FREQUENCY (INTERNAL & EXTERNAL EVENTS)*

INTERNAL EVENTS	7.2E-7
SEISMIC	8.6E-7
TORNADO STRIKE	6.6E-9
TOTAL	1.6E-6

* FIRES AND INTERNAL FLOODS ARE BEING EVALUATED SEPARATELY; CORE DAMAGE FREQUENCY CONTRIBUTION EXPECTED TO BE SMALL DUE TO THE DIVISION OF THE CONTAINMENT.

CONTAINMENT PERFORMANCE (ISSUE 11)

- OBJECTIVES:
  - DEMONSTRATE RUGGEDNESS OF THE CONTAINMENT DESIGN BY PREDICTING THE RELIABILITY FOR SEVERE ACCIDENT SCENARIOS.
  - THE CONDITIONAL UNAVAILABILITY OF THE CONTAINMENT, GIVEN A SEVERE ACCIDENT, SHALL NOT EXCEED APPROXIMATELY 1.0E-1 PER DEMAND WHEN WEIGHTED OVER CREDIBLE CORE DAMAGE SEQUENCES,

    - OR -

    DETERMINISTIC ANALYSIS SHALL DEMONSTRATE COMPARABLE PROTECTION.
- RESULTS:
  - LEVEL II PRA NOT YET COMPLETE

PUBLIC SAFETY GOALS (ISSUE 1)

- o OBJECTIVE:
  - COMPLY WITH THE SAFETY GOAL POLICY STATEMENT

- o RESULTS:
  - MEET MEAN CORE DAMAGE FREQUENCY GOAL OF 1.0E-5 EVENTS/YEAR.
  - MEET LARGE OFFSITE RELEASE GOAL OF 1.0E-6 EVENTS/YEAR.
  - EVALUATE DESIGN CHANGES WITH RESPECT TO THE ABOVE GOALS.
  - DEMONSTRATE A SUBSTANTIALLY INCREASED LEVEL OF SAFETY RELATIVE TO CURRENT GENERATION PLANTS.

RISK REDUCING FEATURES FOR DOMINANT SEQUENCE #1

SEQUENCE TYPE - Loss of Offsite Power (LOOP) including Station Blackout with Battery Depletion

REPRESENTATIVE DOMINANT SEQUENCE

(LOOP) (FAILURE of EFW)

FREQUENCY

OLD - 3.8E-5
NEW - 9.1E-8

FEATURES

- o Alternate AC Power Source (Gas Turbine)
- o Separate Offsite Power Source that Bypasses the Switchyard
- o Dedicated Battery for Each Diesel Generator
- o Four Train Emergency Feedwater (two with Turbine Driven Pumps
- o Turbine Generator Able to Run Back to Hotel Load.

RISK REDUCING FEATURES FOR DOMINANT SEQUENCE #2

SEQUENCE TYPE - TRANSIENTS

REPRESENTATIVE DOMINANT SEQUENCE

(LOFW) (FAILURE TO DELIVER EMERGENCY FW)

FREQUENCY

OLD - 1.2E-5
NEW - 2.3E-8

FEATURES

- o FOUR TRAIN EMERGENCY FEEDWATER SYSTEM
- o REDUNDANT SOURCES OF EMERGENCY FEEDWATER
  - 2 EFW TANKS
  - CONDENSATE STORAGE TANKS
- o HIGH RELIABILITY COMPONENT COOLING SYSTEM
  - TWO PUMPS PER TRAIN
  - NORMALLY RUNNING
- o START-UP FEEDWATER SYSTEM
  - FROM CONDENSATE STORAGE TANK
  - ACTUATED BEFORE EFW
- o FULL RUN-BACK CAPABILITY
- o TWO EFW ACTUATION SYSTEMS
  - REDUNDANT
  - DIVERSE

RISK REDUCING FEATURES FOR DOMINANT SEQUENCE #3

SEQUENCE TYPE - STEAM GENERATOR TUBE RUPTURE

REPRESENTATIVE DOMINANT SEQUENCE

(SGTR) (FAILURE TO DELIVER EFW)
(SGTR) (FAILURE OF SAFETY INJECTION)

FREQUENCY

OLD - 1.1E-5
NEW - 1.4E-7

FEATURES

- o FOUR TRAIN EMERGENCY FEEDWATER SYSTEM
- o FOUR TRAIN SAFETY INJECTION SYSTEM
- o SAFETY DEPRESSURIZATION SYSTEM

RISK REDUCING FEATURES FOR DOMINANT SEQUENCE TYPE #4

SEQUENCE TYPE - SMALL LOCA

REPRESENTATIVE DOMINANT SEQUENCE

(SMALL LOCA) (FAILURE OF SI RECIRCULATION)
(SMALL LOCA) (FAILURE OF SI INJECTION)

FREQUENCY

OLD - 9.4E-6
NEW - 4.3E-8

FEATURES

- IN-CONTAINMENT REFUELING WATER STORAGE TANK
- FOUR TRAIN SAFETY INJECTION SYSTEM
- ELIMINATION OF RAS
- SAFETY DEPRESSURIZATION SYSTEM

RISK REDUCING FEATURES FOR DOMINANT SEQUENCE #5

SEQUENCE TYPE - ATWS

REPRESENTATIVE DOMINANT SEQUENCES
(ATWS) (ADVERSE MTC)

FREQUENCY
OLD - 4.8E-6
NEW - 2.0E-7

FEATURES

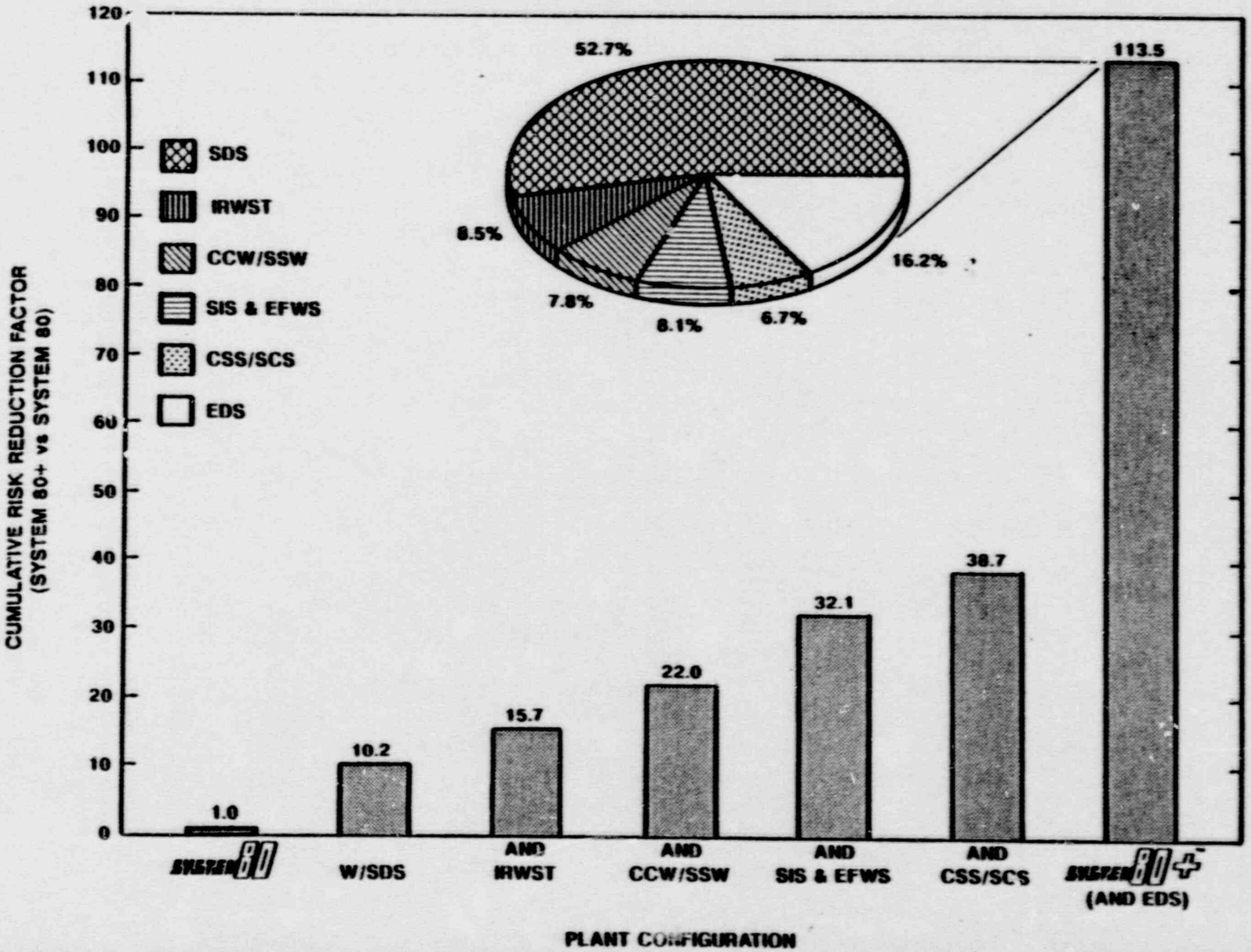
- o LARGER PRESSURIZER
- o LARGER STEAM GENERATOR
- o SAFETY DEPRESSURIZATION SYSTEM
- o DIVERSE PROTECTION SYSTEM

CORE DAMAGE FREQUENCY COMPARISON

INTERNAL EVENT	FREQUENCY (MEAN/YEAR) SYSTEM 80+	SYSTEM 80*
Large LOCA	3.54E-8	1.57E-6
Medium LOCA	8.62E-8	3.59E-6
Small LOCA	4.31E-8	9.41E-6
Large SLB	2.74E-10	9.04E-7
SGTR	1.38E-7	1.05E-5
Transients:	2.30E-8	1.17E-5
Loss of Ffedwater Flow		
Other Transients		
Loss of Component Cooling Water		
Loss of 4.16 Kv Vital Bus		
Loss of 125 VDC Vital Bus		
LOOP/SBO	9.14E-8	3.78E-5
ATWS	1.97E-7	4.79E-6
IS-LOCA	3.01E-9	4.48E-9
RV Rupture	1.00E-7	1.00E-7
TOTAL	7.17E-7	8.14E-5

*Typical; Not Plant Specific

IMPACT OF SYSTEM 80+ DESIGN FEATURES ON SEVERE ACCIDENT RISK
(Core Damage Frequency, Internal Events)



DOMINANT CONTRIBUTORS TO SEVERE ACCIDENT RISK
(Core Damage Frequency, Internal Events)