ACRST-1767

ORIGINAL

OFFICIAL TRANSCRIPT OF PROCEEDINGS

Agency: Nuclear Regulatory Commission
Advisory Committee on Reactor Safeguards

Title: Subcommitee on Advanced
Pressurized Water Reactors

Docket No.

LOCATION: Bethesda, Maryland

DATE: Friday, November 3, 1989 PAGES: 1 - 231

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UNITED STATES NUCLEAR REGULATORY COMMISSION'S

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

DATE: FRIDAY, NOVEMBER 3, 1989

The contents of this transcript of the proceedings of the United States Nuclear Regulatory Commission's Advisory Committee on Reactor Safeguards, (date) Friday, November 3, 1989, 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

ADVANCED PRESSURIZED WATER REACTORS

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PUBLIC MEETING

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Nuclear Regulatory Commission
7920 Norfold Avenue
Room 110
Bethesda, Maryland

FRIDAY, NOVEMBER 3, 1989

The Commission met in open session, pursuant to notice, at 8:30 a.m., J. Carroll, Chairman, presiding.

ACRS MEMBERS PRESENT:

J. CARROLL, Chairman
I. CATTON
D. WARD
C. WYLIE
C. MICHELSON
N. EL-ZEFTAWY

ACRS STAFF MEMBERS PRESENT:

C. MILLER

L. DONATELL

H. L. BRAMMER

H. WALKER

T. KENYON

C. Y. LIANG

N. TREHAN

WESTINGHOUSE MEMBERS PRESENT:

M.H. SHANNON

R.S. ORR

T. VAN DE VENNE

B.F. MAURER

J. MILLER

R.M. WILSON

W.M. SCHIVLEY

P R O C E E D I N G S

[8:30 a.m.]

MR. CARROLL: The meeting will now come to order. This is a meeting of the Advisory Committee on Reactor Safeguards, Subcommittee on Advanced Pressurized Water Reactors. I'm J. Carroll, subcommittee chairman.

The other members of ACRS in attendance are, on my right, Charlie Wylie, on my immediate left, Ivan Catton. The fellow nobody wants to sit next to is Dave Ward. I believe Carl Michelson will be here a bit later.

The purpose of this meeting is to continue the discussion and review of the Westinghouse Advanced Pressurized Water Reactor, RESAR SP/90 design. Ned El-Zeftawy 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 on October 18th, 1989. A transcript of the meeting is being kept and will be made 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.

A couple of comments before we get started, I guess. Since most of the committee members have been here since Tuesday and want to go home, I polled everybody but you, Charlie. I guess we'll probably break the meeting up around 4:00 so that people can catch their airplanes. I thought the Westinghouse people might want to know that in case they wanted to make some travel plan changes.

I can we can proceed witn the meeting and I'll call on Charlie Miller who wants to make some preliminary remarks about the status of priorities -- is that the subject?

MR. C. MILLER: Thank you, Mr. Chairman.

I just wanted to make a few opening remarks and then I'll be turning over our portion of the presentation on the project to Loren Donatell. As recently as this week, Westinghouse had briefed to the Commission and basically the status of their review, their philosophy with regards to advanced reactors and how they see themselves fitting into the scheme of things. One of the things that I wanted to set the stage for again this morning is how many of the subcommittee members are also members of some of the other subcommittees for evolutionary plant reviews.

I think we have to put on this morning is a hat and remember that this is a TDA and not an FDA. That's something that we have trouble with, how to get into the review at the TDA stage. The staff basically has a goal of trying to get this wrapped up -- this portion of the review wrapped up as soon as possible. Westinghouse has stated its intentions to do so today.

We recognize that in doing it at this stage, there are probably going to be open items left until such a time as receipt of an PDA. I think what we are trying to accomplish is to get to a point where we can neatly tie this up into a package and put a ribbon on it. Basically, for lack of a better word, get it on the street and set it aside and recognize that we're not going to be able to close everything. As we proceed in this meeting and in some of the upcoming meetings on the subject, I think you'll see as we go along, our plan on trying to reach that goal.

I recognize that there are certain policy issues that we have been wrestling with and discussed in our various meetings with the committee. It may not yet have reached what I would call sufficient maturity that the agency is ready to take a position on it yet. That is also something that we have to figure out, a neat way to wrap up with regard to this.

A call to some of the severe accident considerations. With those remarks, I would like to turn to the formalities over Loren Donatell.

MR. MICHELSON: I'll go ahead, Carl. When we talk about closure of a P.D.A., what are we really saying? What does closure mean on a particular item or a particular design? Let's take the case of a residual heat removal system defined in some manner an A level. Right off on that at the P.D.A., what does that mean?

MR. C. MILLER: It could mean one of several things. It could mean that the staff has looked at it in a level of detail that has been presented and is generally happy with what they've seen, realizing that F.D.A. stage, you may look at more detailed information but at this point, we have not seen anything that's outstanding.

MR. MICHELSON: Closure in that view would mean, we don't see any problem with it so far.

MR. C. MILLER: Yes, sir. Closure may also mean that there's an issue where the staff has taken a position that maybe is not clearly been identified or responded to by Westinghouse to reach that kind of closure and it may get deferred for whatever reason to the F.D.A. stage. It doesn't mean that Westinghouse would be recalcitrant and fighting us on the issue.

It may be just for whatever reason, we would defer the actual closure of that issue to the F.D.A. stage. What we would have on the record and in our documentation is where we left the issue off, what we feel. Closure could also mean that perhaps the agency is just not ready to take a position -- a formal position on this subject so it would be impossible to reach true closure and we would so identify that with some kind of committment as to how we would proceed once the agency did take such a position and we did proceed to an F.D.A.

So what we're looking for is really a road map that goes with the P.D.A. that basically --

MR. MICHELSON: Let me ask another question and complete the clarification.

Is closure in the case of a P.D.A. does not say in any case that we could not revisit the issue?

MR. C. MILLER: No, sir. I think you'll see in the P.D.A. that when we're done -- that brings up a good point.

MR. MICHELSON: So you are saying that there are cases and I guess we'd have to know which are which, in which your P.D.A. level of acceptance is also final acceptance; is that what you're saying?

MR. C. MILLER: I think that we will always have the opportunity and right to revisit it at an F.D.A. stage. I think that what we're going to be able to say is that at this point in time we see no problem with closure of that issue but I intend that when we're done this effort, the P.D.A. will have a certain amount of caveats in it that basically gives us an opportunity to do that at such a time that we would proceed with an F.D.A. and review it in full detail.

MR. CARROLL: Even though you may say in the P.D.A. for example, that based on the information that Westinghouse has submitted in response to our questions, the residual heat removal system design is, to use your words, "acceptable for a P.D.A.."

MR. C. MILLER: Yes.

MR. MICHELSON: What does "acceptable for a P.D.A." mean as opposed to "acceptable for an F.D.A." which I think I know what it means.

MR. C. MILLER: I think it means at this stage that the information that's provided by Westinghouse is sufficient to satisfy the staff.

MR. MICHELSON: But it doesn't -- you know, the idea on the F.D.A. and certification process was we would not revisit once we write off. In the case of P.D.A., I think that we might want to revisit anything in the P.D.A..

MR. C. MILLER: I'm not arguing that point whatsoever. I'm in agreement with you on that. We want to leave ourselves open, have that opportunity, because in our F.D.A. efforts, our intent is to proceed toward design certification. So really, we're proceeding to an effort that is a final --

MR. MICHELSON: I just wanted a clarification so we kind of knew what we were committing to at the T.D.A. stage.

MR. C. MILLER: The staff is concerned we don't commit to anything more than we have to. We will have to revisit these issues at an M.D.A. stage but I think it gives our best thinking with what information is available at this point in time but I'm sure that when we put out the final documentation, words to that effect will be put in.

MR. WARD: What is the applicant buying then by going to all this trouble?

MR. C. MILLER: I think the applicant is buying -- maybe I could say a few words concerning philosophy and how the thing is developed. Westinghouse embarked on this effort starting in 1983 and it was prior to really when the Agency was starting to really focus on standardization and what we wanted to do as the wave of the future. So, if you will, the Westinghouse SP/90 has kind of bridged for lack of a better word, two generations of thinking.

If we were to start on an effort such as this today for an evolutionary type of plant that's based on light water reactor technology, the staff would not embark on a P.D.A.. But given the fact that several years have gone by and a lot has been invested both on the part of Westinghouse and the part of the staff in reviewing it, I think all parties agree that we want to be able to document our findings for the effort that's been done so far so that if it is pulled off and we do proceed, that we have the accurate records of where our thinking was at the time.

MR. CARROLL: An example you were talking about, the RHR system, is acceptable for the PDA stage. Does that imply that there is a burden on you, if you want to reopen the issue of, say, since the time we said that, some new issue has come up, or is that sort of commitment implicit in your statement, that it's acceptable?

MR. C. MILLER: I think what we will do is, when the final document is written, either in the cover letter that transmits it or in the opening remarks, I think we want to make clear all of those kinds of things and exactly what it means.

We, obviously, haven't got to the stage where we have worked out the exact language that we are going to put in there, but I think our thinking is clear in that we will put in there what is necessary to keep the appropriate caveats available for the staff and the Committee and the Commission to take whatever action is necessary to have to review that, and as I said, we're bridging two generations of thinking, and on one hand, you have to kind of think of it as we thought of PSARs in the past, to a certain degree.

We've basically revisited things at the FSAR stage, but at the same time, we're trying to also think of it in the current generation of thinking with regard to standardization, but I find that, having written it, the staff and the agency itself has not bound itself not to revisit anything.

Everything -- at an FDA stage, I believe everything will get revisited, because a whole new set of documents will be submitted for the staff to look at, and I also anticipate that, at an FDA stage, Westinghouse itself would probably enhance, modify certain things, as development goes on. So, that, in itself, would call for a complete relook.

"Progress", I guess, is the word that I was searching for.

MR. CARROLL: Well, I mean, can Westinghouse take any comfort from your saying their RHR system is acceptable for PDA? My philosophical question about RHR is should they be a full-pressure RHR. Do you agree that a not-full-pressure RHR system is okay at this stage? Would you feel some obligation, if you were going to insist on a full-pressure RHR system for whatever reason, that you would have to justify doing that?

MR. C. MILLER: Do you mean at some later stage?

MR. CARROLL: Yes.

MR. C. MILLER: I think we would have to certainly address it, and "justify" is the right word. We would certainly have to say why the staff's thinking had changed, if it changed, and what made us reach that conclusion, yes.

MR. CARROLL: Okay.

MR. C. MILLER: And it may be new information. It may be more operating data. It may be a variety of things. It may be policy. Yes, Sir. It could be a change in policy.

MR. WYLIE: If I heard what he said, he said he could revisit it for any reason.

MR. MICHELSON: That's right.

MR. CATTON: So, what benefit is there to Westinghouse?

MR. WARD: Well, maybe when they get up, we ought to ask what they perceive as the benefit.

MR. C. MILLER: I think Westinghouse has some clear reasons that they have stated to both the staff and the Commission as to what they feel the benefit is, and I'm sure that they would be more than willing to share it with the Subcommittee today.

I think, from the staff's perspective, the main benefit we see is a fair amount of effort has gone into the review of it, and I think we're looking for a way to get that review documented and tied up and through the Committee to get their views, so that that can be factored in, so that we have a clear record to proceed from, because naturally, an FDA would build from that.

MR. MICHELSON: I have on my bookshelf in my office several volumes, more or less, of Westinghouse material. Is that being kept up to date by additional revisions being sent to me?

MR. C. MILLER: Revisions being sent to you?

MR. MICHELSON: Yes or sent through ACRS to me. Am I reasonably assured that I'm not looking at a real old copy?

MR. EL-ZEFTAWY: We have an updated copy in our office.

MR. MICHELSON: I update it whenever something is sent to me, but I don't go through and find out what Westinghouse thinks is the latest revision of what I have. I don't even have the documentation to check it with.

MR. EL-ZEFTAWY: We have an updated copy in our office.

MR. MICHELSON: Is there some pack of paper that identified what the latest revisions of everything might be, so when I look at something and I wonder why it appears so old, that maybe it, indeed, is old. I don't know.

MR. C. MILLER: If I could address that --

MR. SHANNON: Excuse me. Mike Shannon from Westinghouse.

Yes, we do have a set of papers than can tell you whether or not you have the correct amendments in each of the modules. The modules have been amended numerous times, over the years, to pick up responses to staff questions and other things.

MR. MICHELSON: Is that set of papers periodically sent to the NRC so they can check their records to see if they have the correct copies? That is what I am looking for, an index that I can go to quickly if I think something looks old.

MR. SHIVELY: Bill Shively, Westinghouse.

Yes. We try to maintain that list, which includes all the transmittals to and from the staff. We would indicate the various module submittals and amendments, and I'll make an attempt, next week, to make sure that we get it to the NRC project manager in Med.

MR. MICHELSON: I sometimes wondered if some of this stuff I was reading, whether -- I thought, in some cases -- I was pretty sure, in fact, thinking it changed, but it wasn't reflected in the document.

MR. DONATELL: Mr. Michelson, Lauren Donatell of the staff.

As far as the process on the amendments, the latest update that you have official received, frankly, was the March draft SER, which listed all the amendments that had been transmitted by Westinghouse and received by the staff at that time.

MR. MICHELSON: That doesn't help me any, because I don't know what's in the amendment. I can tell, when I look at a given page.

MR. DONATELL: That should tell you which amendments were transmitted. The amendments come into the organization, and they go out through our accelerated distribution system, and they do go to the ACRS with the appropriate number of copies.

As far as the modules, you're probably correct. Without (1) having a complete list of the amendments and (2) going through each individual module to ensure that, in fact, that amendment has been entered, whether you do have a complete listing. As Med said, he has got what considers to be an updated copy.

MR. MICHELSON: That doesn't help me any.

MR. DONATELL: Well, it should, if Med and I were to ensure that his updated.

MR. MICHELSON: I think what Westinghouse said they had, if sent to me, would help me identify, on a section-by-section basis, whether I have the latest material or not. That's all I need.

MR. CARROLL: Okay. Lauren?

MR. DONATELL: Good morning. My name is Lauren Donatell. I'm the project manger for the RESAR SP/90 PDA application. I've just got a few brief remarks and a few changes that have occurred since we met the 28th of September. Current review status is this: you say everything that's in black on the 28th of September as having occurred up to that time.

Since then, we have, in fact, received Westinghouse's submittal on Amendment 3 to Module 2, which is the USIs and GSIs. That has been transmitted to the staff and that is entering the review process at this point in time. That is a fairly significant amendment. Of course --

MR. MICHELSON: Transmitted to the staff? Does that mean it's also been transmitted to ACRS?

MR. DONATELL: Yes, sir. You should have, I think, somewhere around 12 copies from the accelerated distribution system, directly to ACRS on that.

MR. MICHELSON: All right.

MR. DONATELL: And then, of course, the Subcommittee meeting today. Last month, I went through a schedule to complete what I thought was the schedule of complete PDA review. I have a new schedule to share with you this morning which I think is an aggressive schedule. It is significantly different from the September schedule in the following areas:

One is the end date. In September, I told you that October would more than like be an end date for this particular endeavor. Based on the comments from that schedule, some of which were directly related to the business of the ACRS, such as, I had a Subcommittee and a full Committee meeting in the same months.

Essentially, that was considered to be difficult at best. There were also some comments about the numbers of Subcommittee meetings and full Committee meetings necessary to get through this. There were also comments related to the areas that we were, in fact, reviewing and the sequence in which we were reviewing them.

I've tried at this point in time to fix those problems. What I have since come up with, of course, is a very aggressive schedule. As we go through this, I would like to ask if you would take at least a critical look at it, and if not today, through Med, give me an idea of what you think would probably be necessary for your information as far as the numbers of meetings and the topics, if possible.

We're still expecting to get the PRA backend draft SER out in November. That seems to be progressing. I think we have a pretty good opportunity of doing that. As I said, the amendment for the USIs and GSIs is, in fact, in-house. It is entering review.

We would expect that we will be providing input to Westinghouse from that review this month and next month. We've set aside a Subcommittee meeting in January to go into the further draft SER chapters, the ones we're not going to get through today, hopefully to complete -- again, that may be a very ambitious meeting -- expecting responses back from Westinghouse on the USI/GSI input in January.

My expectation is that actually, as we start doing this, we'll probably start getting feedback more in the December type timeframe through January. Again, a Subcommittee meeting in February to relate the results of this effort on the USIs and GSIs; issue the draft SER on that issue, and then go into the Subcommittee and full Committee with the draft final SER and request for a letter.

Again, that sounds rather ambitious. My thought process here was that what we would probably address in this draft final SER area would be those issues that were thought by the ACRS to be significant issues at this time to readdress, reaffirm and provide further clarification on, if possible, as opposed to attempting to again present the final SER from page

1 to whatever it is.

MR. MICHELSON: I am sure you appreciate that in this same timeframe, the ABWR final --

MR. DONATELL: Absolutely.

MR. MICHELSON: -- approval is proceeding with numerous meetings and attention of the ACRS. That is what makes the schedule look doubly difficult and I'm not at all certain what the combustion engineering situation is at that time.

MR. DONATELL: As I mentioned at the beginning, I consider this to be an extremely aggressive schedule, not only from your viewpoint, but from the staff's viewpoint, and I'm sure, from the viewpoint of the applicant.

We would then expect to issue the final SER in May; hopefully have a decision on the PDA and issue the Supplement to the SER in June of 1990.

MR. MICHELSON: That was originally to have been done in the Fall, wasn't it?

MR. DONATELL: The last -- when we were together in September, I had that schedule out to October of 1990; that's correct. So, one, this is a significant improvement, but what you get with improvements is more work.

Briefly today, the chapters are 3, 4, 5, 6 and 8. I have listed the open items by number just to give you an appreciation for how many open items exist in the five chapters that we are going to be looking at today. There is essentially a total of 66. We certainly don't expect to approach each one of those open items one at a time. I think that as we get through the presentation process, some of the harder items we'll probably become aware of and we'll have an opportunity to discuss them.

I've got preliminary input from the Staff on most of these items. Right now I think the review is progressing extremely well from the Staff's viewpoint. There are still a few items that will probably require a little additional clarification and very few apparently hard items that will take some hard discussion to get over at this point in time.

Westinghouse's responses in general seem to be adequate for the Staff's questions.

In summary, this is what I showed you in September. It hasn't changed. We are still obviously looking for approved priority for the reviews. We have issued three draft SER's. The open items still remain, 107 before the PDA, 53 before the FDA, 99 before FDA and/or plant specific.

Again, last month I mentioned that I would expect as these items are closed, the majority of them will be closed and some will gravitate into these other columns or categories.

Initial review tells me that that was a fairly correct assessment. It looks like some of these will in fact gravitate into these other two areas.

Resolve the USI/GSI and severe accident issues -- as I said that submittal is in-house.

MR. WYLIE: Let me ask you a question about that.

MR. DONATELL: Yes, sir?

MR. WYLIE: Is station blackout included in that?

MR. DONATELL: Yes, sir.

MR. CATTON: In your SER, in your summary of principal review matters, item 3 says that the PRA and consideration of severe accident vulnerabilities that exposes along with insights, where will that appear?

Is that part of that USI?

MR. DONATELL: I'm not familiar with that particular statement and I probably should be, however we would expect those issues to surface, one in the PRA review which is ongoing, so that we've issued the draft on the front end of the PRA. The back end is coming. That in conjunction with, yes, the review of the USI's and the severe accident issues.

MR. CATTON: I am particularly interested in the insights that are supposed to be given us by Westinghouse and where are they going to appear.

MR. DONATELL: Mike?

MR. SHANNON: Mike Shannon from Westinghouse. Module 16 will provide it. That was a four volume module that provided the results of our PRA and there is a draft SER that the Staff issued. The first of the draft SERs was issued by the Staff on that. I have a slide in a few moments that will give the date that is associated with that.

MR. CATTON: And you in particular discuss the insights that you gained?

MR. SHANNON: Yes. Yes, it's a very comprehensive discussion of what we have done so far in the area of probabilistic risk assessment. There is a draft SER. There was basically one other item in that draft SER report.

MR. CATTON: I am more interested in seeing your report.

MR. SHANNON: Module 16 contains that.

MR. EL-ZEFTAWY: What we got from the SER was only the front end of the SER. We got that last year. We are still waiting for the back end which addresses your concern. We still have not got this one.

MR. MICHELSON: If I understood the process, I thought you said we did have it.

MR. WARD: You don't have the Staff SER but we have a Westinghouse one.

MR. EL-ZEFTAWY: Right. We do have Module 16.

MR. CATTON: I just want the part of it where Westinghouse tells us about the insights they have gained in the severe accident arena.

MR. SHANNON: Okay, we'll supply you with this.

[Slide.]

MR. SHANNON: Again, this is just a reiteration of what we have discussed in our current schedule. That is all I have at this point in time. Are there any questions?

[No response.]

Thank you.

MR. CARROLL: In guess this would be a good time in today's discussions to mention that we received a note from Dr. Shumoud who was unable to make it today. I guess I would like to deal with his materials questions at a meeting that he attend.

I'll give you the flavor of what he's interested in. Questions primarily deal with the pressure boundary. Examples are, will they have any wells in the core region, is there any standard they've accepted for a pipe joint design to make QT inspection more reliable, what specs will they have for cast stainless steel pipe elbows, bodies, et cetera, to make inspections more reliable and aging less of a problem, what will be the composition of the steel in the reactor pressure vessel, how will it be made, what will the materials and construction be in the steam generators -- I guess he means steam generator tubes.

So those are the kind of things Paul is interested in. I'm not sure how you can handle this today but I'm sure at a future meeting, he's going to want to get into the materials questions in more detail.

MR. SHANNON: If he wants to get into those questions in future meetings, I suppose he can. We had planned to cover a good portion of that as part of the Chapter 3 review today. A fair portion of the agenda, in fact, is devoted to the structural and other issues that are in Chapter 3.

MR. WARD: This may put enough information in the record.

MR. SHANNON: I don't know if that's enough. I guess the other thing is, if we could somehow get a written transcript -- not a transcript -- but a written list of his concerns, then perhaps we can briefly summarize our positions on that at the next ACRS briefing. As I go through my little introductory speech here, I'll indicate how we plan to attend.

MR. MICHELSON: One way of handling it which is probably the most efficient is to just ask Paul to have a meeting of his material subcommittee at such time as he's available and pick up an agenda of what he's interested in that way. It's hard for this subcommittee, I'm sure, to schedule his interest when schedule doesn't allow him to --

MR. SHANNON: I'm Mike Shannon. I'm the manager of the licensing group at Westinghouse responsible for the licensing activities on RESAR SP/90. I don't have a slide on this but I thought I would start by providing our insights on what we believe are the benefits of the PDA activity that we've been doing for the last period of years and Charlie Miller from the staff hit the high points of this very well but I thought I would reiterate and expand upon those a little bit.

Really, we see the benefits of the P.D.A. The primary benefit is it provides us some measure of certainty with regard to the ability of our design to satisfy the current and for that matter the expected future safety criteria in this country. We're looking for some measure of certainty so that as we enter into final design activities on this plant, we have some feeling that there's not some big item from a safety viewpoint that we're missing.

We view that kind of certainty, that measure of certainty, in conjunction with the activities that are currently going on with the EPRI utility requirements document review although our plant RESAR is obviously more specific and requires a more specific review that EPRI requirements documents do, we believe that between those two activities, we can get sufficient certainty to give us confidence that our final design activities as we enter into those are pointed in the right direction.

So that's really our primary benefit.

MR. MICHELSON: Is this project by Westinghouse being sponsored by Westinghouse or do you have other sponsors?

MR. SHANNON: The licensing program that we have been doing since 1983 is strictly sponsored by Westinghouse.

MR. MICHELSON: How about today's program? Is this still just Westinghouse sponsorship?

MR. SHANNON: There are some final design activities that we have started into that are sponsored in conjunction with our partners around the world.

MR. MICHELSON: Who are the partners?

MR. SHANNON: Primarily in Japan.

MR. MICHELSON: Who are they in Japan?

MR. SHANNON: It's Kansai Electric and there's a list of utilities in Japan. I don't have that.

MR. MICHELSON: Are they doing the design work in Japan?

MR. SHANNON: No, we're doing the design work.

MR. MICHELSON: Those are just monetary sponsors; is that the idea?

MR. SHANNON: No, there is some work going on in Japan as well. That work is not being reflected in the RESAR at this point. That will be reflected at the F.D.A. stage.

MR. MICHELSON: Okay, at the F.D.A. stage, because we are interested in who is actually doing the work and how their quality is controlled and so forth.

MR. SHANNON: I understand.

MR. MICHELSON: This is not in any way a DOE-sponsored program; is that right?

MR. SHANNON: No, the Department of Energy has no active role in this program.

MR. MICHELSON: Thank you.

MR. WYLIE: From a philosophical standpoint, to what extent are the designs influenced by your partners?

MR. SHANNON: I'm not sure really how to answer that. Theo, can you answer that? Mr. Van De Venne is our engineering manager. He, I think, is more able to answer that question.

MR. VAN DE VENNE: It was in our scope, I would design activities to a certain extent influenced by the Japanese utilities and their operating practices at this point in time. In other words, you know, we are addressing specific problems that they have seen in their plants, for example.

We're in some cases incorporating features that they have in their plants and that they like very much and that have proven to be reliable and useful. So, there is certainly input from the utilities that are funding this program.

MR. WYLIE: They have made a significant input into the design of the plant then.

MR. VAN DE VENNE: Yes. Right.

MR. SHANNON: Okay, the other benefits then are that it provides a place to document the results of the staff safety evaluations of the design features and the safety analysis of the plant that we have done to date. So we're looking for a way to document that preliminary safety evaluation of those things at this point and the P.D.A. is the way to do that.

We're afraid that if we don't document it in some way that we can all retrieve, that then when we get into the F.D.A. activity it will be gone and we'll have nothing to look back at. We do believe as was stated earlier by the staff that the staff has the full right to go back and re-review every and any feature of the design or safety analysis as part of the F.D.A. process and we are not in anyway trying to lock the staff into whatever position they might have today.

We recognize that the requirements are evolving and we recognize that the technology is evolving every day that we're here and we're not looking to create a cast in concrete type of situation at this point so it would be useful for me to clarify what Westinghouse's views are on this.

MR. CARROLL: Several points in your discussion. You made it sound as if there was a certainty of evolution at Westinghouse on this particular design. I guess my information is, in conversation with the Commissioners, you have no present plans to move this into an FDA stage?

MR. SHANNON: That is correct. We have no present program to move this into an FDA. What we will do is when we have a final design project, then we will move forward with an FDA. Now, if that final design project ever happens, then we will never go into an FDA. But it depends on what measure of optimism one wishes to take as to whether or not that is reality.

MR. MICHELSON: I would like to hear the answer a little more relative to certification process. Do you have any, are you going to wait until you have a customer before you try to certify, or do you even have any intention of certifying, or just what?

MR. SHANNON: We are going to wait until we have a final design project, until we go after design certification on this.

MR. MICHELSON: In other words, there is some customer that at least wants you to get a certified design?

MR. SHANNON: That's right. And that customer, if he exists now, he is not apparent to us.

MR. MICHELSON: Thank you.

MR. VAN DE VENNE: Well, I just -- Theo Van de Venne for Westinghouse. I do want to clarify that Kansai has formally stated that the next plant they build will be an APWR. There is also a need for power in Japan. And the only real holdup right now is the site. And you know, that has been a struggle for several years now. And frankly, I am not optimistic that anything will break in, say, the next two or three years.

But there is a verbal commitment that the next plant will be an APWR.

MR. WARD: Are their siting problems social problems or is there a problem of box sites?

MR. VAN DE VENNE: No. It is purely an intervenor type problem, and it is particularly severe in the Kansai area because it is a densely populated area. It is also a difficult area. There are not many sites to start with. I mean, the land does not lend itself, because of the very mountainous terrain, to having a lot of sites. So that is one problem. There are not many sites. There is a lot of opposition to nuclear, you know, as a result of the Chernobyl thing. And Kansai does not have any sites that have more room. The logistics in Japan are that once a site is approved, you can build as many units on it as you want. So, for instance, the ABWRs are proceeding on a site that already has I think four or six units on it. And it is a very large site. All the Kansai sites are small, and there is really no room on any of them to build another unit.

So it does have to be a new site. And there have been several sites identified, and they have all fallen by the wayside, as a result of intervenor opposition, because the first approval in Japan is by the local population. That is the first step that you have to go through. And that has just not happened.

We have had at least four sites identified. And all have been basically rejected.

MR. SHANNON: Okay. So the purpose of today's meeting as we saw it was to review the status of the Staff's safety evaluation of Chapters 3, 4, 5, 6 and 8, as Lauren had indicated. We drew the line at 8, because it seemed like the right place to draw the line in terms of how much we could get done today. We had planned an agenda through 5:00 or 5:15. If we are going to stop at 4:00, then we are going to have to probably not get all of this done today. But I would suggest that we just dig in and get as far as we can get. And at 3:00 O'clock or so I think we should stop and have the Staff do their presentation, since I believe they want to have about an hour.

So as far as Westinghouse gets by 3:00 is as far as we will get. And then we will pick up the next meeting wherever we left off this time.

MR. DONATELL: Excuse me, Mike. We don't need an hour at the end of this thing. I think it is more important that we go over these chapters and get as much information as we can today.

MR. C. MILLER: Mr. Chairman, the review staff will be available. We will try to have the appropriate people here to answer those questions.

MR. CARROLL: Okay. That sounds like a good plan.

MR. SHANNON: So we will go until 4:00 and interweave the Staff views with the presentations that we are making in response to the questions.

MR. CATTON: At the last meeting we had, I requested some reports dealing with fluid-structural interaction, in particular steam generator core and kernels. And I haven't received anything. Have you sent them?

MR. SHANNON: I don't believe any reports have been sent. We do have a presentation scheduled that I will show in the agenda a little bit later today, to deal with where we stand and what we have done on steam generators in particular.

MR. CATTON: Well, I would like to get the background information on your analytic tools. And it doesn't need to be a presentation. I actually would prefer to look at a report.

MR. VAN DE VENNE: Theo Van de Venne, Westinghouse. I suggest we talk with the steam generator person that is going to make the presentation, and we agree on what your particular interest is. And I think he can go back and make that available. Because he is more knowledgeable than any of us on that.

MR. CATTON: Is he here?

MR. VAN DE VENNE: He will be here after lunch.

MR. CARROLL: Okay. Good. Thank you.

[Slide.]

MR. SHANNON: Just as a note of completeness, Chapters 1, 2, 13, 14 and 16 aren't really a part of this PDA, per se, so we have not planned specific presentations. We have no tech specs on a PDA, which is 16. We have no startup test program as yet. We have no site. We have no facility organization. So that is why those chapters are not included in the two lists that I've provided.

MR. CARROLL: A Chapter 2 issue that jumped out at me looking over this pile of paper is the seismic design. It sounds from what I'm reading that there is a difference between the Staff and Westinghouse on the OPE issue and I guess I am a little puzzled about how you can go ahead and design systems and equipment without that being resolved.

MR. SHANNON: If I understand your comment correctly, we've picked it up as part of our Chapter 3.

MR. CARROLL: Okay.

MR. SHANNON: So I think that should be made clear. If not, then point that out at the time. I agree that's an issue that needs to be dealt with.

MR. CARROLL: Okay. Let me also, as long as we are talking about what we are going to be doing at future meetings, give you a heads up on Chapter 7, ACRS is getting interested -- in fact, there was quite a bit of discussion of it in our meeting earlier this week with the Canadians. We met with the Canadian ACRS, if you will, about the issue of software QA. We're using computer-based control and safety systems. I'm sure Dr. Lewis among others would be very interested in what you are doing with your INC computer-based schemes in terms of V and V of software.

MR. SHANNON: Okay. It sounds to me like we should be prepared to make a presentation on what we have done in terms of software QA and Validation and Verification. Okay.

MR. VAN DE VENNE: This will be addressed at the next meeting, I think. We were planning to address that.

MR. CARROLL: Right, right. I realize that. I was just giving you a heads-up that it is an item of considerable interest. For your information, it sounds like Darlington is held up because of this issue and they're ready to go and the Canadians just don't feel comfortable that they have their arms around it for their extension. They have historically used a lot of computer based control systems and they have extended it now into their so-called safety-systems and they do not feel comfortable that the V&V efforts that they've made are adequate.

[Slide.]

MR. SHANNON: I included this slide the last time and I just changed the bottom couple of bullets just to indicate where we are and to refresh our memories on the history. I guess I won't go through that in the interest of time today.

I do show a next ACRS Committee meeting, subcommittee meeting, scheduled in December and Med and I and Staff have talked about when we can next schedule that. I would hope that we can do it next month. Lauren's schedule showed that in January of 1990, so we're trying to keep the heat up to keep the schedule moving in that regard.

[Slide.]

MR. SHANNON: I promised you I'd show you what the draft FERs are.

[Discussion off the record.]

[Slide.]

MR. SHANNON: Okay, this slide is also in the package. I won't review it in detail but this provides the details of the SERs that we've received and the column on the right provides when we responded to the open items that are contained in those SERs, so that should match up with the records that you have.

In terms of what we've planned today, the schedule that is laying on the table shows just a generic Westinghouse block from 9 o'clock through 4:15 and I have a breakdown of that by chapter and which speaker we've brought with us to discuss those chapters.

Our plan is to start with Chapter 3 and work our way right through.

Richard Orr will do Chapter 3. He'll continue that until probably at least 11:15 and perhaps lunch time since we're already half an hour behind.

We'll go into Chapter 4 on the reactor system. Jack Miller will present that.

Chapter 5 on the reactor coolant system -- T. Van de Venne and Con Wilson. Con Wilson will do the steam generator part of that.

Chapter 6 on the engineered safety features -- we show T. Van de Venne will do it and Chapter 8, if we get to it, also T. Van de Venne will do, and then we'll pick up next meeting with perhaps a summary of the Chapter 3 items and then Chapter 7 and go on from there.

That will be our plan for today. We'll stop at 4 p.m. or whenever the committee is ready to start.

MR. MICHELSON: By the way, when do you anticipate being open for questions on layouts and so forth? Are you going to put that in a separate chapter or how are you going to do it?

General plant layout -- there are some interesting comments perhaps on it. Where is it going to fit into the schedule, since it doesn't fit into the items you have listed here. These are more specific to systems and components and not the plant layout.

Theo, do you have an answer to that?

MR. VAN DE VENNE: Theo Van de Venne, Westinghouse. I suggest you're correct, that's in Chapter 1 I think and we would normally miss that and I suggest we put it at the end of the next meeting because it's useful to have run through the systems before you really look at the layout, so we'll take an action to add that to the agenda the next time.

MR. MICHELSON: I've noticed you appear to -- we weren't going to do anything on Chapter 1.

MR. SHANNON: I think that's an oversight on our part.

MR. MICHELSON: Is that just an oversight? Okay, but at least the layout portions of the plant ought to be discussed a little bit at the appropriate time and sometimes it's nicer to discuss layout before you discuss details simply because there's some general concepts in layouts that have to be satisfied irrespective of the design of the system and if you want to talk about heating and ventilating and so forth, it's a lot better to talk about the building layout before you talk about the details of that particular system.

MR. SHANNON: The next thing I wanted to cover briefly was the 107 open items and just indicate to you a categorization process that we have gone through to try and categorize these 107 items. We didn't want to come here today and try to work from item one through item 66 sequentially because that would be very time-consuming, and we think, not to the point in all cases.

So what we did is we tried to go through the list and the next slide provides a summary of that. I'll talk about the categorization. We've tried to go through the list and categorize them into bins, the first bin being where we have provided the initial clarification that the staff requested, we expect from our understanding where the staff was and from the words that were in the draft SER that that will satisfy the open item and it will just quietly go away.

The second bin we have is where we've revised our application to reflect the staff position or at least our view of what the staff position is and again, we expect that we understood what the staff was saying, we agreed that they were right and we've changed our application to reflect that and those again we expect for the most part will quietly go away.

Most of the issues fit into those first two categories. Every time we count them we come up with a slightly different count but about 85 or 90 of the issues fit into those two categories, we believe at this point.

The third category is where we have adopted current industry codes and standards position that are beyond the status of where the reg guides and the regulations are. One example would be the classification standard ANSI N51.1. In these cases, NRC either hasn't taken a position on these codes and standards or they are in the process of taking a position or they don't agree but they haven't documented what their position really is yet in a way that can be licensed. In those cases, the NRC is reviewing our position on a case by case basis. That's the third category.

The fourth category is where the draft SER was issued prior to the NRC being completely finished with the review of whatever that piece of the plant is. There are some issues that because they weren't finished, the SER was -- had an open item that said, we aren't finished yet. In those cases, we're trying to find out from the staff where they stand. So those are a category of open issues that something has to happen with yet.

The fifth category is where we have provided additional information to justify our approach and where the staff has, at least so far, disagreed with that and there is still work that has to happen to try and bring Westinghouse and the staff together or change in one direction or another.

So we've tried to fit all the items into one of those categories. Today we're going to concentrate in our presentations at least on those items that fit into the last three categories, which are, as I said, a small subset, about 20 percent of the total.

Now we recognize and I think staff also recognizes that this is a moving target to an extent. Some of the items just because of the fact that they're written down, you can't always get all of the nuances that the reviewers are always looking from reviewing his words, so there are some times when we've just missed each other. We didn't understand their words or whatever. In those cases, some items may move around as we come closer to resolving those with the staff. The staff and Westinghouse are working hard to try to bring all those items together but I wanted to make the point clear that the categorization that we've come up with is a moving target.

[Slide.]

MR. SHANNON: So the last slide then I've highlighted in green. I hope it shows up. Those items that fit into those last three categories, just so it's a little easier to see and we can really stop. You can stop looking at 66 for the purpose of today's meeting and perhaps somewhere above that although you can see most of the category three, four and five items are in those first eight chapters anyhow.

MR. CARROLL: Now does the staff agree with your categorization? Have you looked at this?

MR. DONATELL: I have looked at it and I have also done my own categorization to some degree using a few different classifications.

MR. CARROLL: I guessed.

MR. DONATELL: If we looked at the pure numbers, I think that we've got a general agreement as far as numbers. Probably where disagreement lies is that we can't really just skip over the Westinghouse's category one items and say well, here's our answer and staff's going to accept that. Let's go on to category two, three and so on. It's just not working that way. What we found so far in a preliminary review is that we have tentatively accepted some items out of every category and I think some of the items that are remaining open which will require further information or meaning, are going to be a lot of these category one items.

Again, it's possibly a matter of communication as to what was asked and what was provided and hopefully we can get over that in a relatively rapid fashion. However, it became painfully obvious to me there was no clear way of really categorizing these things to make it a nice, neat little package.

MR. CARROLL: Okay, so when Westinghouse is talking about a particular issue today and says, well, there are three category one items there, you're prepared to comment on what you feel the status of them is?

MR. DONATELL: I believe we can do that, yes.

MR. CARROLL: All right.

MR. SHANNON: Okay.

MR. MICHELSON: Is your category one their category one? I thought you said no.

MR. DONATELL: No, sir. I didn't use the same classification.

MR. MICHELSON: We can't talk about categories if --

MR. DONATELL: They'll tell me category one and I'll look at the issue and we'll see relatively where we are with it.

MR. MICHELSON: Okay.

MR. SHANNON: With that, I'd like Richard Orr to come up and start on the chapter three if there's n more questions about where we are in our approach.

MR. ORR: My name is Richard Orr. I'm in the advanced PWR development group. I'm going to walk you through all of the chapter three items, structural and equipment. As needed, I have some back up in the back of the room, people who will help me respond to your questions.

Before getting into the specific items, let me address the issue of operating basis earthquake versus safe shutdown earthquake. It is not included in the list of issues for P.D.A.. It is however one that is identified to be resolved prior to F.D.A.

In our application, we have proposed that the standard plant be designed for an SSE of .3 G and for an OBE of .1 G. We believe that that is appropriate for the future generation of standard plants and will make the plant suitable for most sites east of the Rockies. NRC to some extent are bound by Appendix A of Part 100 that says that OBE must be at least one half of SSE.

On a plant specific basis, they have allowed reductions below one half but on a generic plant, they were not prepared to. However, they do agree and they have said in the SER, the staff agrees that the OBE should not control the design of the safety systems. It is an area in which there's going to be change over the next few years. I believe the staff recognizes that. There have been discussions I think in ACRS going back ten or fifteen years on that particular subject and the staff basically accepted our position and said it can be resolved at the time of F.D.A..

MR. CARROLL: So in terms of design issues at this point, since the SSE controls, this is really not an issue.

MR. ORR: Yes, well I think in the extreme, if the position came about a few years from now that OBE must be one half of SSE, what it says is our standard plant is good for an OBE of .1 G and we might have to reduce the SSE from .3 to .2 and thereby reduce the number of sites available for such a standard plant. So there are some options in the future. We believe that the OBE is going to decrease in importance and the plant will be okay for an SSE of .3 G.

MR. WARD: Richard, what part of the structure -- is there any particular issue as far as part of the structure, piece of equipment, that keeps you from just increasing the OBE to .15?

MR. CARROLL: Or is it just a philosophical matter of principle?

MR. ORR: It's philosophical. It's sort of economics. It doesn't make sense to build -- for instance, the initial design, the work being done in Japan, is capable of taking about a .6 G SSE but we have decided from an economic point of view that it doesn't make sense to replicate that design in this country.

We have picked .3 G SSE because we believe that that will cover probably 90 percent of the sites in this country. It will not cover obviously the West Coast, the Diablo Canyons, the San Onofre. That is going to be a long time before there's another plant out in those locations.

MR. WARD: I guess what you're saying, there are a large number of items in the structure or in equipment that are not built to accommodate the OBE of .5 then?

MR. ORR: That's right, because on past plants, from a structural point of view, the operating basis earthquake has got and we will be designing effectively for an operating basis earthquake of .1 G which ends up being approximately the same as an SSE of .3 G.

So the plant as we designed it actually is comparable to most of the plants that are out there now because there are very few that have been designed for greater than .2 G SSE.

MR. WARD: You're claiming there's sort of an almost kind of a natural ratio there then? That's what I heard you say?

MR. ORR: It depends a little bit whether you're looking at structure, whether you're looking at equipment but we believe that an OBE in the range of one third of SSE is roughly comparable. So a structure designed for an SSE of .3 G is going to meet the more stringent stress requirements for an OBE of .1 G.

MR. WARD: I guess it is fundamental.

MR. ORR: Mike has shown you the Westinghouse categories that show the open issue. I am going to tackle 40 of the 41 that are up on this list. One of them Theo Van de Venne will be picking up later in the presentation, because it is more related to systems.

Of those 40, I have prepared a presentation for those that we have categorized in the Category 3, 4 and 5. I am going to go in reverse order, Category 5, then 4, then 3, and then I have a summary overhead of what is in the Category 2 and Category 1, and would be prepared to talk on any of them in response to your expression of interest.

[Slide.]

MR. ORR: Let me apologize, first, that you may have difficulty reading the overhead. You do have handouts in front of you. We felt it was more important to put together a fairly complete position on each one of the issues, and that could not be done easily in one overhead. So we put it on one page and it is there in the handout and here on the overhead.

On each one, we have identified the open issue number. This relates to the draft SER. In all cases for these ones, it is the March 1989 edition. We have identified the section of the draft SER. We have identified the page number. We have identified the title that appears in the draft SER, the open issue. And we show in the top right hand corner our characterization of the issue.

The first issue is on instrument lines and the safety classification of those instrument lines. These are the lines that extend basically from the piping up to the instrument and include both the portion up to the isolation valve, that is effectively piping, and beyond that portion, tubing that goes up to the instrument.

In our first submittal --

MR. MICHELSON: When you say "up to the instrument" do you mean up to a root valve on the instrument?

MR. ORR: Up to the root -- yes, I believe that is correct.

MR. MICHELSON: Because the code doesn't go into the instrument, unless it has been changed.

MR. ORR: If I recall, the code doesn't go even on to the sensing line. I think the code really covers three quarter inch line.

MR. MICHELSON: It depends on how you define it. Some people define the root valve as right at the process pipe and everything else as instrument.

MR. ORR: No. We are talking here of the line that goes all the way out to the instrument.

MR. MICHELSON: And it will be an ASME Class II or III line, according to this.

MR. ORR: Yes. In our initial submittal, we were not making it ASME Class II. In the later submittal, we agreed that we would make that line Safety Class II or III. We would design it to ASME II or III. And the only exception that we are still taking is that we do not want to have ASME Class NF supports. Typically, this tubing is attached to tube crack, which in turn is attached to steel structure. And we have said that we will make the supports from the Seismic Category I structures rather than ASME.

MR. MICHELSON: My question still is, at what point do you terminate the Class II or III?

MR. ORR: At the instrument.

MR. MICHELSON: At the instrument's root valve or at the instrument itself?

MR. ORR: At the instrument itself, I believe.

MR. VAN DE VENNE: I believe at the root valve.

MR. MICHELSON: Well, then it does not go to the panel?

MR. VAN DE VENNE: The root valve itself will be ASME Class II or III. And so will the piping that goes back to the equipment being monitored. But downstream -- oh well, you can't really say downstream.

MR. MICHELSON: In other words, up to the instrument panel at the root valve?

MR. VAN DE VENNE: Yes. Right.

MR. ORR: The position that we have taken here is consistent with the positions being taken in the EPRI ALWR requirements document. That is currently being reviewed with NRC staff. And we have also committed that we will follow the resolution of the EPRI ALWR requirements document, and NRC's acceptance or agreements on that.

We believe it appropriate to leave this issue for resolution at the FDA stage.

MR. CARROLL: The SER clearly states that the Staff is going to require you -- therefore, the Staff requires the Applicant relies, in order to be consistent with the position of Reg. Guide 1.5.1.2, this is an open item and must be satisfactorily addressed for the PDA.

MR. ORR: The draft SER was issued prior to our submittal of additional information.

MR. CARROLL: Okay.

MR. ORR: In the additional information, we committed on the piping and the tubing to meet that NRC Staff position, and the only question remaining is the supports for that tubing, whether the supports have to be NF or whether Seismic Category I structure is acceptable.

MR. DONATELL: Lauren Donatell of the Staff.

I would just like to say something about the NRC position not known. Obviously, it was known, because they responded to it. Right now, on Open Issue 4, we think that the FDA stage is very likely for this issue, based on the EPRI requirements document review.

[Slide.]

MR. DONATELL: The next issue, No. 12, relates to postulated breaks in ASME Class 1 piping. It's Section 3.6.2 of the draft SER and here we have a change that occurred in the standard review plan in 1987 that we at Westinghouse are not wishing to follow. We are requesting that we follow the 1981 standard review plan. The standard review plan 3.6.2 covers the postulation of breaks in Class 1 piping and in particular requires postulation of breaks based on a stress criterion. When the stress at a specific location exceeds a specified magnitude, breaks shall be postulated.

Now, this addresses specifically intermediate locations in Class 1 piping. There's no disagreement on the terminal ends. We will postulate breaks there in accordance with the standard review plan. At intermediate locations in the July 1981 standard review plan, the statement was that you will postulate breaks when the maximum stress range as calculated by equation 10 and this is ASME Class 1 piping and either equation 12 or 13 exceeds 2.4 SM.

The new standard review plan only says where the maximum stress range as calculated by equation 10 exceeds 2.4 SM. The ASME for Class 1 piping still has equations 10, 12 and 13. There were some very minor revisions in what goes into equations 10 and 12 and that was factored into the change to the standard review plan.

The standard review plan was published as a draft for comment in the Federal Register, 12/3/86. At that time, our people did have discussions with the staff and their consultants and basically the purpose of the revision was stated to be to simplify the engineering calculations without resulting in more pipe rupture locations.

As I'd indicated, it also incorporated reference to the more recent ASME codes. However, by making this change, there are indeed cases where the stress exceeds the range calculated by equation 10 but was less than the acceptance criterion of one of the other two equations and so it would not at that stage be necessary to postulate ruptures. Under the new standard review plan, it will be necessary to postulate additional ruptures.

Westinghouse made this comment at the time of the draft standard review plan and it was acknowledged in the Federal Register of 6/19/87. There was a discussion of the comments and a resolution. The staff position indeed acknowledged that the revision could lead to more pipe rupture locations. However, they then went on to say that the revision would have minimal impact since it will apply only to Class 1 piping in future designs where demonstration of leak before break is expected in many situations.

Now, we concur for those lines where we demonstrate leak before break. We're not concerned about the change.

However, we believe that we will be able to demonstrate leak before break on lines that are greater than six inches in diameter. We would not expect to on lines less than six inches and I think the six-inch diameter is sort of in the gray area we may or may not be able to demonstrate.

MR. CARROLL: Why is that?

MR. ORR: The reason is related to the capability to detect leaks. The smaller the line, the smaller the flaw size that you've got to be able to detect with your leakage detection equipment.

MR. CARROLL: Okay.

MR. ORR: For the smaller piping, it's extremely difficult to detect that leakage. So for piping less than -- equal to or less than six inches in diameter, we have taken exception to the new standard review plan position and we are proposing to comply with the July '81 edition.

MR. CATTON: How much more difficulty does this give you? Are there more breaks that you have to consider?

MR. ORR: There will be more break locations and therefore, it will mean that there's more pipe rupture, restraints, jet shields, things like that that make operation and sort of inspection that much more difficult.

MR. CATTON: The jet shields --

MR. CARROLL: I never noticed that to be a problem at Diablo Canyon.

MR. ORR: They have pipe rupture restraints though on the big lines as well. We're only talking less than six inches.

MR. CATTON: The jet shields are so that you don't have direct impingement on something; isn't that right?

MR. ORR: Yes. If you do a good job of layout, then basically you've got structural separation. You don't have jet shields, but there are cases or there may be cases where you end up with jet shields.

MR. CATTON: Do you do anything other than try to protect from the direct impingement of the jets?

MR. ORR: Yes. There's a subcompartment pressurization that's looked at. There's pipe width that is looked at and there's the direct jet impingement.

MR. CATTON: I visited the HDR containment in Germany just a couple of weeks ago and the feeling I got is that it's not just jet impingement. The flow through a doorway and the eddying, I mean it literally hurled pieces of equipment around and did all sorts of damage and this was not the direct impingement. Typically the direct impingement didn't do that much.

MR. ORR: That I think is all part of the subcompartment pressurization. There's differential pressure across structures and equipment.

MR. CATTON: But that won't do it for you. It's the flow that gets you. It's the "V" not the "P" that causes things to shake. It does all sorts of things. Now I haven't heard you say you analyzed that yet. Do you?

MR. ORR: That is included as part of the forces on an object from the jet.

MR. CATTON: No, no, you're missing the point.

The direct impingement of the jet is just a small part of the problems that can evolve out of a broken pipe. You indeed do pressurize the room but the pressurization of the room causes flow through the doorways. The flow through the doorways is troublesome.

MR. ORR: Yes, but that's all included in either that subcompartment pressure or the jet impingement. There is a pressure --

MR. CATTON: We're talking at 90 degrees. We're talking at 90 degrees. It's not the pressure -- certainly the pressure in the compartment is important because if you get a delta P across a wall, you've got a problem but more importantly, it's the flow of steam or water or whatever that results from the pressurization that's important through the doorway.

MR. ORR: It's basically a change in momentum --

MR. CATTON: On the other side of that doorway, that flow causes problems and this is far away from jet impingement. Now what I'd like is if you could supply the document where you show how you treat these things because I really don't think you do.

MR. ORR: Let me look in our resource submittal. I believe that we have got that covered but it may be by reference. We'll have to provide that information to you.

MR. MICHELSON: I think in other words he is saying, are you taking credit for shadow shielding, you know, being just around the corner from the break but if you're just around the corner, you have a lot of velocity effects that are not a part of that jet impingement. You're in the shadow of the jet but you take care of those kind of effects and I don't think the regulatory regulation ever required that you take care of devices that are in the shadow of the jet instead of in the line of the jet.

MR. CATTON: Well, they can even be a compartment or two downstream from where the break is.

MR. MICHELSON: The shadow can be anywhere. Right. Round the corner of a door.

MR. CATTON: You almost need to go visit that containment building. It's a wreck from this kind of processes.

MR. MICHELSON: That I think is a whole new issue, Ivan, which maybe ought to be entertained in a different arena.

MR. CATTON: This is a new reactor, isn't it? It seems to me that in light of what -- one of the things that was in the SER about giving consideration.

MR. MICHELSON: I guess what I'm saying is I think it ought to be one of the generic issues, as a generic issue, not a --

MR. CATTON: I don't know but to me it's certainly a vulnerability and I don't believe that PRAs pick it up either.

MR. MICHELSON: The analysts don't pick it up because they're not required to. My understanding is that they're not required to look at devices that are in the shadow because they can't be impinged directly.

MR. CATTON: If you do the proper kind of analysis of flow and things that result from the break, you could pick this up. The thing is, this subcompartment analysis that's based on a volume connected to a volume doesn't do it. It seems to me that because of the inadequate analysis, you're missing something.

MR. MICHELSON: I think you --

MR. CATTON: And you ought to make the analysis adequate. Does making the analysis adequate make it a generic issue? I don't know.

MR. MICHELSON: No, this has been a question for a long time in this business. You have to worry about the ricochet of the jet. That's where it comes back. No, we don't worry about ricochets.

MR. CATTON: Every time I visit the HDR containment and I've visited it twice, I come back with this reaction.

The steam flow has picked up cncrete blocks and hurled them across the room into things because they were in the doorway or near the doorway or just around the corner. It rips pieces of sheet metal off walls, it tears down stairways.

MR. MICHELSON: Insulation flies around.

MR. CATTON: Insulation is everywhere. I mean, it gets all over -- there are people in Germany who now feel igniters won't work because of this.

MR. ORR: Certainly the items that are in fairly direct sight do get considered because I know on things like steam generators we look at grating, insulation, and all those other items in the local area, but when you refer to sort of two or three subcompartments over, that's where I will have to take a look at --

MR. MICHELSON: Well, do you look at just line of sight or do you go around the corner?

MR. ORR: Well, typically we follow for -- one of the critical regions is always sort of the flow around the steam generator and venting up through the operating deck and there it is indeed taken all the way up through that compartment, but I'm not sure that I could say that for all compartments we go to a shadow area.

MR. MICHELSON: But you will supply the reference documents?

MR. ORR: Yes, sir.

MR. DONATELL: Excuse me, I just want to point out that this item will remain open. If necessary it could be revisited on a case-by-case, system-by-system basis at some future point in the design but our stance right now is that this will in fact remain open.

MR. CARROLL: You're talking about the basic element of the contrast --

MR. DONATELL: The basic item, yes.

MR. CARROLL: --is contrasted to the item that Ivan has brought up.

MR. DONATELL: That's correct.

MR. CARROLL: Okay.

MR. ORR: The next open issue, number 13, is also related to pipe rupture. In defining locations for the break for safety class piping the breaks at intermediate locations are defined by stress level.

Standard review plan 3.6.2 also allows for non-safety class piping that you analyze the piping in the same manner as for the safety class lines and that you identify breaks again on high-stress points.

In the particular example would be a steam generator blowdown system, that is a non-safety line, or at least the portions outside containment, but is close to certain safety related items, so we have to look at high energy pipe rupture.

The position that Westinghouse has taken is that these lines, even though we do a dynamic analysis on them that is comparable to that performed on safety class lines, we are saying that the lines remain non-safety, that they are designed and built to B31.1 code and that we classify them as a seismic category 2 and as seismic category 2 they're designed to maintain their structural integrity during the SSE.

We believe that that provides a sufficient basis for the selection of pipe rupture locations.

MR. MICHELSON: I guess you have, then, three basic seismic design types, category 1 is full seismic, category 2 is SSE for this non-safety piping, and then all the rest?

MR. ORR: Yes, all the rest being seismic 3 would be designed to a uniform building code.

MR. MICHELSON: Do you call that category 3 then?

MR. ORR: In this application I'm not sure that we've used the terminology seismic category 3, I know in the application we talk seismic I and seismic II because we're only addressing safety items. In RSER we really don't go heavily into the --

MR. MICHELSON: What you're basically saying is that instead of seismic category 2 piping you're allowed to stress level as an indicator of where the breaks will be?

MR. ORR: That's correct, and the NRC's Staff's position as expressed in the draft SER is that that piping should be classified as seismic category 1 and then effectively it becomes ASME safety class two or three including all the paperwork and the construction requirements that go with it.

MR. MICHELSON: Some people have in the past have used a somewhat similar idea of being full seismic versus partly seismic. Your category 2, does that mean that a piping system to category 2 is designed to both retain its pressure boundary and its position or just retain its position?

MR. ORR: No, to retain its pressure boundary as well.

MR. MICHELSON: Okay.

MR. ORR: It meets in fact the same stress criteria as safety class 2 or 3 piping. The only difference is it does not get a code stamp that goes with it.

MR. CARROLL: On this issue and the preceding issue are these matters at issue in the EPRI requirements document review or is this a level of detail beyond which the requirements document --

MR. ORR: I think is a level of detail below the EPRI requirements document.

The EPRI requirements document certainly says apply leak before break to the maximum extent practical. I don't think they've gone to the next step of looking at the lines for which you don't apply leak before break.

MR. CARROLL: Okay.

MR. MICHELSON: Now, do you anticipate anywhere in this plant to qualifying the integrity of non-seismically designed equipment by using something equivalent to the scrug process for piping. Is that needed anywhere or you just need this category 2 and that's it?

MR. ORR: On the equipment qualification we are basically following the requirements of IEEE or 344. There are, I think, instances where sort of the scrug type approach of sort of comparing against an existing database --

MR. MICHELSON: Well, let me be specific, I'm thinking of, for instance, tanks that are not required to be seismically qualified but whose failure under a seismic event might cause an interaction with seismically qualified equipments. But those tanks or whatever, what category do you call those?

MR. ORR: Those tanks would be seismic category 2, they would be designed and analyzed for the big earthquake or alternatively we would demonstrate that failure of the tank is not unacceptable.

MR. MICHELSON: Okay, so -- okay, and then you wouldn't call them category 2 anymore or any other seismic category, you'd just do a special analysis them, is that the idea?

MR. ORR: Well, if you do the special -- this is -- really, they are seismic category 2 and you've got two options under seismic category 2.

One would say do the analysis for the SSE and show that they satisfy the stress limits. An alternative would be to say that to demonstrate that failure is acceptable and then you'd probably downgrade it and say that seismic II is not a requirement.

MR. MICHELSON: You say, what is a seismic 2 but --

MR. ORR: But --

MR. MICHELSON: I didn't understand the last part of your statement.

MR. ORR: If you are able to demonstrate when you do your detailed evaluation of the tank that the consequences of failure are acceptable then it says you do not need to classify it as seismic category 2.

MR. MICHELSON: And you would not?

MR. ORR: We would not.

MR. MICHELSON: Okay.

MR. ORR: However, early on in the design process you have to be doing this classification before you know the detail layout. So, on a tank like that it would certainly start out as seismic category 2.

MR. MICHELSON: Now, your comment here is B31.1, which is a piping, what are you doing about tankage and so forth which are built to other codes but have all the same arguments?

MR. ORR: The particular open issue is related to piping --

MR. MICHELSON: You mean --

MR. ORR: But there are other examples, tanks are one, structures are a second, where in both cases we do an analysis that is comparable to that done on a safety class piece of equipment. We compared [illegible]sses against the same allowables or equivalent allowables and show that the equipment or the structure will withstand the big earthquake.

MR. MICHELSON: And you call them seismic category 2 after --

MR. ORR: Yes --

MR. MICHELSON: You have done that, okay, thank you.

MR. CARROLL: Let's see, maybe this would be a good time to take our ten o'clock break and in the interest of getting the max accomplished today, let's be back at 10:15.

[Brief recess.]

MR. CARROLL: Let's charge ahead.

MR. ORR: Are we ready to continue?

[No response.]

MR. ORR: The next open issue and this is still in category five where we think there may be some disagreement with the staff, open issue No. 36 relates to pipe support base plate and anchor bolt design. The draft SER was issued in March. We have made a supplemental submittal of information that partially resolves the issue but I expect there to be a portion remaining open that I will discuss this morning.

The open issue relates primarily to the implementation of IE Bulletin 7902 on expansion anchor bolts. That was issued back in 1979 and required that for nonductile expansion anchors and I'll show you what I mean by them. Specifically in the bulletin, they talk about wedge and sleeve anchors. They require a safety factor of 4 on SSE loads.

For those anchors, we have now committed to 79-02 and that was in some supplemental information that went into the staff in August, I believe. Since 7902 Bulletin came out, there has been considerable work in the industry and a new class of expansion anchors has been developed known as ductile expansion anchors that are undercut and again I'll show you in the next slide what I mean by that.

These have been developed really to eliminate some of the problems inherent in the expansion anchors that were covered by the 7902 bulletin. Let me come back to this slide again later.

A typical expansion anchor is a method of attaching to concrete where you've already got the concrete cast. You drill a hole in the concrete. You drop in an expansion anchor and then by applying torque to the bolt, you expand the wedges inside the base of the anchor such that you get resistance against pull out. This is the type of expansion anchor or wedge anchor that is covered by the 7902 bulletin.

In the late '70s and early '80s, new types of expansion anchors have been developed and they are known as undercut anchors because rather than just drilling a hole and dropping in the bolts, you drill the hole and you put down a special tool to develop an undercut. In this case, it's in the upward direction. In this case, it's the downward direction and you then expand the bottom of the anchor as you tighten the expansion bolt such that the resistance against pull out is primarily bearing on the concrete rather than friction.

All of the test data on these anchors shows that this mechanism is considerably better and typically the failure mechanism on this type of anchor is a steel failure where the failure mechanism on the wedge anchor is either slip of the wedges or a concrete failure mechanism.

What do we mean by ductile? Firstly, if we look at a bolt -- a cast in place bolt embedded in concrete, we find that as we apply tension loads to the bolts, we get up to yield and beyond yield we get significant deflection prior to failure. This is steel elongation and we're looking at displacements of about half an inch before failure.

For an expansion anchor, and these are the expansion anchors covered by 7902, we get deflection with increasing load but basically it's linear and then the failure. This particul[illegible] one it's a concrete failure. It occurs at a deflection of about one eighth of an inch rather than one half of an inch and it is brittle. In other words, there's not a long, flat portion as there was on the upper curve.

Now for the undercut anchors, they behave very similar to the cast in place bolt. This is a high strength steel undercut anchor. The high strength steel in this case had a strength of 150 k.s.i. We see displacements in the elastic portion that are in the range less than .1 of an inch up to yield and then we get very pronounced yield displacement such that we actually have a displacement of one inch before the expansion anchor fails.

The position Westinghouse has proposed for the design of these expansion anchors, the undercuts, is to follow the requirements of ACI 349, Appendix B, that covers the design of ductile expansion anchors. A typical anchor that we would be proposing uses A193B7 material. This has a minimum ultimate stress of 125 k.s.i. and typically it may go as high as 150 k.s.i. as it did on the last slide. It has a minimum yield stress of 105 k.s.i. This typically may go as high as 115, maybe even 120 k.s.i.

Appendix B requires that the anchorage design be controlled by the strength of the embedment steel and not by the concrete. We want to be sure that we get that large yield of the embedment steel before we have a pull out failure of the concrete. There's therefore very conservative requirements in Appendix B on how you design the depth of embedment and hence the strength of the concrete cone in order to ensure that it is a steel failure.

Once we have demonstrated that it is a steel failure, the design load is based on -- 90 percent of yield first of all is what a cast in place anchor bolt would have and we then have a further .9 factor because it's an expansion anchor and therefore, we limit the design strength to .81 times yield which for 105 k.s.i. minimum yield material, comes out as 85 k.s.i.

This would result in a factor of safety on minimum specified tensile strength of 125. This should be divided by -- I think it is but it's difficult to see on the slide -- divided by 85 equal to 1.47. That is the safety factor on steel failure. The safety factor on concrete failure is about 50 percent higher.

This safety factor compares with a safety factor of 4 that is required by 7902.

[Slide.]

MR. ORR: Going back now to the summary slide, the position we've established -- because we are talking here a failure of steel, we have compared now the allowable, the design strength that we're using with that that would be permitted with other steel structures in a nuclear power plant.

We have limited it to .81 times yield. Category 1 steel structures typically will allow you to go to .96 times yield in membrane tension. ASME 3 Subsection NF for supports limits you to the lesser of yield or .7 times ultimate and again, the .81 times yield is actually more conservative than these numbers.

Current staff position is that ductile expansion anchors should meet the safety factor of 4 required by 7902. However, I think they do recognize that the ductile anchor is better than the type of expansion anchor covered by 7902 and I like to think that they will move away from the position of imposing a factor of 4 because right now it discourages the applicant from using what is definitely a better product.

So in summary, we will continue working with NRC and the industry in trying to establish a regulatory position for this type of anchor bolt.

MR. CARROLL: Where is this effort taking place?

MR. ORR: One of my other activities, I am chairman of the subcommittee of ACI 349 Appendix B that developed these requirements. We do have some NRC staff people on it. We do want -- in fact under this application, I would like to try and get NRC to accept this position.

I'm not sure whether they're ready to accept it in the short term. I do hope that within about a year or so they will be able to take a position.

MR. CARROLL: So the industry effort you're referring to is principally an ACI effort?

MR. ORR: Yes. Yes. This particular type of product is covered under the ACI Appendix B.

MR. CARROLL: I guess the only thing that jumps out at me in looking at it is quality control aspects of it. How do I assure myself that in drilling into concrete that I'm getting the right configuration down at the bottom of the hole?

MR. ORR: There is a fairly elaborate sort of a QC program that goes with the installation of all anchor bolts and guarantees that you get the depth of embedment necessary and you get the expansion mechanism expanded correctly. Now on this particular anchor bolt, you actually preload to 80 percent of yield so you've got a reasonable assurance when you preload it in the field that the expansion mechanism has actuated.

MR. CARROLL: Okay.

Does the staff have any comments?

MR. DONATELL: I believe that Westinghouse has adequately addressed the issue at this point in time meaning we still have an open issue and it's still under review by the staff.

MR. ORR: I've lumped together here Open Issue Nos. 2 and 3, one of which we had put into category three, one of which into a category four and the prime issue here is that we are referencing a new code that has not yet been endorsed by NRC. We are putting together a proposal for a new plant that is going to be built in the '90s or even later and we do not feel that we should be using obsolete codes and standards.

In this particular example, the prior code, the AMS 18.2 code has been withdrawn and has been replaced by ANSI ANS 51.1. Recently we did have discussions with NRC and they have agreed that we may use this code for the pressure retaining systems and they are still conducting the review in that area. I don't think we yet have agreement for the non-pressure retaining systems. We definitely want to continue referencing the new codes and standards and hoping that NRC will be prepared to take a position on these codes and standards in reasonably close time frame.

I think one of their problems is clearly they have not been assigning resources in the area of standard review plans, reg guides and endorsements of codes and standards.

MR. MICHELSON: This is a 1983 document. Staff since 1983 has not reviewed it for endorsement purposes?

MR. BRAMMER: This is Jim Brammer. That is correct.

MR. MICHELSON: Is there some good reason why we ignore it for that many years?

MR. BRAMMER: I don't think there's a good reason. It has to do primarily with the reorganization of the staff starting back in the '84, '85 time frame.

MR. MICHELSON: Yes, but it's been reorganized several times since then. It boggles my mind just a little bit.

MR. BRAMMER: I understand. I personally don't think -- we've determined I think from mechanical engineering branch standpoint that it's not necessary or not endorse this document. We think we can perform the review without that complete.

MR. MICHELSON: Yes, but I somehow got the impression I guess mistakenly that the staff likes to endorse commercial standards where they are acceptable and likes to encourage their use. It doesn't seem to be much of an encouragement of its use when it's -- review it.

MR. BRAMMER: I agree. I don't have any defense.

MR. MICHELSON: I just didn't realize you hadn't endorsed it.

MR. BRAMMER: The way the system has worked -- or hasn't worked.

MR. MICHELSON: I guess the subject never came up. I just didn't --

MR. BRAMMER: Another aspect of this situation has to do with lack of staff review -- necessary for staff to review new plants. After Vogo, South Texas time frame, there's a lapse there of several years where we were not asked to review and therefore we deferred our resources to other areas. I'm speaking only as an individual. I don't know what the answer is from our management standpoint.

MR. MICHELSON: It isn't a controversial standard.

MR. BRAMMER: No, but it takes a person who has worked in this for years to really assess it. We only have one person to my knowledge on the staff and he's not available.

MR. CARROLL: Did a staff person participate in the development of this standard?

MR. BRAMMER: Back in early '80s, this gentleman participated but now he is in a position he doesn't totally agree but I think what's happening is people on our side of the house are not overturning his decision. We're saying we can get by without a review of this. He has some problems with the non-pressurized --

MR. MICHELSON: I guess the EPRI document is also hinging back to ANSI 51; is that right?

MR. BRAMMER: Pardon me?

MR. MICHELSON: Is the EPRI document also going back to this ANSI standard?

MR. BRAMMER: This is an issue on all three. I'm working on GE, EPRI and Westinghouse and it's a minor issue on all three. I call it a minor issue because I think it's resolvable.

MR. MICHELSON: I don't think it changes the world any. I'm just surprised that we haven't paid any attention to it.

MR. ORR: This is only a type one example of codes and standards not being endorsed. I could have put the last item in that same category, ACI-349 appendix B was issued in 1978.

The 1976 edition was endorsed by our regulatory guide but the later edition wasn't. A draft was prepared endorsing -- making comments on appendix B, I believe it was in about 1980, and nothing has happened since that time.

MR. CARROLL: Well, that's because you made a tactical mistake in calling it appendix B. Nobody wants to have anything to do with it with a name like that.

MR. ORR: Yes, but I can also mention there are certain other documents, there's an AISC1N690 that we have partially referenced in our application that has not been reviewed and I will get to one other, I believe, in my next slide.

I will take things slightly out of order because really the message again is the same on this particular issue number 25. We have referenced ASCE4-86 "Seismic Analysis of Safety Related Structures" that really provides a fairly comprehensive set of requirements for seismic analysis. NRC staff have not yet been prepared to accept this standard.

I bel:eve that it may be easier for them now to accept it because a large part of it is consistent with the revisions being incorporated in standard review plans 371, 372, on seismic analysis and that was recently, I believe.

The revisions to the standard review plan have been approved. They were all published in New Regs and it's now, I think, just a matter of getting it into the standard review plan itself. That would cover the structural type issues.

4-86 also covers certain seismic analysis and mechanical items and the mail may not still be some open issues there.

In discussions with the Staff, they agreed at one time to come back to us and tell us what the open issues are on this particular standard and we are still awaiting that response.

[Slide.]

MR. ORR: Now, I'll will get very briefly into a category 4 item. Category 4 item was an item where in the draft to SER the Staff identified that they had not finished their review of some information that we had supplied. In this particular case there were two open issues, number seven and number eight. One relating to internally generated missiles inside the containment, the other to internally generated missiles outside containment.

There was a request for addition information, question 430.4-7 -- sorry, 430.4 through 7, there were four questions. We submitted a response in our letter of June 14, 1988, this was included in an amendment to RSER in January 1989 or it would be in your copies and at the time of the DSER, NCR was still reviewing it.

So, our position, we don't have any action required and we're still awaiting from the Staff statement whether our response is adequate or whether there's still an open issue.

Open issue number 23 --

MR. DONATELL: I was just going to say, the initial input I've got on those particular open issues is they will probably be accepted.

MR. ORR: Open issue number 23, limited design audit of containment design, I'm going to show you one of the sections of the general arrangement drawings in the Westinghouse APWR application. We have a spherical steel containment, approximately two hundred feet in diameter, and approximately an inch and a half thick material.

MR. CARROLL: As a matter of curiosity, why have we now gone full circle back to spherical containments?

MR. ORR: In the evaluations that were done for this particular design it appeared that spherical looked attractive from an economic point of view. There are recent applications that have spheres. Unfortunately, they were never finished. I gather there is at least one that is about one-third built at the moment, one of the duke units and a cherokee, none of them, though, of the recent ones were ever completed.

MR. CARROLL: It's a movie studio in here, yes.

MR. ORR: The sphere is very effective for resisting pressure.

MR. CARROLL: That's what I've heard. Yes, I mean, Yankee Road, Dresden 1 were spheres.

MR. ORR: They're a little bit more expensive to build, I think, in terms of -- because you've got to form the plate in both directions, and I think that's why people went to another way.

The draft SER states that the Staff cannot accept the standard design of containment without performing a design audit or reviewing a structural integrity test. The Staff will perform a limited design audit before the PDA is issued.

Our position is we have identified in RSER that we have spherical containment, we're going to identify it as some of the major parameters, the overall dimensions, the plate thickness, the design pressure, and we believe at this stage that that is sufficient.

The containment vessel will be built in accordance with ASME and that requires that the manufacturer both design and build it. So, the design will be performed by someone like CBI or PDM at the time that we release the purchase order for a containment. It's therefore on the same category as other equipment.

For a standard application one does not identify vendors at the time of that application. We believe that the appropriate time for the limited design audit would be when the sufficient design information to demonstrate the design configuration and designs and that this would occur a few months after placement of a purchase order for the containment vessel.

Thus, the limited design audit should be performed prior to FDA and/or the first plant specific construction permit.

MR. DONATELL: At this point the Staff finds that we will put off a comment on this.

MR. ORR: Okay, that has completed all of the items in our category 3, 4 and 5, except for one on testing of valves that Terry Van De Venne will pick up during his presentation on chapter 6 because it's more related to systems.

What I've got listed here is the remaining open issues in category 2 and in the next two slides I've got the similar ones for category 1. We believe it is of not worth going through these in any of the detail that we did for the previous ones but if you identify any here that you want more information on I will be happy to address it.

[Slide.]

MR. ORR: The last one, flow induced vibration testing for non-prototype plants. Here we have -- Terry, you want to respond to this one? Okay.

MR. VAN DE VENNE: Yes, let me address that one. I think the issue here was that we have committed to flow induced vibration testing in accordance with the specific regulatory guide for the first unit, prototype. But we have not committed to put in a dummy core at this point in time. We have just said that --

MR. CARROLL: We're talking flow induced vibration limited to core internals?

MR. VAN DE VENNE: Right, yes, flow induced vibration testing is limited to core internals.

We have said we will either put in a dummy core or provide sufficient analyses at the FDA stage so show that it's not necessary to put in a dummy core to do the test.

So, that is basically what we have said here.

We have done some preliminary analysis that indicates that it may not be necessary to have a dummy core but we need to do a more detailed analysis to make that and we will provide that analysis at the FDA.

MR. CARROLL: Now, the standard review plan doesn't require flow induced vibration testing of anything else other than the core?

MR. VAN DE VENNE: The specific regulatory guide addresses only reactor internals.

MR. MICHELSON: I thought there was another portion of one of the guides, though, dealing with heat for having a vibrations program during start-up in which you go -- the plant -- vibrations, but this is not that, but I assume at another time we'll hear about --

MR. BRAMMER: There is a reg guide 168 which covers the entire plant. Is that what you're referring to?

MR. CARROLL: That would be part of chapter 14? You're not going to find anything in there, Ivan, if I remember right about the flow induced vibration.

MR. VAN DE VENNE: The next two overheads provide a summary of those items that are category I. Again, if there are any that you see here that you'd like discussion on, we'll be happy to discuss it.

MR. MICHELSON: Yes. Item 16 -- issue 16, limits of break exclusionary --

MR. VAN DE VENNE: Okay, this particular one, the concern is a short portion of piping immediately downstream of something like the main steam isolation value. You've got the main steam isolation value and that is the class boundary between safety class 2 and the non-nuclear safety.

MR. MICHELSON: Did it restrain itself or is there a restrainer?

MR. VAN DE VENNE: There's a restraint immediately adjacent to the value. You can't -- you don't want to put the value. You can't -- you don't want to put the restraint on the value body, the restraint is on the pipe and so there is a small portion of pipe that you are actually counting on to stay in tact to protect you against the affects of a break in the turbin building.

MR. MICHELSON: What's the issue?

MR. VAN DE VENNE: What we're saying is that we are locating the restraint as close as possible to the isolation value and it is actually on a portion of pipe that is not safety class. However, that particular --

MR. MICHELSON: You're not safety classing the pipe up to the restraint?

MR. VAN DE VENNE: No, because the class boundary occurs at the stop value.

MR. MICHELSON: Well, a class boundary is wherever you put it.

MR. VAN DE VENNE: In practice the quality of that pipe, that portion of pipe that the restraint is on, is indeed sort of the equivalent of a seismic category 1 piece of pipe.

MR. MICHELSON: That's why I don't know what the fuss is all about as far as changing the classification until after you have passed the restraint. A big monetary difference.

MR. VAN DE VENNE: Well, normally the safety class is identified more from a system approach.

MR. MICHELSON: No, you can identify safety class any way you wish. Now, whether or not it affects fabrication is the key issue in this case and I wouldn't think it would affect the fabrication cost, at least, except for a little more paper, enough paper to cover up to the restraint. I was wondering why it would even be an issue.

MR. BRAMMER: This is Jim Brammer. As I recall, the original issue was not what you're talking about, directly, it had to do with the limits of the bridge exclusionary area. A standard review plan calls for the break exclusionary to terminate at the outboard isolation value. This approach goes a little farther than that, but not much further.

MR. MICHELSON: Okay, you're -- they're asking, then, to extend it --

MR. BRAMMER: To extend it --

MR. MICHELSON: Onto the restraint?

MR. BRAMMER: Yes.

MR. MICHELSON: And I think the same issue will arrive for the ABWR and I thought the answer was that the piping classification will also go out to the restraint boundaries.

MR. BRAMMER: Normally to the restraint and after, I believe, it's --

MR. MICHELSON: And then I don't think there's an issue --

MR. BRAMMER: I believe it's --

MR. MICHELSON: And then I don't think there's much of an issue about whether or not you're going to include breaks. But if they're not going to extend the boundary of class 1 out that far then there's a real issue.

MR. VAN DE VENNE: This is Van De Venne here. If what it takes to resolve this issue to make a commitment to extend that safety classification through the restraint, then we can do that.

It is true, what Mr. Orr is saying, that historically it always seems that safety class changes at value it's just engineering practice, but in this particular case the other two feet or whatever it is not going to be a big deal.

So, if that's what it takes to resolve this, we'll make that commitment.

MR. MICHELSON: I think you'd have to extend it in order to -- it does create confusion -- apparently the break exclusion rule didn't really allow you to -- those couple of feet or more?

MR. BRAMMER: Not directly. There is a paragraph in the Standard Group Plan 362 which allows a higher threshold stress criteria, I think, for that. You still got to protect the pipe but not go beyond a plastic hinge, in words to that affect, and there was some accounting for it, but it wasn't directly.

MR. MICHELSON: You didn't see it in so many words?

MR. BRAMMER: It has been my understanding in reviewing this issue that the class 1 did extend out to the restraint, but I guess maybe I misunderstood. At any rate, it should

MR. MICHELSON: Clearly it should if you're going to start talking about -- the fact is, it should anyway, because in part of the restraint it's confusing as to what kind of breaks you postulate --

MR. BRAMMER: Normally the class break is at the seismic restraint.

MR. MICHELSON: I just didn't realize.

MR. CARROLL: I'm interested in what open issue 40 is all about. I guess I thought maybe this was abbreviation, when I look at the Westinghouse response they still don't tell me what IEEE 344 is. It would be helpful in looking at this if you'd give the title of the document. What is it?

MR. ORR: IEEE 344 is the standard for qualification of electrical equipment.

MR. CARROLL: This is the AQ standard?

MR. ORR: Yes, sir.

MR. WARD: Issue 20.

MR. ORR: Issue 20, I had felt that I had provided some clarification. NRC had asked for information on how we were calculating the soil damping values and the analyses were present in RSER and I provided some clarification to them.

What we have done for the standard plant is we have analyzed it on a range of three soil conditions, good soil and rock, and then we have enveloped the results in the design of the standard plant. In those three analyses we used a semi-infinite half space with soil springs.

MR. CATTON: What's the open issue 22 all about?

MR. ORR: Open issue 22 relates to the design criteria for the containment. We have committed to meet ASME Section NE. The way that the draft SER was worded it seemed that the NRC had a slight concern because they had never seen a spherical containment being built and they were a little hesitant on whether the criteria was sufficient for spherical containment.

We believe they are sufficient. We supplement them with Code Case N 380 -- I've forgotten the exact number. The one's on allowables and that sort of tends to be one of the issues on steel containment.

MR. MICHELSON: Hadn't they ever seen the Yellow Creek containment? I mean, you reviewed that in great depth, a long time ago now, a relatively long time ago, but it's not like you've never seen one.

MR. DONATELL: The reviewer from this particular branch is not available. However, I'm not convinced that we've typified the issue as it stood between the reviewer and the applicant. We're speaking about open item 22, is that correct?

MR. ORR: Yes.

MR. DONATELL: Okay. What the reviewer believes in response to Westinghouse's last response is that at this point in time their responses are adequate. There will be some additional questions and some additional design information required and additional review for the FDA stage.

MR. CARROLL: In your containment design criteria did any of the PRA inside -- oxidants enter into this?

MR. ORR: I don't think they have affected our design criteria but clearly we will be doing the ultimate pressure capability analysis and that is a commitment we have made and typically that shows that the ultimate capability is about two and a half times the design capability.

MR. CATTON: So, your containment is still designed to the large break class of coolant oxidant?

MR. ORR: Yes. The design pressure is about 45 PSI.

MR. CATTON: What are you going to do with insides to -- oxidants from your PRA if you don't incorporate them into things like the containment criteria, design criteria?

MR. ORR: I think generally --

MR. CATTON: Just report them --

MR. ORR: Have shown that the containments have a substantial margin that is sufficient at present with the exception, perhaps, of some of the low pressure containment designs. With the high pressure large volume I believe showing up very well in the PRA analyses.

MR. CATTON: Well, okay, I'll wait until I take a look at your module 16.

MR. MICHELSON: Will you tell me just briefly about that what the issue 34 is about -- that's stress limit on class 2 and 3.

MR. ORR: 34, you're going to have to correct me if I'm wrong, I think this was related to the allowable stress on the disks in the valves and we provided our allowable stress criteria for those disks.

MR. MICHELSON: You're using the code --

MR. ORR: I think this may be a category where the code was not specific. I think we had stress limits in for the class 1 and we didn't have them in before the class 2 and 3.

MR. MICHELSON: Maybe I'm wrong, but I thought maybe they were specific on class 2 and 3.

MR. CARROLL: That is what your submittal says.

MR. MICHELSON: What does it say?

MR. CARROLL: That you hadn't provided it for class 2 and 3.

MR. MICHELSON: And it's not in the code?

MR. CARROLL: It's just a matter of putting it in a table.

MR. MICHELSON: That got in a long time ago unless -- how about item 38, what is the problem there?

MR. ORR: The problem there, I believe, was one of the reviewers wanted a fairly detailed discussion of the pre-service in-service inspection program prior to PDA. I believe that item is now sort of in the category of -- we have committed to the program, the details of the program would be in the FDA.

MR. MICHELSON: And you're maintaining an awareness of the current motor operated valve situation and whatever --

MR. ORR: I believe that is correct. Terry, do you want to comment on that?

MR. VAN DE VENNE: We're aware of the generic letter 89 10 concerns and as the responses to those are developed by the existing applicants, Westinghouse is also looking at what we'll to do for that in the longer term.

MR. MICHELSON: That may eventually lead to some additional pre-service testing? Whatever it is, though, you will do it at the FDA stage, all right.

MR. CARROLL: What the issue 37 about?

MR. ORR: These are the problems we've had on our search lines on the stratification in the search lines on a number of, in fact, almost all of the Westinghouse units. What we have committed to on the advance plant is that that will become one of the design conditions for the piping and therefore it will be evaluated against code allowables for the advance plant.

MR. CATTON: Is the issue gone away then?

MR. DONATELL: No, the issue has not away. Stop me if I'm wrong here, we're still looking for a commitment to a couple of IEV's --

MR. BRAMMER: We haven't asked Westinghouse anything on this. I think it will go away but I think we need a little more -- relative to a commitment to the two bulletins that are out -- on these two broad issues. What you are -- as I recall, what you recommended was an interim procedure to monitor leakage -- or, pressure and temperature, is that right? Something like that. And I think that's been accepted generically by the Staff. So far, in the process of resolving these bulletins, they've been accepted as an interim basis, or an interim position, I think there's a more -- I think there's more detail required, we'll have to discuss it, but it's not totally closed yet.

MR. ORR: But is this at the PDA stage or is some of that at the FDA stage?

MR. BRAMMER: I would say it could be at the FDA myself, but, I might get overruled.

MR. MAURER: Excuse me. Brad Maurer from Westinghouse. What we have committed to, correct me if I'm wrong, is one of two approaches. One is to include a detailed definition of the transients resulting from the stratification and the analysis of those transients or, and this can be and/or, monitoring of the piping to assure that these transients don't occur, so it's a bit open-ended but we're covering both possibilities that were currently in process.

MR. ORR: This is the one on seismic qualification of equipment -- environment. I think one of the problems is it's not clearly worded in the DSER what the issue is. I think we -- our position, we believe we have procedures in existence that show how we qualify equipment. There is under 40, issue 40 is the extent of compliance with IEEE 344 latest edition.

Now, generally we would expect to be complying with that code for those items, those new items, that still are going to go through a qualification process. I think our main hesitation is on those items that have been qualified in the past and are not going to be changed in this new design we wish to be able to rely on the past qualification data.

MR. WYLIE: I think at least the way I read this last response you submitted as to safety related equipment and the Staff has asked you to be more explicit in spelling out where you meet them. I believe that is the issue. Does the Staff want to comment on this?

MR. WALKER: My name is Hal Walker and there I guess there's two points of clarification. Item number 40 is seismic and dynamic qualification and Item number 41 is environmental qualification. If I recall correctly the issue with 41 was the way Westinghouse stated their compliance with the existing reg guides and the rule itself which is 10 CFR 5049. I don't believe it's a big disagreement. I think there was some wording about qualifying by analysis and the implication with analysis only and in some cases that may be acceptable but generally we expect some testing and we wanted to clean up that particular statement and that's why that became an open item.

I now believe that Westinghouse has committed to comply with new reg 0588 and reg guide 1.89 and I think that should clear up our concerns.

MR. CATTON: The environmental qualification, that's just the large break loca of pressure, temperature, humidity, isn't it? And you autoclave it or something?

MR. WALKER: Yes, that's correct.

MR. CARROLL: Is any awareness of the fact that you get stratification in these volumes within the containment that are a 100 degrees C, at least, that in some circumstances you have days at very high temperature in the upper regions of a containment building. It seems to me that falls outside of this kind of qualification.

MR. WALKER: Yes, we are aware of that. The qualification process itself look at bulk temperature and containment for the accident itself, for aging of the equipment which I think you may be alluding to where you get --

MR. CARROLL: No, that's not what I'm talking about. If you a loca --

MR. WALKER: Yes --

MR. CARROLL: And you calculate your pressure temperature and humidity based on volume, you're going to be way off on humidity in parts of the volume and you're going to be quite a bit off on temperature in parts of your volume --

MR. WALKER: Yes --

MR. CARROLL: And you certainly will not have given any consideration to flow. So, if it's an important piece of equipment you may miss the qualification entirely.

MR. WALKER: Well --

MR. CARROLL: There are examples --

MR. WALKER: Which --

MR. CARROLL: This HDR containment, again, the top of it, they cooked everything because it just stayed hot and the bottom was less than 25 degrees C and the top part was over a 120 degrees C and it was for days.

MR. WALKER: What we have been doing about that situation is to break the containment up into areas and the analysis is considered various areas and the particular temperature pressure and humidity in those areas --

MR. MICHELSON: Post accident --

MR. WALKER: It's by zones --

MR. MICHELSON: Post accident?

MR. WALKER: Post accident and as a --

MR. MICHELSON: You've been doing a zonal temperature analysis for qualification for post accidents.

MR. WALKER: That's correct. The containment itself is broken up by zones, yes.

MR. CATTON: I would certainly like to see that analysis because I don't know of any of the codes that are used for this type of analysis in this country that are adequate.

MR. WALKER: What the Staff does is the analysis that we look for or the results of the analysis performed by the vendor or the utility itself. We look for various areas such as, for example, the steam zone, which is usually much hotter -- the containment itself as a result of an accident. Of course, as you indicated, the stratification that occur from the bottom to the top of the containment is looked at by our review process and we do look for specific consider of temperature pressure and humidity in the various zones.

MR. VAN DE VENNE: This is Terry Van De Venne of Westinghouse. We do have a code called Compact which we have not used in this particular application but which we are now using where we can model the zones in the containment and, for instance, on the AB6-100 I believe we have 16 different zones inside the containment where, you know, we model all the interactions between the zones and the various temperatures and pressures -- not pressures, but humidities -- in each of these zones. We have that capability and it's needed for the passive plant because the containment cooling is highly dependent on -- it's a passive containment cooling, so it's highly dependent on the temperature for inside containment. So, we have that capability.

MR. MICHELSON: But for present in compliance --

MR. VAN DE VENNE: We have not used, no --

MR. MICHELSON: For equipment qualification you used an homogenized plant?

MR. VAN DE VENNE: I believe that's correct, yes.

MR. MICHELSON: Now, for this next plant, are you going to still use homogenized --

MR. VAN DE VENNE: No. We will use compact from now on, even for these plants --

MR. MICHELSON: That is a commitment?

MR. VAN DE VENNE: We have not made that commitment, no, but we can.

MR. CATTON: You could make that commitment?

MR. VAN DE VENNE: Yes.

MR. CATTON: That would certainly make me feel more comfortable.

First, if I believe what he said about the code, but then I'd like to look at the code and maybe something we have to be done with that.

These are not easy computations and I know of only a couple of codes that can do this in a reasonably adequate way.

MR. WYLIE: Most of the electrical equipment is at the operator level and then there is around the periphery of the building --

MR. MICHELSON: That depends upon where the break is --

MR. WYLIE: But that is where the equipment is.

MR. MICHELSON: Depending upon where the break is that may be the hottest part of a building -- Not necessarily --

MR. CATTON: If these things are near the floor the qualification is conservative, if they're near the ceiling, it's not conservative, so it depends on where you are. I mean, this process literally cooked the crane in this containment, they've had to completely rehabilitate it, it fried everything.

MR. WYLIE: Was that not safety related to the equipment?

MR. CATTON: That's right. Well, the globe plugs get covered up with stuff because of the flows that are induced.

MR. MICHELSON: The same principals apply to compartments wherein pipes do break and usually we homogenize the compartment and not necessarily -- temperature -- it's a ceiling, for instance, when looking at devices, whatever, it's just the way we do business. Do you intend to use this for compartments also, this type of containment?

MR. VAN DE VENNE: I believe the only pipe breaks outside containment really is a steam tunnel and I think, I believe it's not big enough to justify --

MR. MICHELSON: Don't you have an auxiliary feed water?

MR. VAN DE VENNE: No.

MR. MICHELSON: But pipes can break somewhere along the steam line.

MR. VAN DE VENNE: But most of these volumes are pretty small. I'm not so sure that you would gain a lot.

MR. MICHELSON: Unfortunately, the volumes are small, I'm not denying that.

MR. WYLIE: I thought that the issue on 41 was basically Westinghouse had submitted information on how they qualified this equipment. In looking at those I was having difficulty relating that to the regulatory requirements -- had come back to Westinghouse and say, hey, how do you meet the regulatory requirements? Is that not the case? That is what the SER says.

MR. WALKER: I believe that's correct. We did not feel that they provided the commitment as we expect to the current regulatory requirements, yes.

MR. VAN DE VENNE: Our commitment has been that this W-cap will be updated at the time we are -- I mean, if we update it now it'll be out of date two years from now and if we -- we have made a commitment that we will meet the regulations and we'll update the W-cap at that time when we're getting close to ordering the equipment that we need to order. So, that's the commitment we've made.

MR. WALKER: Well, just so that we're clear, I don't believe we are in disagreement.

MR. DONATELL I think it's just the stage of the review that we're looking at on this issue now and I think we've agreed to probably go off to the FDA at this point.

MR. CATTON: If possible I would like to see some description of this code you're referring to before I see results on the screen.

MR. SHANNON: I believe that the code, the compact code that we refer to, will be submitted as part of the AP-600 submittal --

MR. CATTON: Is there a W-cap on it at this time?

MR. SHANNON: It has not been submitted at this stage. I think that the first opportunity there's going to be for Staff and ACRS to review that code is part of the AP-600 docket.

MR. CATTON: Are you going to do any verification of the code via some of the available data for large containments like the HDR facility?

MR. SHANNON: I'm not certain off hand. The people who do those analyses aren't here today. I'm not certain how they're validating and verifying the code but it's typically our practice to validate and verify codes against test data and experimental data when that's available.

MR. CATTON: Okay.

MR. SHANNON: The specific answer on that code I don't know.

MR. CATTON: I'll ask these questions again when you do submit it.

MR. MICHELSON: Where was that AP-600 on our schedule? W' ' that soon?

MR. CARROLL: No.

MR. DONATELL: Excuse me. I believe the AP-600 at Westinghouse is committed to having an LRB in house around June so it's a ways down the line right now.

MR. MICHELSON: We will want to see that.

MR. SHANNON: The current schedule submittal date for the safety analysis report and the other licensing submittals on AP-600 is June of 1992, so --

MR. CATTON: That's infinity.

MR. SHANNON: It's after next week.

MR. CARROLL: One issue I'm kind of interested in is the fact that the spherical containment is -- the plate has got concrete on both sides of it, what thoughts are being given to long-term corrosion problems or the potential for that?

MR. ORR: Generally the experience to date has been that when you've got concrete embedding the steel plate there is no corrosion. There is, I think, one example, though, where they had borated water on the containment where there was severe corrosion. Clearly, one's got to prevent that from happening. Where the steel plate comes out from the concrete there will be a seal and that's obviously the vulnerable area that we have to inspect periodically to be sure that corrosion hasn't started there.

MR. CARROLL: Both inside and outside?

MR. ORR: There will be some sort of seal on the outside; however, remember, it's a very steep angle at that stage. Really, all you're trying to do is to prevent condensation from getting down into the concrete.

MR. MICHELSON: I thought there was a Mark I problem where the base pedestal and that's all spherical down there right where the vent pipes are going on. I thought they were having a serious corrosion problem. That wasn't borated --

MR. CARROLL: No --

MR. MICHELSON: As I recall --

MR. CARROLL: But there is such a problem, you're right.

MR. ORR: I think there was a corrosion problem from sort of the fuel transfer tube or something like that or residual line where there was borated water that was leaking onto the containment vessel.

MR. CARROLL: He's talking about a boiling water reactor problem with Mark I.

MR. MICHELSON: Mark I is spherical --

MR. CARROLL: The bottom of the lightbulb -- okay -- any other --

MR. ORR: The next speaker then for chapter 4 is Jack Miller.

MR. J. MILLER: We will discuss chapter 4, the reactor, and there really are only a couple of issues in this so I'm going to go over the reactor itself which has some new features that are somewhat different than conventional PWRs.

This is a cross-section through the reactor. We have two different types of upper internal, one for displacer rods which we will discuss and one for the RCC, the control rods. Fuel assemblies -- we have a radio reflector which we'll discuss. The vessel is a little taller, like 53 feet, and a little wider in diameter, 200 inches. Flow comes in, the coal leg goes down the down comer, up through the fuel, up through the guide tubes, and out through an upper calandria which protects the dry rods.

The fuel assembly is different than our standard. It's a 19 by 19, uses coil springs instead of relief springs that we normally use. We have guide tubes going through the grids -- the fuel assembly, we'll show you a close of that.

The top nozzle plate and a bottom nozzle.

MR. WYLIE: Why did you change the spring?

MR. J. MILLER: Why did we?

MR. WYLIE: Yes.

[Slide.]

MR. J. MILLER: This is a removable top nozzle. We actually can reconstitute this fuel assembly and it was easier to do it with a coil springs than it was with relief springs.

This is a cross section through the fuel assembly, the 19 by 19 as I mentioned. There are 16 guide thimbles. Each guide thimble replaces a 2 by 2 array of fuel rods.

The guide tubes that are shown in green either can have a control rod, which is like a figure X, or a grey rod, which we will discuss, which is also a figure X. It's identical to a control rod except for the materials.

All of these, including the green, can in one location or another, have a water displacing rod in them.

This is a typical cluster arrangement, a 3 by 3 fuel assembly array. Control rods are shown in green, grey rods in red -- as I said, they're identical in configuration, and these are the water displacer clusters.

MR. CATTON: What fraction of the water can you displace?

MR. J. MILLER: It's close to 14 percent.

MR. CATTON: 14 percent.

[Slide.]

MR. J. MILLER: Some of the features -- the core has a reduced specific power, which improves fuel cost and gives a somewhat higher design margin.

We have the moderator control with the displacer rods -- again reduced fuel costs and allows us to go to longer cycles for the same enrichment which gives us some availability benefits.

The radio neutron reflector, again, reduces fuel costs and also reduces the vessel fluence. The fluence on this vessel is like 1.4 time 10 to the 19th.

The grey rods are used for low follow and they also do some water displacing so they are acting like water displacer rods in a sense. So, they also reduce fuel costs.

Reduced specific power. This low power density design. We can increase the number of fuel zones for the same discharge burn-up which gives us an economic benefit. The feed fuel loading is maintained while feed enrichment is reduced and this is because of the features of the water displacer we are able to reduce enrichment.

We have a three zone core design for 18 month cycles with a capability going to 24 month cycles. Increased design margins and LOCA DNB and vessel NVT and a higher margin to provide more operating flexibility.

[Slide.]

MR. J. MILLER: Let me show you a comparison of some of the features. Here's the South Texas plant. The APRR. Core thermal power. Number of fuel assemblies, same. Pure rods per assembly, slightly increased. Core length, decreased. And the core fuel loading goes from 95 to 119 metric tons.

The diameter of the core is much larger because of the larger fuel assembly. The average linear power is reduced somewhat and a specific power is reduced somewhat.

MR. CATTON: Is there anything done in the core design especially to reduce the vessel fluence or is that just because the vessel's bigger.

MR. J. MILLER: Two things. The low power density reduces just because you have less power.

MR. CATTON: Yes.

MR. J. MILLER: The reflector reduces it and we also have a little extra water in the down comer which reduces it. Those three things knock it down by about a factor or two.

MR. CATTON: Okay.

MR. J. MILLER: The moderator control concept is that a portion of core water displaced during the first part of the cycle and this decreases the moderation, increases neutron absorption in the U-238 and thereby increases plutonium production. When the boron concentration nears 0 PPM which would be the end of life in a typical PWR displacer rods are withdrawn either in one bank or in stage banks. This increases the neutron moderation, plutonium production rate slows, the fissile burn more efficiently and were able to have feed enrichments which were reduced for the same energy output.

MR. CARROLL: Now, is your boron concentration still about the same?

MR. J. MILLER: Yes, just about the same.

[Slide.]

MR. J. MILLER: Specifically, we call these low-neutron-absorbing rods, which are zircaloy-clad with the zircaloy pellets internally -- 13 percent. I said 14 -- 13 percent.

They remain inserted for about 70 percent of the cycle, and as I said, we either pull them all at once or sequentially -- I'll show you a picture of that, and during refueling shutdown, the rods are reinserted into the core for the next cycle. So, you start out with all the rods in every cycle.

MR. WARD: What do those rods look like?

MR. J. MILLER: Basically, in diameter, they look like one of our control rods, but they're zircalloy-clad and a zircalloy pellet. This is for flexibility, rather than making it a solid zircalloy rod. It's a little over 8/10th of an inch in diameter. We made it a thin-clad with pellets inside. The pellets are hollow, to reduce the weight. They just displace the water. That's the only function they serve.

MR. WARD: That's metallic --

MR. J. MILLER: That's all metallic.

MR. WARD: -- zircaloy.

MR. J. MILLER: Yes.

MR. CARROLL: These are positioned by standard mag jacks?

MR. J. MILLER: No, no. These are positioned by hydraulic mechanisms --

MR. CARROLL: Okay. That's what I thought.

MR. J. MILLER: -- since they don't have to be stepped through anything. We have a system where the reactor pressure passes over a set of piston rings for a group of rods, flows out into the drain tank, and lifts the rods up into a latch mechanism, and when you're ready to unlatch it, you raise them up a couple of inches and let it go, and it drops into the core by gravity.

MR. WARD: So, those rods are changed just at refueling?

MR. J. MILLER: After you're done refueling, you'll probably test them once, but then they're only used once during an 18-month cycle. They go out, and then at the end of that, you drop them back in.

MR. CARROLL: The gray rods, however, are used for --

MR. J. MILLER: They're used for daily load fall.

MR. CARROLL: And they're standard mag jacks.

MR. J. MILLER: They're standard mag jacks, right.

MR. CARROLL: Okay.

MR. J. MILLER: This is a picture of the process. We start with a boron concentration of 800 ppm, and as you approach what would normally be the end of life, you withdraw all of the WDRs or withdraw them sequentially over a period of time. This allows you to increase the boron concentration to offset this increased reactivity, and you get a decaying end, just like you do over here. So, you stretch the cycle from there to there.

MR. WARD: Are you going to tell us what the moderate temperature coefficient does over this cycle?

MR. J. MILLER: It gets more negative as you go through the cycle. I don't have the numbers on me right now, but I believe it goes from, like, -5 to -25 or something like that, over the cycle. We can get that number for you.

MR. WARD: So, you start out with it with a negative?

MR. VAN DE VENNE: Van De Venne from Westinghouse.

On a reload cycle, the moderate temperature coefficient starts out at -12 pcm per degree F, and goes to -- you get the usual sharp reduction to, say, -16 in a few days, and from there on, it, you know, continues to decrease.

So, when we did some ABWR analysis, we used, basically, -16, which is valid for better than 99.9 percent of the cycle or something like that. Only, really, the first part of cycle 1, you are at, like, -8 or -12. You start out at -8, you go -12, and you hit the -16, maybe, in 2 or 3 months.

So, when you do ABWR analysis with that kind of moderated temperature coefficient, you don't get much of a pressure in the system, because you get very good ABWR results. It's much better across the board.

[Slide.]

MR. J. MILLER: Here's a quarter-section of the core. This is the fuel region, in blue, and this is the radial reflector that I mentioned previously, which is made up of modules which are bolted to the core barrel through a heavy -- what we call a "strong-back". I'll show you a close-up of this. This area is approximately 90 percent stainless and 10 percent water.

MR. CARROLL: Where is baffle jetting going to occur on this design?

MR. J. MILLER: We've actually ran tests, because it was one of the things we were concerned about, and it turned out we did not get any jetting at all.

MR. CARROLL: Okay.

MR. CATTON: What is baffle jetting?

MR. J. MILLER: What is it? It's more common on older plants which had down flow through that area. In a normal Westinghouse plant, this is made up of what was called "baffle formers", which are just thin plates with a lot of water in between. In order to conserve flow, they put the flow down through this area and then turned it around and brought it back up. So you had a pressure differential between here and here, and at any intersection of where you had plates that weren't very tight, the water would squirt out and hit the fuel rods, causing a wear.

MR. CATTON: Okay. I understand.

[Slide.]

MR. J. MILLER: This is more or less a closeup of the reflector region. This is the strong-back, which is bolted on to the core barrel here, and this is made up of three different diameter rods in order to get the packing fraction up as high as we can. The large rods are interspersed with medium-size rods and very small rods along the edge.

An axial profile -- the bolts are at the top, so that all the expansion occurs in a downward direction. There is radial support pads, which are adjustable, and these rods are held up here. The large rods are screwed into the top and the other rods are welded to them. They can expand down, and the strong-back can expand down into this positioning, through the positioning pin through the bottom plate. Flow comes in and up through here.

From a fuel cycle standpoint, these features give us the following benefits: We have zircalloy grids in the core and a slightly higher hydrogen-to-uranium ratio when the water displacement rods are all out, and we get a yield-to savings of 3.2 through 4.1, and fuel cycle cost savings of 4.1.

Increasing the loading, which allowed us to reduce enrichment, we end up with 5.6 fuel cycle cost savings. The moderator control feature, 7.1, and the radial reflector, 3.2, giving us a total relative to a standard plant of around 20 percent fuel cycle cost savings.

MR. J. MILLER: You also mentioned the gray rods. They do contribute to the moderator, to the displacement features, but the main purpose is xenon reactivity control during the load fall maneuver.

They are normally inserted during base-load operation, and at low concentrations, they can completely replace the boration. I'll get into that in a little more detail during the load fall.

Now, when the power is reduced, you can withdraw the gray rods in sequence, to compensate for xenon buildup. When power is increased, the reinsert them, and this, again, takes care of the xenon burnup, reduces water-processing requirements, and extends load-fall capability to around 95 percent of the entire cycle.

This is a diagram showing the water-processing requirements. The red line is if you just use boron -- soluble boron dilution as a means of doing this. You see it goes up fairly rapidly, and depending on what your evaporator size is, you hit some kind of limit. When you put gray rods in, you can actually keep this value way down here.

We've done studies subsequent to the submittal where we've looked around at changing the material in the gray rod, for example. Originally, they were stainless-clad with zircalloy pellets, and by changing from zircalloy pellets to stainless pellets, we were able to increase the worth of the rods sufficiently that this line is now actually horizontal. We do not have to dilute boron at all. We can completely do a daily-load follow just using gray rods, temperature, and a control system.

MR. CARROLL: And daily load follow means down to 50 percent.

MR. J. MILLER: Yes, for, like, 8 hours.

MR. CARROLL: So, what are you going to do to get it down to 30 percent?

MR. J. MILLER: Well, this is the normal customer request. Okay? If you had to go to 30, you probably would have to come back in and use some of the boron again.

MR. VAN DE VENNE: You can probably do -- load follow would be a fairly significant amount of the cycle to load in 50 percent.

It's only when you get to certain extremes in the operating condition -- for instance, very early in life, actually, it turns out to be more difficult, and also, when the water-displacement rods are just withdrawn. there is a slight window there where you are somewhat limited, but I'm sure you can -- if you exclude those -- the requirement here is to be able to do it all the time, at any point in life, but if you are willing to accept some limitations, you can get further down.

MR. CARROLL: And you're not including in this load-follow strategy any programming of "T" average?

MR. J. MILLER: We allow "T" average to go about 7 degrees off normal.

MR. CARROLL: Okay.

MR. WARD: Let's see, with this arrangement, what is the maximum individual rod worth at any time?

MR. J. MILLER: The gray rods, you mean?

MR. WARD: Well, the strongest rod.

MR. J. MILLER: The gray rods, as a whole -- there's 28 gray rods --

MR. WARD: Yes.

MR. J. MILLER: -- are worth, like, equivalent to 60 ppm of boron. It's a very small worth.

MR. WARD: Well, I'm thinking about a rod-ejection accident.

MR. J. MILLER: Not even a bump on a -- divide 60 by 28. It's like changing boron concentration by 3 or 4 ppm.

MR. WARD: But what about the control rods?

MR. J. MILLER: Well, control rods are just about the same.

MR. WARD: Just about the same. That's what I was trying to figure out.

MR. J. MILLER: Yes. They're just the same as a normal reactor.

MR. WARD: They're not, in some part of the cycle -- you don't have a higher worth of --

MR. J. MILLER: Well, I'm sure they do vary, but the actual absolute value is no higher than you would get in a normal reactor.

MR. WARD: Okay.

MR. J. MILLER: Getting down to the open issues that are associated with the reactor, Issue No. 43, which is a category 4, concerns a DNB correlation that we're using. We are calculating DNB using what we call WRB-2 critical heat-flex correlation, coupled with a THINC-4/THINC-1 computer code, which we've used for quite a while.

Critical heat plus tests were run at Columbia University. We ran two 6 by 6s, one containing all simulated fuel rods and a second one containing a large thin one in the middle surrounded by fuel rods, and the data in that test showed that the WRB-2 correlation was satisfactory and that the 95-percent confidence label, we could utilize a 1.17 factor.

Staff says that the submittal is under review and the results will be addressed in a final SER. So, we have really no resolution approach to this. They have reviewed this for other applications, and we don't see this as a real problem.

MR. CATTON: THINC-4 is a code that must be 10 to 15 years old.

MR. J. MILLER: Which?

MR. CATTON: The THINC code.

MR. J. MILLER: It's not the THINC code. It's the WRB-2 correlation.

MR. CATTON: Yes, but you used the THINC code to get the local conditions to put into your critical --

MR. J. MILLER: That's right. We use it to verify the test results. The same combination is used for the test.

MR. CATTON: But that code is ancient.

MR. J. MILLER: THINC-1 is. THINC-4 is a somewhat modernized version, a couple of years old -- maybe 3 or 4.

MR. CARROLL: Is there something wrong with being ancient, Ivan? What have you go against that?

MR. CATTON: No. It's just that all the work that was done by Westinghouse on development of best-estimate codes and everything else, I'm just wondering if any of that has folded into the THINC-4.

MR. J. MILLER: THINC-4 is sort of a two-dimensional flow-redistribution code that gets you local conditions with hot rods located, thimble rods, thimble cells, and so forth, and that calculates the DNB from the correlation based on those local conditions.

MR. CATTON: But the correlation was developed in concert with the THINC code, right? So, really, it's a package.

MR. J. MILLER: It's a package.

MR. CATTON: With lots of compensation.

MR. J. MILLER: Well, it's not a lot of compensation. You predict the data for the test with the THINC code.

MR. CATTON: As I remember, when that THINC code WRB-2 critical heat flux correlation was reviewed, I recollect that NRC had said that it's a package deal.

MR. J. MILLER: It basically is.

MR. CATTON: WRB-2 plus THINC of that particular vintage were the package deal, and now, you have indicated that you changed the THINC code. Did they redo the --

MR. J. MILLER: No, no. This is the code that was used for the WRB-2 correlation.

MR. CATTON: So, it's 10 years old, at least.

MR. J. MILLER: No. WRB-2 is not 10 years old. WRB-2 is 4 or 5 years old.

MR. CATTON: Okay.

MR. J. MILLER: WRB-1 was a little bit older correlation.

MR. CATTON: Okay.

MR. J. MILLER: Maybe that's the one you're thinking of. It's been modified with new data that we have to WRB-2.

MR. CATTON: There's a WCAP in this, isn't there?

MR. J. MILLER: Yes.

MR. CATTON: Would it be possible for me to get it?

MR. SHANNON: Has the WCAP been submitted? If it has been submitted and referenced, then we can get that, I guess.

MR. CATTON: Just for historical interest, and if things have been done to the THINC code, I'd like to take a look at some of those, too.

MR. SHANNON: Let us examine which of those have been submitted and let Med know the numbers, and then he can go retrieve those for you.

MR. CATTON: Okay. Thank you.

MR. J. MILLER: Okay. The second issue is 44, another category 4. It has to do with fuel-rod bowing, which is described in WCAP-8691. We account for rod bow by applying a factor to the normally-calculated DNBR.

The amount of fuel-rod bow we expect to get with these rods, compared to 17x17, is much less, for several reasons. The rods are a little larger in diameter, have thicker clad than a 17x17, and our grid spacing is smaller than a standard 17x17. So, we did not, when we calculated the expected bow -- we did not think there would be a problem, but we still applied the generic penalty.

Staff's position -- they've reviewed that. They conclude the rod-bow penalties have been properly offset. The conclusion is contingent upon the approval of the DNBR safety limit, or the WRB-2, again, which they, again, have reviewed in other submittals, and since they have said they will address this in their final SER, we don't see this as a real issue, either.

MR. CATTON: To calculate the rod bow, don't you have to get the Delta T across the pin?

MR. J. MILLER: Delta T?

MR. CATTON: Temperature difference across the pin. Is it thermal that makes it bow?

MR. J. MILLER: We have an empirical correlation that's based on --

MR. CATTON: Data?

MR. J. MILLER: -- data.

MR. CATTON: You have measured the bow.

MR. J. MILLER: And it's a function of burnup, pin diameters, lengths, stuff like that -- thicknesses, clad thicknesses.

MR. CATTON: Okay.

MR. J. MILLER: So, we have an empirical correlation, but we apply the penalty irrespective of what we calculate as the amount expected bow.

MR. CATTON: You mentioned the 1.17 DNBR limit, and that goes back to your heat-pressure correlation.

MR. J. MILLER: We apply a penalty over and above that.

MR. CATTON: Okay.

MR. J. MILLER. Just as a matter of interest, since the submittal, we have done a bowed-rod DNB test on this fuel assembly. Remember, I mentioned that we had done two DNB tests at Columbia -- one of all fuel rods and one with a thimble in the middle. For the bowed-rod test, we chose this one, and we bowed one fuel rod in until it touched the thimble and the fuel rod, located at the point where we thought the maximum DNB would occur, based on the previous data, and I'll just show you some representative results.

This is at 1,500 psi and a mass velocity of 2. There's 3 data points. This is our straight rod DNB correlation, the WRB-2, and you can see that the data falls on it pretty well, indicating no penalty. Again, an even a little better data point there, at 1,800 psi, and finally at 2,100 psi, there's another 4 data points that fall there.

We don't think that the one geometry and 100 data points means that there is no penalty. That's why we still use the generic penalty, but we were really surprised to see that, with this geometry, that we didn't get any penalty, and we can't explain it completely. It may be that the big thimble acted as a heat sink and mitigated some of the bow penalty, but all of the results indicate that we have little or no penalty associated with these.

MR. CARROLL: What is the ordinate on these?

MR. J. MILLER: This is the major power. You predict what power you're going to get DNB, from the correlation, and then you run it as a function of temperature. You increase the power until you see an indication of DNB.

MR. CATTON: So, the rod-bow penalty that you take is to avoid the DNB.

MR. J. MILLER: That is right.

MR. CATTON: Okay.

MR. J. MILLER: In other words, this is what we would predict from a straight rod. This is actually reduced by some magnitude to account for rod bow. There is a generic equation that we use for it.

MR. CATTON: Is this the concern, because when you move the two pins together --

MR. J. MILLER: Yes.

MR. CATTON: -- the transfer between them will be reduced?

MR. J. MILLER: Yes. Tests have been done in the past at 50- and 80-percent closures, and there has been some indications. A correlation was derived from that, and that is applied.

MR. CATTON: Okay. There's also some indication that the heat transfer gets a little bit better.

MR. J. MILLER: Well, in this case, it did look like that, yes.

MR. CATTON: Yes. It just the fact that -- the way of the flow.

MR. J. MILLER: It increases local velocity.

MR. CATTON: Right, and that enhances the heat transfer. So, really, the penalty is a result of the two you're moving further apart.

MR. J. MILLER: Well, that's the end of my presentation, if there's no more questions.

MR. CARROLL: Does the staff have anything to say?

MR. DONATELL: Right now, the staff has those issues listed as under review, and in the absence of the review, I would say not.

MR. WARD: I guess it's another issue, but there's a lot more zircalloy in this core. It seems to be --

MR. J. MILLER: Yes, there is.

MR. WARD: -- with the displacer rods and the thicker clad and everything. Would that present a problem in a severe accident review?

MR. J. MILLER: We've taken that into account.

MR. VAN DE VENNE: Well, one of the reasons I think that we have included the igniters in the design and have assumed 100-percent zirc-water reaction is because of that reason.

MR. CATTON: With respect to your igniters, there was a paper written by Karvot at GRS in Munich, and you ought to take a look at it. He is very concerned about whether or not these igniters will do the job you expect them to do and gives reasonable arguments to give you a little bit of unease.

I will give ycu a copy of that paper if I can find it here.

MR. CAPROLL: Is it in some other section that we get some details about the device that moves .hese displacer rods?

MR. J. MILLFR: I have a couple of slides I could show you.

MR. CARROLL: Yes, I would like to see those.

MR. J. MILLER: I anticipated the question.

[Slide.]

MR. J. MILLEP: This is an artist's rendition of the reactor, and you see the thing called "DRDM". That means displacer rod drive mechanism. CRDMs are regular mag jack, and the DRDMs are located in between these and are operated hydraulically, using the pressure of the core.

MR. WARD: You might want to take that other slide off.

[Discussion held off the record.]

[Slide.]

MR. J. MILLER: Okay. These drive rods -- let's see if I can find -- I guess I don't have -- it doesn't show the piston here. Oh, here it is -- piston ring here. Okay?

There is a piston ring located around each of these drive rods. When you operate it, what you do is open up a solenoid valve, which is on the head package. This is connected to four symmetrically-located displacer rods. When you open that valve up there, there is another valve in series, which then has to be opened, which has an orifice in line, and it goes to the dump tank.

You get a pressure drop across this piston here. We have what we call a Viscojet orifice in the top, and we get another pressure drop across that. We get the flow through the pipe and finally a drop through this main orifice.

The reason it's done this way is for safety purposes. It's impossible to withdraw more than two of these banks at one time, because the flow through that downstream orifice would use up all of the pressure and there would be none left over to take a pressure drop across this piston here.

MR. WARD: A bank is how many?

MR. J. MILLER: Four.

MR. CARROLL: But if you had a line break ahead?

MR. J. MILLER: The main orifice? If you had a break before the main orifice, you have several or more solenoids that have to be opened, and they are connected, so you can't do that to start with. So, just the break itself would not do it.

You have to have a multiple, triple, quadruple failure or something like that. I will show you how this works.

[Slide.]

MR. J. MILLER: This side of the picture is the upward motion. This shows the piston. This is a rotating mechanism here. This is the Viscojet. As you put the pressure on it, the piston is forced up through an opening in the side of this rotating mechanism. Here, you see it hitting. It rotates as it bends the shaft a little bit, rotates the thing, gets up above the rotating mechanism, and then you shut the flow off, and it drops back and is captured. That's one bank.

If you want to open up another bank, you've close the valve already on this one. You open up a valve on the second one, and you go through the same process, withdraw as many as you wish.

Now, when you want to take it down, you're in this position here. You, again, increase the pressure. It drives the piston up above. There is a pretty fancy little -- like a parallel subway ditch, with a switch in the middle, so that when you go up the second time, it goes down through this side of it. I don't know whether you can see that, but it's going down through the right side instead of the left side, and drops. You open up a valve between the head vent and here, so that any vacuum that is created here is displaced by vessel fluid, so that it drops into the reactor just on force of gravity.

MR. CARROLL: How do I know where these things are?

MR. J. MILLER: We have indicator lights that are similar to what we have on our CRDM drives that show when a magnetic section of the rod passes from the bottom. You have a "bottom-on" light. It goes to a "not-on-the bottom/not-on-the-top" light, and finally, when it goes past the other sensor, it has an "on" light, so you know it's in the "up" position.

MR. CARROLL: How much prototype testing has gone into these?

MR. J. MILLER: We have tested, like, three times or four times.

MR. VAN DE VENNE: We have built two prototypes in our Chesapeake facility, and we have one shipped to Japan, which was used in full-scale temperature tests over there. We have two prototypes that were both life-tested.

MR. J. MILLER: More than life-tested.

MR. VAN DE VENNE: More than.

MR. J. MILLER: Yes. We expect less than 80 cycles of operation, assuming nothing happens, and we tested them to over 200 in both cases.

MR. CARROLL: I always worry about something that just sits for a long period of time. I guess you do have differential pressure available.

MR. J. MILLER: I guess the pressure is 2 square inches. No, it's 5 square inches. It is 2-inch diameter.

MR. CARROLL: That is for withdrawal.

MR. J. MILLER: Correct.

MR. CARROLL: How about insertion? It's just gravity, though, isn't it?

MR. J. MILLER: Well, it's gravity plus a backfill, in case you create a vacuum.

MR. WARD: What is the worst thing that can happen here, as far as unwanted reactivity?

MR. J. MILLER: The worst thing that we envisioned that could happen was we would get a control-rod ejection, which would rupture a mechanism and break the hydraulic lines that ran in the vicinity of that mechanism. So, we went through a very careful layout so that if that ever happened, the number of lines that run near any mechanism was reduced so that we could not get a significant withdrawal.

MR. CARROLL: And the failure you're talking about is a mag jack housing.

MR. J. MILLER: The mag jack comes up, splits its housing, and the housing breaks the adjacent.

MR. CARROLL: Okay. Got you.

MR. WARD: And what sort of reactivity rate increase would you get?

MR. J. MILLER: That would give you -- the most we'd get is 8 again, and it's probably done in graphs. It's probably, like, less than, oh, I don't know, 5 ppm of boron, essentially, something like that. We went through this and did the calculations. It's much less than the least control-rod withdrawal accident.

MR. CARROLL: Any more questions on this?

What other slides did you bring that you thought we might ask questions about?

MR. J. MILLER: We have changed our CRDM design slightly. Our standard, we have added two lips on our latch arm, to improve the wear characteristics. This was done because the gray rods have to be stepped out once every day for the number of cycles you get. Plus, in Japan, we have to allow for frequency control using control rods. So, the number of cycles we were getting were up around what our "expected" wear lifetime was on latches.

MR. CARROLL: I guess on the subject of frequency control, I noticed that was discussed in here, as if everybody does it in the United States. Is it the staff's position that this is okay?

MR. DONATELL: I don't think we can address that.

MR. CARROLL: Have you proposed that in your last revision?

MR. VAN DE VENNE: The plant has the capability to do that. There's particularly two items that are of concern when you do frequency control. One is the lifetime of the CRDMs.

Well, there's more than two.

In addition to that, there is the concern about wear on the control rods, because you're doing a lot of stepping, and we have tested for both conditions. We have tested this mechanism for 8 million steps, which is about 3 times as long as anything else we have ever tested, and it has passed with flying colors.

We also found that control rod wear under these conditions was acceptable, and those two items really go together. This is the control rod.

The second item is the fatigue transience that you get on the primary equipment, because you are using a lot of pressurizer spray actuations and a lot of heater actuations to control these small steps. So, they are factored into our design.

So, the plant has the capability. Now, how it would be operated, I guess, is another question.

Of course, you know that the French use frequency control, and they use our plan. In fact, this idea of the double twos, to be perfectly honest, came from them, but we tested it independently.

MR. J. MILLER: Their gray rods are different.

MR. VAN DE VENNE: The French gray rods are pretty heavy in terms of --

MR. J. MILLER: They actually have control rods and light rods on the same spike. Their gray rod is a partial gray, partial black rod. Ours is completely gray.

MR. VAN DE VENNE: To answer your question as to whether it could be used under current regulations, I can't comment.

MR. CARROLL: Okay, because I remember, historically, back 30 years ago, the staff was appalled that somebody called a "system dispatcher" might be operating a reactor and would probably need a senior reactor operator's license in the system dispatcher's office. I think we have gotten more sophisticated since then.

So, what we're talking about here, Ivan, is this unit could be the frequency-control unit on a utilities piston and the load would vary.

[Indicating.]

MR. CARROLL: It would be automatic. It's continually cycling, and you would have frequency changes.

Okay. I guess we have come to a breaking point. Let's have a short lunch today.

[Discussion held off the record.]

MR. CARROLL: We will be back at 1 o'clock.

[Whereupon, at 12:06 p.m., the hearing recessed for lunch, to reconvene this same day at 1:00 p.m.]

AFTERNOON SESSION

[1:00 p.m.]

MR. CARROLL: Let's reconvene. I don't know who the next presenter is.

MR. SHANNON: The next presenter for Westinghouse is Tom Wilson.

MR. VAN DE VENNE: There is one open issue of Chapter 4 and 16, which I will discuss later. It will be a little more appropriate at 16.

MR. MICHELSON: Are there any open issues related to open reactors? A whole spectrum? There wasn't even a presentation on --

MR. VAN DE VENNE: Is that correct?

MR. DONATELL: I have no information related to this. They are particular areas, sir. You have reviewed all of the reactor materials and so forth? I have to assume that that was, in fact, done.

MR. MICHELSON: Then you can answer a quick question for me. On Westinghouse future vessel containment, --

MR. VAN DE VENNE: There is a low-end PT.

MR. MICHELSON: You have made the appropriate arguments that show there's not a problem?

MR. VAN DE VENNE: For six-year life, we basically get 2 x 10 to the 19th, which we feel is our -- together with the fact that we will use improved materials with lower impurity levels and also the fact that there are no valves in the core region, should be --

MR. MICHELSON: Does the staff agree that this was acceptable? I guess they must have. It's not an open issue on the agenda.

MR. VAN DE VENNE: Well, the staff has not reviewed 60 years. They have only reviewed 40 years at this point.

MR. MICHELSON: You're not yet claiming this is an FDA for certification?

MR. VAN DE VENNE: Right.

MR. MICHELSON: When you got from 40 years to 60, then you will have to do something.

MR. DONATELL: I'm sure that's correct, sir.

MR. MICHELSON: The reason I ask these questions are that we've gone over at great length with on the ABWR on reactor materials because there were a number of questions and I thought many of those same questions pertained here. Vessel annealing is even moreso here, because the fluence is somewhat higher, and yet I saw nothing discussed and I wondered why the anomaly.

MR. WILSON: Now that lunch is over, this session will begin the discussion of Chapter 5, Reactor Coolant System. Ted, Van De Venne and myself will be giving the presentations. I'm going to begin by describing the steam generator to you.

My name is -- there was a handout and I believe it's probably been distributed. I notice this is kind of a short building here, so I hope you can see the overheads. My name is Robert M. Wilson, and I managed the Steam Generator Design and Development Group in Pittsburgh.

My group was responsible for much of the work that relates to the steam generator. I wanted to begin by stating that many of the features that we're going to discuss are not first-of-a-kind, and that the experience that they're based upon -- this is a list of 307 steam generators manufactured by Westinghouse -- just different model sizes.

This number is -- Westinghouse has on the order of 80 percent -- if you count our licenses -- of all the steam generators in the world under their belt. Now, I just want to comment that what you're going to see today has taken advantage of that experience. We have tried to --

MR. CARROLL: Could I also conclude from the large number of models that you've been having a hard time getting it right?

MR. WILSON: Well, that's -- I'm not sure if -- how to politely answer that.

MR. CARROLL: You don't have to.

MR. WILSON: Let me say that Westinghouse, because it has been in the beginning of this industry, very often the industry has benefitted from our facing problems and the industry has basically gotten the benefits of our resolution of those problems.

I will say that the experience of having those hardships does, I think, enable us to produce a steam generator with greater reliability. I think that it does make us more cautious. Now, that's why one of the first objectives of the design was emphasis on design simplicity and reliability.

This is -- you'll see as we walk through the design, that the design -- this is a strong emphasis in what we've done. Also, the second part of this is minimizing occupational radiation exposure. We are find that, as you may be aware, the reactor vessel side of the plant in the early days, was strongly designed, assuming that remote maintenance would be going on, but the steam generator was not.

Today in plants, radiation exposure in the steam generators is quite high. I mean, proportional to all the radiation exposure in the plant, so there is a strong emphasis on accessability in areas where maintenance occurs.

Just for a sense of perspective -- this may have already been presented, but let me just summarize it. We're talking about a plant that's at the 3800 megawatt level, four loops, four steam generators, standard operating primary pressure; flow rate of 100,000 100 gpm and a hot leg temperature -- maximum temperature of 625 degrees T-hot.

Steam pressure for this model is 1024 psi. This temperature is very important. What the basis for it is, is primarily tube material -- corrosion is the basis for not going over that number.

I think that I'd like to just -- it's hard for me to summarize in the short time, all the work for four years, but I thought this one might be kind of interesting to you. It has to do with the operating envelope of the steam generator.

What you can see here on this scale is steam pressure and over here is the T-hot; this is primary inlet temperature to the steam generator. Out here, the last number is 625, and on the far side here, you can see that these are percent tube-plugging numbers and this is electrical megawatts over here. There is a lot of information in a fairly simple format here.

If there's no plugging in the steam generator when it begins, it can begin at 622 and a half degrees, T-hot, or it could begin at 625 and have four more electric megawatts. As plug in occurs -- this is really our design point. All of our calculations assume 10 percent plug-in at 625 and so essentially we've -- rather than analyzing at this point or at this point, we just started out analyzing at this point.

Also, I will point out that the turbine limit is -- what this means is, as plug-in occurs, at this point, you'll start to lose steam pressure and you lose some efficiency in the turbine, but still, the critical point in the turbine; it doesn't occur till 29 percent plug-in, so there's a lot of margin in the tube bundle of these steam generators.

Please, if there's something that I say that interests you, ask a question, and I'll stop. This is a figure of the steam generator. There are a few of the unique features --

MR. MICHELSON: Excuse me, this turbine limit that you pointed out at 29 percent; is that some kind of a steam hydraulics problem, or is that just --

MR. WILSON: It's a volumetric --

MR. MICHELSON: -- or is that the full capacity of the turbine?

MR. WILSON: Valves wide open, volumetric flow.

MR. MICHELSON: You're saying that you built in about 30 percent extra tubes?

MR. WILSON: That's the way to interpret that. It means that if you -- right now, many operating steam generators can get to about 20 percent plug-in when they reach the valves-wide-open point; some even higher, some lower. Okay?

MR. CARROLL: Just to get me calibrated on hot leg temperature, what would you say your limit, your comparable limit Roentgen L-600 is, if 625 is here?

MR. WILSON: I have a figure -- I have a table instead, comparing the 600 with the 690. Let me see, there are plans out there at 626 with 600 tube material.

MR. CARROLL: But they're not very approved operators, are they?

MR. WILSON: Cooler temperatures will reduce the corrosion rate.

MR. MICHELSON: Do these tend to be continuous blowdown type things?

MR. WILSON: Westinghouse has always recommended that blowdown operate continuously, but at a low flow rate. Excuse me, it's hard for me to hear you.

MR. MICHELSON: I guess I'm doing the best I can without a microphone.

MR. WILSON: You have a microphone, but it's just not being amplified. The blowdown is located in the bottom portion here.

MR. MICHELSON: What pipe size do you draw through containment with? The pull down is through containment somewhere?

MR. WILSON: I don't know the pipe size, but it will compensate 3 percent continuous blowdown. Then I believe it is a four-inch line.

MR. MICHELSON: Where do you blow down to?

MR. VAN DE VENNE: You blow down to a heat exchanger and then, let me see, --

MR. MICHELSON: Is this a part of the heat economy of the system?

MR. VAN DE VENNE: Yes. We are using a separate heat exchanger, but it is cooled by condensate.

MR. MICHELSON: It is a pretty big blowdown heat exchanger then?

MR. WILSON: We are not recommending that you operate 3 percent continuously. It is a capacity.

MR. MICHELSON: My interest is not in the process, but rather in the hazard that the blowdown line constitutes in sometimes people kind of overlook that this is another kind of pipe that might break. It has some interesting characteristics. It is rather through vital areas -- the way of getting to the turbine area. At least I'm always interested, but we will get into this some other time.

That is the reason for asking. It is about a four-inch line, you are saying? Thank you.

MR. WILSON: I'm sorry about the height of this. I'm not sure you can see the bottom part. I'm going to work up from the bottom.

[Slide.]

MR. WILSON: This design is unique in Westinghouse steam generators, but you have seen this concept or a similar one in combustion engineer. There is a center column support for the tube sheet. This steam generator is wider than Westinghouse models about the same height as our Model E steam generators.

They are actually a little shorter. This center post enables us to do a number of things, but one of them is -- one of our design criteria was to leave the tubes out of the center of the bundle so that sludge that settles on the tube sheet will settle where there are no tubes.

That is in this area to be removed, and blowdown -- you asked about connects here. There is a settling zone in the center of the tube bundle. As I come up the bundle, it's fairly normal in this area. It uses 690 tube material. The tube support plates are stainless steel quatrefoil design and the U-bend design we have changed in our last two plants we manufactured.

We now have what we call a zero gap and U-bend. The biggest gap between bars and gills is 5 mils. Each one is measured in six different places and controlled in diameter. The bars are controlled in diameter and after assembly. We have done extensive measurements and the gaps used to be nominally 17 mils and there was a fairly wide range around that number.

In this one, the max is 5, so it is an extremely tight structure.

MR. CATTON: What is the basis for that?

MR. WILSON: A basis for making it tight?

MR. CATTON: Reducing the gap to 5 mils.

MR. WILSON: The experimental work describing where and also the effectiveness for support for tubing has led us to what we are trying to accomplish here. There is a statistical probability that even with a 5 mil gap, that the tube will be in the middle of the gap unsupported.

What we've done is, we've developed a MONTE CARLO model for evaluating support conditions. We've also designed the U-bend such that it can operate with two consecutive missing supports in the U-Bend, so the point is that this is possible, but we do a probabilistic analysis to determine the support conditions.

In any case, tighter gap gives you a much higher probability of support. That's the motivation behind it. Going higher, --

MR. CATTON: Can you back up a couple of sentences? What do you do with the MONTE CARLO?

MR. WILSON: What we do is, we know the dimensions of individual, discrete parts, but when you put this U-bend together, you will have gaps anyway. You are going to have them and you don't know where they are.

There are 6000 tubes with three sets of these on the order of a 300 bars and the number of intersections. I am not sure.

MR. CATTON: It is a lot.

MR. WILSON: It is a lot. What you want to know is; are there any tubes -- what are the support conditions of each tube and the MONTE CARLO approach allows you to determine the population of tubes that have different kinds of support conditions. Our goal was to make it improbable to have unsupported tubes that will vibrate.

MR. CATTON: Then I don't understand how you use MONTE CARLO. If you have to say something about the tube and then say MONTE CARLO.

MR. WILSON: You solve the problem many times, and --

MR. CATTON: What do you do; assume it's an even chance that it will be supported in any given support?

MR. WILSON: You have to know the probabilities of all of these sum parts, the variation of the diameter of the tube; you have to have that distribution. You have to have the distribution of the thickness of the bars and you have to have these things under hot condition, in the operating condition.

MR. CATTON: So the float valves are open too?

MR. WILSON: Definitely. The main point I am making here is that this design is, we believe -- you may not be familiar that we have had experience in the last about five years on wears on the U-bends on turbine steam generators in which we have removed the ABB's which take up all of the gaps.

I say all the gaps -- you take them up with something on the order of 5 mils or less. In those units where we experienced wear, the wear has stopped. I think it's reasonable confirmation that tighter gaps will provide better support and less wear.

I'm not prepared to go into much detail beyond what

I've said, but I will say that this is a very important evolution in the design as far as dealing with U-bend vibrations.

MR. CATTON: I certainly would be interested in getting more detail. If you have an W-caps that relate to that, I would appreciate it if you would send them to us.

MR. WILSON: Moving above this point, there is a device called a mud drum or sludge collector. This is unique in this design and unique to Westinghouse. The idea here is that sludge usually forms on this horizontal surface at the bottom of the tube bundle.

What we try to provide is a place in the recirculating loop that sludge is more likely to go and therefore will be less likely to settle in this area. I will describe that more in a minute.

The moisture separators, these are seven inch. They are modular separators that are in operation in the field. And this is a single tier peerless drier veins, or equivalent to peerless drier veins. And I will show you that in a minute.

MR. CARROLL: Moisture design is .25 percent still?

MR. WILSON: Moisture carryover? The basis in this documentation is a quarter of a percent. In our last two plants that we have supplied steam generators, it was .1.

[Slide.]

MR. WILSON: This is a summary statement about alloy

690. It is principally comparing, this is in a comparison with 600. Primary water release rates are lower.

MR. CATTON: What does that mean?

MR. WILSON: What it means is the water on the primary side as it comes through the tube bundle removes material through, you know, particles come off the primary side. Release rate means material coming off the inside of the tubes. That is really kind of important here, because these alloys have cobalt in them, trace elements of cobalt, which can become a source of radiation on the primary side. So this is an important element.

MR. CATTON: Is that an erosion-corrosion problem?

MR. WILSON: Yes. But it is on the order of a mil and 40 years. It's not a big number. Better high temperature, caustic stress corrosion resistance, improved stress corrosion cracking resistance in dilute caustic solutions. Each one of these statements relates to environments that are known to exist in operating steam generators. And there is an improvement in these.

Let me show you something that may be of interest to you.

[Slide.]

MR. WILSON: What this is, we have picked a number of environments that were relevant steam generator environments. Primary site -- can you read this from that distance?

MR. WARD: Is it in the handout?

MR. WILSON: Well, let me -- this page is not. This is a proprietary page that we left out. But I wanted you to see primary environments, secondary side, low stress environments, secondary side high stress environments. And these we judge to be most relevant for operating steam generators.

Then we took alloy 600, mill annealed, and thermally treated; 690 mill annealed and thermally treated; and then alloy 800 with the KWU special shot pin treatment, and tested them head to head in these environments.

And the main point I would draw your attention to, if we take alloy 600 mill annealed in the primary area, stress corrosion cracking in reactor coolant water, ten out of ten cracked, if you thermally treat it, four out of ten. And this is in 14,000 hours. And alloy 690, zero out of five; 690 thermally treated, zero out of five. We had no data here. We didn't run that in this test. But this, we would also have zero out of whatever. It does not respond to this.

So the primary, one of the primary advantages of 690 over 600 is the fact that it does not exhibit primary water cracking. That is real important.

And if you look down in this area, the main drawback of this material over here is the throughwall stress corrosion cracking in a high stress, caustic environment. This would be representative of the top of the tube sheet where the tubes are expanded.

And this is the reason that, among others, EPRI ha recommended this material, and all the major utilities in the world have specified this material for use in steam generators.

And now, incidentally, all major suppliers of steam generators have manufactured tube bundles with this material.

This is a figure showing a cross section of a flow model of this tube bundle. The main thing I want to draw your attention to, in this figure, this is the hot leg half of the tube bundle and the cold leg half. And this is a tube lane. And this is a line of symmetry in the tube bundle. So this is left off.

The main thing is, this zone in here has no tubes in it. And the flow basically comes radially inward, and then vertically up at this point. And I have a couple of figures that we will show you. These are vectors. This part of the bundle is pretty much in single phase flow. But I've picked these figures because of our criteria to try to sweep sludge so that it won't settle in the area where the tubes are.

Do you see this here? What we have in the tube lane in this area, right in these areas, are what we call tube lane blocks. Their purpose is to stop, because there is very low resistance in the tube lane, there is a tendency -- See how these areas get longer? There is a streaming effect here. And what we do is we, by putting a few blocks here, it is diverted off, it slows down. In fact, this stuff starts turning vertical in about here. You can't see it in this figure. But what is going on here is, that is a dead zone. What this represents is in this zone, real low velocity. It doesn't mean that it is not going up. But it is not going sideways there.

I have another picture that might show that.

[Slide.]

MR. WILSON: These are contours of velocity. The green areas are areas less than two feet per second, lateral, which our testing demonstrates that sludge will be either, if you go from two to greater, it will pick sludge up. If you go from two feet per second to lower, sludge starts settling.

The idea is that this zone, the low velocity zones are in the areas where there is no tubing, no tubes.

As you can see, there is still an offset toward the hot leg side. All generators have this. And if we don't put these blocks here, this streaming effect here, and the same thing from this side, tends to push this further out this way.

So that is one of the reasons that these blocks are here.

In any case, one of the criteria we developed back in the '70s was, you are going to have a low velocity point on the tube sheet, remove the tubes from that zone, and put the blowdown in that location. That way at least you have a chance for, in this case, we've got a cavity. There is a depression. You know, a hole here. So any sludge coming over the edge will tend to drop down and move out of the action as far as the flow pattern that is going on here.

Slide.]

MR. WILSON: Now, this picture shows -- I didn't know what might interest you, so I picked here, this is a figure that shows some of the design basis for the top half of the steam generator. The tube bundle is sized based upon the performance figure I showed earlier, once you have the surface area, and the top of the bundle is determined.

In this design, we decided on a 40-inch access space for maintenance. Once we did that, that established this depth line here. And our mud drum was 12 inches high. And so there is a zone here -- and I will tell you more about the mud drum in a minute -- but we established the top of the mud drum was an elevation where we would set this low level trip. Okay, the idea is that when the water level drops to this point, at this elevation, there is a plant trip.

And incidentally, this span, this 95-inch span was set based upon evaluations of how quickly the water level moves and how much response time there would be for an operator, you know, if something occurred like there is an interruption of feed flow, the water level would begin immediately dropping. And so with the volume of the shell, we could determine how long it would take to reach this trip point from the nominal level.

Actually, you can't make it real long. I mean, it is on the order of seconds. But I think we are on the order of, I think it was about 30 seconds, on that order, that we were able to get in this span.

The high level trip point is at the top of these primary separators. Above this, you flood these separators out. So you pick that elevation.

And we felt like it was more probable to have the event where you would trip on low level than high, and so we put this level on the high side here.

There is another restriction on water mass. Energy released to containment is partly influenced by how much water is in the steam generator. So there is an upper limit to how much you can put in here. We could not just arbitrarily take this and put more water in it. So that has been factored in also.

Above this is access space again. Two man ways, 18 inches in diameter provide access to this space, and these dryers are in a single tier, parallel banks. And the steam flow is out of these. It goes -- well, I can show you over here. It goes out through the bank and then out the top, then out the steam nozzle.

And these banks, the separators are standard veins that Westinghouse has used in many plants for many years, but just organized in parallel arrays. And at the top, the steam nozzle has a, what we call a steam nozzle flow limiter. It is made of seven venturis, and if there is a steam line break, this limits the rate of energy released to containment. These venturis choke the flow.

It also reduces, or controls the load on the steam generator internals, if such an event were to occur. That is also a feature that is standard in field units.

I will briefly describe the sludge collector, or mud drum. This is just a figure that shows that sludge, there is a low velocity sludge-settling region provided by this mud drum here. And the idea is that settling, the sludge is only, it would prefer to go here instead of here is the idea. And if it is in the tube bundle, it really makes the designer's job, it sort of undoes the designer's job. Sludge will build up around the tubing and produce dryout, and then chemical concentration. And even the best tube bundle design cannot stand up if sludge is permitted to build up in the tube bundle.

So the idea here is to provide sludge a better home than the tube sheet, and the tube bundle.

This figure is a little more detailed. The mud drum is a cylindrical box. These primary separators pass through it, and there is a top plate on it. We tested many designs. Without the top plate, there is too much turbulence and nothing settles in here, but with this top plate, with a small access, the water in here is pretty stagnant. There is flow through it, but very low velocity, and so, any particles entering stay in the mud drum.

To give an example of the performance, this figure, which -- what this figure shows is time, on this axis -- the diagram is with a mud drum, this diagram is without a mud drum -- time and pounds of sludge in the experiment. What we did is we had a half-scale tube bundle in at room temperature and upper shell assembly that we circulated water through.

We injected 80 pounds of sludge over a period of time, got it into solution, and then we quit adding sludge and then just monitored over 30 hours. You can see that, without the mud drum, the stuff that's suspended -- we had 34 pounds of sludge still in suspension after 30 hours. On the tubesheet, we had 29 pounds, and in other locations, 17 pounds.

When we put that mud drum in that loop, what was in suspension was down to 12 pounds. So, in 30 hours, we cut by a factor of 3 what was in suspension. This is equivalent to blow-down, having a blow-down continuously of 4 percent, believe it or not, as far as the effect on solids.

The mud drum held 53 pounds, and on the tubesheet in this test, which didn't -- we were counting the center zone, also -- had 12 pounds, and then, in another locations, 3.

The main message here is that this 53 pounds in the sludge collector, in this case, was primarily in the tube bundle, and so the value here, taking everything in suspension out of this recirculating loop, in an area away from the heated zone. That's the intent of this feature.

MR. CARROLL: I'm having a little trouble with the physical configuration of this guy.

MR. WILSON: All right.

MR. CARROLL: Back to your earlier drawing --

MR. WILSON: This figure?

MR. CARROLL: Yes. I've got two-phase mixture exiting the bundle.

MR. WILSON: Coming off here.

MR. CARROLL: Coming up there and going up into the separators.

MR. WILSON: In here, steam is coming off the bundle here, steam-water mixture going through these separators this way. Okay? Then what happens is the separators, through centrifugal separation, pull the water out, and the steam goes up and the water comes down. I'm going to draw in here a water level. Let's say it's here, like this.

MR. CARROLL: All right.

MR. WILSON: This is outside these barrels.

MR. CARROLL: Yes.

MR. WILSON: So, what happens is that, in this zone -- and there's water inside this box.

MR. CARROLL: Sure.

MR. WILSON: Okay? And any water entering -- there are exit ports here. It turns out this water level is not exactly flat. In the center, it's a little higher than it is on the outside. There is a general flow regularly outward. So, there's a little higher pressure here. So, there's flow in and out, and the stuff that's inside here drops its sludge as it passes.

The steam generator recirculates every -- oh, I think it's about every 20 to 30 seconds the entire inventory goes around the loop. So, you know, in a day of operation, when you shut down the plant, just coming down, this thing is going to clean up -- sludge that's in places will -- when you quit adding sludge to the feed, this thing will really -- I think it will clean itself up as you shut down.

MR. CARROLL: What am I seeing in the circle up there?

MR. WILSON: That circle?

MR. CARROLL: Yes.

MR. WILSON: What you see here is the wall of the riser barrel. Here are two walls, and there is a deck plate that goes across the top.

MR. CARROLL: Okay.

MR. WILSON: So, what you are seeing is two separators. This is the water in this base. This is the solid plate in the top of this motor.

MR. CARROLL: Okay, and that's to keep the turbulence down.

MR. WILSON: Right, and these are little. This shows an annular gap around this, where water can enter. These little dots symbolize particles in the water.

MR. CARROLL: Okay. Now, how does this sludge-laden water go from the mud drum box down to the blow-down?

MR. WILSON: Down to the blow-down. Okay. First of all, it doesn't. It stays in here. This guy is not turned on. In fact, my recommendation is that this thing is not piped into anything in the plant. When you come in to clean the bundle, when there is a cleaning operation, you come in here and clean this thing out.

MR. CARROLL: So, this is just going to accumulate sludge.

MR. WILSON: Yes, it's a collector -- a sludge collector, and the idea is that -- the reason for that, the reason it's good, I think, to isolate and not -- we've done tests with blow-down in place. It doesn't change its effectiveness.

What we have decided to do is -- it has a built-in jetting system -- just two pipes like this, with nozzles on them that, when we shut down, when the plant is in a maintenance mode, then the sludge would be in this tank alone, the jets would be turned on, and blow-down would be turned on, and this would be cleaned out.

This system has been tested in the lab, and in fact, we start out with this deep of magnetite in the tank, solid magnetite, and it was able to clean itself out. But anyway, that's the concept.

MR. CARROLL: Okay. I was not clear on that.

MR. WILSON: The idea, though, is that this is -- this area is a much -- we're even trying to put these in field units now, the idea that it is hard to keep sludge or get sludge out, once it's gotten in. I think that this thing will -- I think, if it's moving around, it will move -- transport to this place.

MR. CATTON: Does the sludge build-up of this pipe -- does it change its flow characteristic?

MR. WILSON: Well, remember, in this section, it's a dead zone anyway. It's got a top on it, a bottom on it. It's got walls. The sludge that builds up in there, it's not in any major flow part of the steam generator.

[Slide.]

MR. WILSON: It really is not in the -- it's sort of like a side track that, you know, the trains don't go in there at all.

[Slide.]

MR. WILSON: In this figure of the steam generator--

just to make sure it is clear, the water level is up here. What comes out up here goes through these. They are awfully small. These primary separators go through the inside.

Steam is going this way and water returning into the pool. It goes behind the wrapper and goes down till we enter the tube bundle here. This is really a dead end, and whatever enters, exists on the perimeter. It really doesn't change any.

You can just imagine it's a real thick plate, if you want.

[Slide.]

MR. WILSON: This picture shows a little bit more about the primary separators. These separators are operating. We just had a plant start up with this design. It was developed for APWR. They are centrifugal and what happens is, the steam/water mixture is spun. The water is stripped off and steam exists the top.

These show a curved blade in here which reduces its flow resistance. This is probably the lowest resistance pressure drop separator in the industry. That is important only in that it affects the circulation of the steam generator at the higher resistance you have here.

This is a two-phase region and high resistance in a two-phase region recirculating generator has a destabilizing tendency. That means minor water fluctuations will occur if you have a drop here. So anyway, this design has been tested and was tested as part of this program and actually operated in the field with carryover. It couldn't be measured, incidentally, well below .1.

[Slide.]

MR. WILSON: This is just for completeness, the top of the dryer. I wanted to show you how they were. As the flow comes through the banks, each one of these banks, inside of these banks are some veins that are shaped like this. As the flow of steam -- basically this steam -- with water droplets, passes through these pockets where the steam can make the turn and the water can't.

Water runs downs these pockets caught in a bottom collection pan that goes to drains, and drains off. These are intended for environments that have qualities of, say, 70 percent and above.

MR. CATTON: So we are looking about at the top, the top one?

MR. WILSON: That is looking down at the top and this is a cross section. I am used to seeing this figure, so I assume that it is obvious what it is, but you are right. You take one of these banks and we look down on it that way and you will see this cross section.

[Slide.]

MR. WILSON: This figure; I just thought I would introduce to you an idea we incorporated into APWR. It affects the maintenance access and the channel head, down in the channel head, because we have to inspect all of the tubing. We do have refined on the periphery of the tube bundle, access to these tubes is more difficult.

This is a 51 series steam generator, and you see there is about 16 inches of space under the outer tube and maybe two inches of radial distance. On APWR, we have changed this to a large clearing radially and vertically and this shows -- it says a double-walled region.

If we were to put a sleeve in this tube, there is room to sleeve an outer tube. But this also goes for any kind of tooling that you need to get inside the tube for inspection. Access is very good on the periphery of this tube.

But the height of the channel head and its volume are not changed. It turns out that where this was a sphere, they came to this point -- this is a sphere that comes to a point out here. It just has a cylindrical section.

Also, with the center post that's in this design -- this has a little less primary volume than a standard steam generator.

[Slide.]

MR. WILSON: I'm getting near the end. This s that the features that are incorporated have been extensively tested and most have already been implemented in operating steam generators. Most of this was done in years '82, '83, '84 and somo in '85.

So we have gone ahead and taken many of the pieces that are in the design and put them in replacement steam generators that are operating. As an example, the 690 is in field units at Indian Point and Cock Unit 2.

Another major enhancement of the tube material is the sludge control I mentioned to you. Although it may not be obvious to you, when I said 40 inches space above the tube bundle, many field units have only 18 inches there.

The manways are all enlarged to 18 inches. Most in the field are 16 inches, so these -- I picked these three as what I consider to be the three most important elements that are in this design. Also, this last comment:

This design meets/exceeds all of the EPRI steam generator owners design recommendations. There is a reference handbook they put out for the industry and they recommended, even suggested, a mag drum would be a good idea.

That concludes my prepared material.

MR. CARROLL: I take it you have better manway closure designs than on Model 51?

MR. WILSON: That is an interesting question. Let me say that the 51's -- there is a program in place that many of the plants are changing over from studs to bolts.

MR. CARROLL: I know the first one that did and the disaster that we had.

MR. WILSON: In any case, bolted closures; that is an interesting design point. There is a tendency when you have two bundle corrosion, for customers to want many ways to get into the tube bundle, yet each multi-closure is a source of leakage.

What we have opted to do in this design, incidentally, is the shell is sized to permit access openings. This stress report covers analysis that all is required. You can put three-inch ports anywhere by facing off the shell, tapping some bolt holes in, but no buildup required.

That was a better option than putting in ports everywhere, but I hear you. I'm not sure though that the leaking manways is something that there has really been a technological leap in yet, but operating plants are in need of upgrading in design.

MR. CARROLL: Any steam generator questions?

MR. CATTON: Could you give me the name of the person at EPRI that I might contact?

MR. CARROLL: Contact EPRI on which subject?

MR. CATTON: On the international program you mentioned to me earlier. You mentioned a program, French-U.S.

MR. WILSON: I would say Stanley Green is the man I believe who is the Project Manager or the Project Manager reports to him, one or the other.

MR. CARROLL: Some of the questions I had about vibrations and so forth I can pursue with him.

MR. WILSON: As far as on the flow side, definitely. He can bring you up to speed on the state-of-the-art in the industry and the steam generator industry.

MR. VAN DE VENNE: The steam generator is undoubtedly the area in the reactor coolant system that most of the work was done. The reactor coolant pump I really don't want to dwell on since we are using a standard model 100 pump that's also on South Texas -- it's really an identical pump. Just the operating parameters are a little different than South Texas but not much and the design flow is 100,000 gpm approximately, which is typical for the range of Westinghouse plants.

Some plants have somewhat higher flows, maybe up to 105,000. This is a little bit less but it's basically the same.

The seal injection or the seal design is also conventional and the number one hydrodynamic seal on the number 2 and 3 seals which come as a cartridge. The motor power is 800 horsepower, which is also identical to South Texas.

MR. CARROLL: Is that 12 KB?

MR. VAN DE VENNE: Yes, we have, well, we use 13.8 KB, which is nominal so the actual voltage is probably 13.2 or something like that.

MR. WYLIE: Is that rating, is that the power requirement that's hot or cold?

MR. VAN DE VENNE: This is the rating of the motor. I think the power requirement during cold is probably somewhat higher. The motor runs slightly at overload conditions and during hot it's less than this. The input power hot is probably 6.5 or 7.

MR. WYLIE: Is that a water cooled motor?

MR. VAN DE VENNE: Yes.

MR. WYLIE: Totally enclosed?

MR. VAN DE VENNE: Well, the way the design works is it's an air cooled motor where the air is cooled as it exits the motor, so it's really an air cooled motor with an exit to prevent the air from being, the hot air being dumped in containment thereby overloading the fan coolers, so it's really a water cooled motor -- I mean an air cooled motor with water cooling. Then the bearings, of course, are cool.

MR. MICHELSON: It is an air cooled motor -- the cooling air coming from the containment.

MR. VAN DE VENNE: Right, right.

MR. MICHELSON: Now the water cooling has nothing to do with it except to keep from overheating the containment. It's the containment cooler.

MR. WYLIE: They could have done it different ways. Some of them are totally enclosed in case you don't circulate. I don't know why you don't do it that way. You could keep the containment atmosphere out of it.

MR. VAN DE VENNE: The other item is the pressurizer, which is 2500 cubic feet, which is substantially larger than any other pressurizer we have. The largest -- our normal pressurizer for the plant is 1800 cubic feet and South Texas is 2100 cubic feet. This one is 2500 and it has a traditional distribution of 40 percent steam volume and 60 percent liquid volume and the heating capacity is 2500 kilowatts, which contains about 15 to ?0 percent margin, installed margin to account for potential heater failures as time goes on.

We have three safety valves and three power operated relief valves which are safety grade and AC-independent.

MR. CARROLL: What are they sized for?

MR. VAN DE VENNE: The relief valves are essentially sized -- the dominant sizing criteria is bleed and feed operation.

MR. CARROLL: Safety valves or PORV?

MR. VAN DE VENNE: PORVs. Safety valves are sized for a loss of load, traditional sizing.

MR. CARROLL: Does this plant use loop seals on --

MR. VAN DE VENNE: Yes, it does.

MR. WARD: For feed and bleed, do you need all three valves or two or one, what?

MR. VAN DE VENNE: It depends on the number of pumps that start. You can live with two valves and four pumps or you can have three valves and two pumps, so it depends a little bit on -- we can take some failures in the combination but not failures in both, I believe.

MR. WARD: The fact that in ATWS analysis I guess it's more negative and a higher coefficient, did that feedback affect the valve size here at all or do you just take what you can get?

MR. VAN DE VENNE: No, not really. As I mentioned, the safety valves are sized on a loss of load condition without taking credit for the first safety grade reactor trip which is high pressure, and that really is the sizing criteria and then you take that safety valve and you do the ATWS evaluation and you see what the results are.

Now as part of the policy issue with the staff, we have made a commitment that we will revisit the capacity of these valves at the FDA stage and we'll do ATWS specific analyses to verify that ATWS criteria are met, so we may if necessary increase these valves in size if ATWS analysis would indicate that there would be a benefit.

MR. ORR: Let's see, the pressurizer spray comes from where in this system?

MR. VAN DE VENNE: The pressurizer spray comes from the cold leg. There is a six inch line from the cold leg. Well, there's two six inch lines from the cold leg that go to the spray nozzle and they have a capacity of 1200 gpm total, the two lines combined and there is an alternate spray line from the CVCS for those cases where the reactor coolant pumps are not running and the cold leg pressure is not sufficient to get spray.

That's a typical Westinghouse design except that the spray flow is quite a bit higher than our normal plants.

MR. WARD: And that is why? Simply because the pressurizer is bigger?

MR. VAN DE VENNE: Yes, it's simply because the pressurizer is bigger and also we want to be able to control bigger pressure swings more rapidly and not have to rely on PORVs.

The intent of the PORVs is that they would never open during a transient and so the size of the pressurizer and the size of the spray are on that desire not to open PORVs on a full load rejection.

That sort of determines the size of the pressurizer and the size of the spray flow.

MR. WARD: Now the backup spray, you say that's from the --

MR. VAN DE VENNE: Chemical volume control system.

MR. WARD: Are those the makeup pumps?

MR. VAN DE VENNE: Charging pumps.

MR. WARD: That is not safety grade?

MR. VAN DE VENNE: No.

MR. CATTON: Now are there any lessons learned by

Westinghouse from experience that Calvert Cliffs is having with the pressurizer heater sheaths?

MR. VAN DE VENNE: Yes. I understand that we do not use Inconel in our heaters. We have always used stainless steel. In fact, I was very surprised that also Framatone has gone to the Inconel and has basically run into the same problem. We have never made that change so I don't think we've ever had any instances of cracking, stress corrosion cracking, around the heater sleeves.

MR. CATTON: Will your PORVs handle two-phase flow?

MR. VAN DE VENNE: Yes. The intent is that they would.

MR. CATTON: They'll be qualified for two-phase flow?

MR. VAN DE VENNE: They would be qualified for that, yes.

MR. MICHELSON: Would they be qualified for the select-all or two-phase?

MR. VAN DE VENNE: I think this question came up before. The slug flow is -- you are talking about clearing of the loop seal?

MR. MICHELSON: No, mainly in case of overfilling of the pressurizer early on and in certain kinds of events you may get intermittent liquid and then steam phase and this creates a so-called slug flow condition.

MR. CATTON: It depends on the void fraction. If you qualify your valve over the whole of void fraction you would include slug flow.

MR. MICHELSON: Not necessarily, by definition -- there is a mixture of steam and water, I think. Slug flow means 100 percent liquid phase followed by --

MR. CATTON: But if you look at a flow regime map, that's right on it. You get a slug of water and then you get steam, you get a slug of water and then you get steam.

MR. MICHELSON: Well, why do a datapoint in which I pass only water and then do another datapoint in which I pass 90 percent quality, it doesn't mean that I've tested with liquid --

MR. WARD: I think he's not talking about the capacity but the forces on the --

MR. MICHELSON: I was referring to the forces too.

MR. CATTON: If you range over the right flow parameters and void fraction you will include slug flow. I mean you pick two phase flow and pick a region where it wouldn't bother anything.

MR. MICHELSON: I believe the drawing that shows both liquid phase and then 90 percent quality and the fact that there is no test in between --

MR. CARROLL: Your semantic problem, I think, is you're moving over this --

MR. CATTON: Well, you bet -- when you say a two phase flow --

MR. MICHELSON: But they don't move over that range necessarily. They get datapoints and then they draw a curve and it looks like you're moving over a range, but you're really not. You can move up and down the range, I suppose. If you move up and down the range, certainly you ought to be able to get slug flow.

MR. CARROLL: Are the PORV block valves capable of closing against any postulated flow? And what is your basis for your answer?

MR. VAN DE VENNE: We have motor-operated gate-valves at this point in time for that, and I cannot say that they have been tested for that particular condition. This is an area -- and I think I have discussed it the last time -- where, at the FDA stage, we will probably make a change in these valves, in that we will use float valves in both the block valve and in the PORV at the FDA stage, and we're planning to do testing of those valves in the first quarter of '91.

Once we have those test data in hand, then that probably would be our intent to do that, and that design has the advantage that with two identical valves in series, either one can be the block valve and either one can be the primary valve. So, if you get leaking in one of the valves, you can close the other one and open the one that leaks, and that's a big advantage of that particular design.

Now, the only reason -- well, first of all, we don't want to upset the PDA stage, but the other thing is we really don't have test data on that valve, but we are planning to test these valves in the spring of '91, and that's probably what we will do. That testing would also, obviously, include some closing.

MR. MICHELSON: Are you going to use flow restrictors on that line? Are you going to have 1,000 pounds across the flow valves?

MR. VAN DE VENNE: There are no flow restrictors, no.

MR. MICHELSON: That's real rugged duty, then. That's why you design safety valves the way you do, to take those large pressure drops without total disruption. Good luck.

MR. CARROLL: Okay. Any more questions on the pressurizer?

[No response.]

MR. VAN DE VENNE: The next item which is part of Chapter 5 is the residual heat-removal system, and I would like to defer the discussion on the specific diagram to the ESF, which is immediately hereafter, because it's really part of the ECCS containment spray. It's intertwined with that.

I just wanted to put the parameters up here. The fact is we have four RHR pumps which also function as spray pumps, and we have four RHR heat exchangers. So, we have substantial more redundancy in the RHR than conventional plants, which really have only two RHR pumps, and there are some advantages to this additional redundancy.

One, the line flows are generally smaller, which is an advantage from the vortexing problem that occurs during -- potential vortexing that occurs, but like I mentioned, I will have a picture of the system somewhat later.

An issue related to RHR is the fact that we use the RHR relief valves for low-temperature overpressure protection, LTOP, and the RHR relief valves are specifically sized for that purpose.

MR. MICHELSON: How large are they?

MR. VAN DE VENNE: I think each of them is 6 inch, but I'm not 100-percent sure of that, but it's on the flow diagram.

As part of using the RHR relief valves for LTOP, the RHR isolation valve auto-closure interlock has been eliminated. So, we do not want to get into a situation where these valves would inadvertently close.

The system sizing is such that, with two out of the four RHR systems -- in other words, two relief valves are sufficient to provide the LTOP function over the range of conditions that it needs to be provided.

The power is removed from the RHR isolation valves in those substances that perform the LTOP function at any one point in time.

MR. MICHELSON: Could we go back to your first bullet for just one second?

MR. VAN DE VENNE: Yes.

MR. MICHELSON: Pardon me, your second bullet. The auto-closure feature was originally in there in the unlikely event that you would lose the water out the RHR system somehow, like a pipe-break. Wasn't that the purpose of it?

MR. VAN DE VENNE: No.

MR. MICHELSON: Let me ask it differently. What is the purpose? What is the reason to have an auto-closure feature?

MR. VAN DE VENNE: Mike Shannon will answer that question.

MR. SHANNON: Mike Shannon, Westinghouse.

The reason, I believe, originally, for the auto-closure interlock feature was as a result of number of things that resulted in RSB branch technology position 5-1, and that was to isolate the RHR system against overpressurization in the eventual -- that overpressurization which would eventually cause an inter-system LOCA.

MR. MICHELSON: What provision do you have, then, for preventing loss of reactor coolant in the unlikely event of an RHR pipe-break during shut-down and cooling?

MR. SHANNON: Well, there are several things. One is that we have shown, over the years, and I think the staff now agrees completely, that the additional risk of having an inter-system LOCA --

MR. MICHELSON: Not an inter-system LOCA. This is an RHR system break --

MR. SHANNON: Well, okay.

MR. MICHELSON: -- which may not be at the inter-system --

MR. SHANNON: It may or may not be, but when you compare that against the effects of having inadvertent closure of the RHR suction isolation valves, it turns out to be safer to not have that.

MR. MICHELSON: Let me ask --

MR. SHANNON: Secondly -- let me finish first. Secondly, we've designed the RHR system at a higher design pressure than in existing plants, so that it can take that RCS pressure better.

MR. MICHELSON: Do you presently monitor reactor water levels during shutdown cooling and also at the isolation valves? There was a provision in the older plants. Is this a provision in this plant?

MR. SHANNON: I didn't follow your question. Automatic isolation when?

MR. MICHELSON: Do you monitor reactor water level during shutdown cooling to make sure the RHR pumping system isn't -- and do you find the reactor water level is not correct? Do you isolate this? Is that still on your reactor?

MR. SHANNON: As far as I know, if I follow you correctly.

MR. MICHELSON: That is not the auto-closure you're talking about here?

MR. SHANNON: No. This auto-closure is on a high-pressure RHR.

MR. MICHELSON: You still have an auto-closure?

MR. SHANNON: No, I don't believe we have a single auto-closure system. I thought I was answering your question about monitoring during low water system level.

MR. MICHELSON: Then when you get to a certain trip point, what happens?

MR. SHANNON: Well, we are monitoring.

MR. MICHELSON: What are you monitoring?

MR. SHANNON: We have RHR monitoring functions held in place.

MR. MICHELSON: What about at Diablo? Didn't you have the isolation of the RHR?

MR. CARROLL: We had the auto-closure feature, which we got rid of.

MR. MICHELSON: What prevented you from pumping the reactor dry when in isolation? There are several ways of pumping water from RHR.

MR. CARROLL: There was a monitor.

MR. MICHELSON: It was an automatic isolation?

MR. CARROLL: No.

MR. MICHELSON: Even on the VWR? I thought you had it on this.

This has happened in the real world, too.

MR. CARROLL: Part of the difficulty is --

MR. MICHELSON: No. You isolate it and it makes the operator go check and see what's going on and why the water is disappearing.

MR. VAN DE VENNE: I believe if you wanted to prevent or have some automatic signal to isolate on low water level, you would not close the valves, because that would not solve the situation. You would still ruin your pumps. In that case, what you should do is trip the pumps.

MR. MICHELSON: You have minimum full bypass to protect the pumps, I assume.

MR. VAN DE VENNE: No, no, no, no. I mean if you close the valves, the pump will just immediately dry up. You will go dry.

MR. MICHELSON: Don't you have a minimum flow protection?

MR. VAN DE VENNE: If you have no suction, there is no minimum flow protection. If there is no water in the suction, you would just go dry.

MR. MICHELSON: I thought it recirculated.

MR. SHANNON: No. These are valves on the drop line.

MR. MICHELSON: So, they do not have the recirculation?

MR. SHANNON: There is a recirculation of many flow lines around the pump, but you have to have some feed to the pump in the first place, but these isolation valves are before where that mini-flow line comes back into the suction of the pump. So, if you cut off flow, you have no feed to the pump at all.

[Pause.]

MR. VAN DE VENNE: I can show you that when the picture comes up.

As I mentioned, we removed the power from the RHR isolation valves and subsystems performing the LTOP. There is an alarm that will indicate that less than two subsystems are aligned.

So, whenever the system is below 350 psi, the two systems must be aligned, and if they aren't, there will be an alarm to the operators, and then, as a last measure, we will also specify that, of the two remaining subsystems that are available, no more than one should be taken out any one time, such that if anything happens here that would force you to somehow have to isolate the one subsystem, there would be another subsystem available that you could align at that point to still have the LTOP function available to you, and this address several open DSER issues, also, that the staff asked and asked for clarification and additional information.

That is what we presented the last time. I don't know that I have to go through that unless you have any questions on that particular aspect, but again, this was one of the open issues on the DSER, issue 54. We've had discussions with the staff on that particular item.

The were a number of open issues on the RCS. These are the Category 1 issues and the Category 2 issues. I mentioned there were two open issues here that were related to LTOP and some other ones and if you have any questions or would like to have some additional information on any of these, I can provide that to you.

The other open issue that was mentioned was the one that was part reactor cooling system and that referred to the use of N16 and excore power detectors to reach a part of the protection system and the N16 power measurement is very similar to the delta "T" measurement that we really have in current plans and one of the objections here was to eliminate the RTD bypass system which has been a source of trouble in operating plants. So instead of using a delta "T" signal, we use an N16 signal which measures power directly.

As such, it does not really involve any fundamental change in the protection system. It's just a different way of measuring basically the same parameter. Our understanding is that the staff's review on this particular feature was not yet completed. We had this initial LSA as part of our PDA of the RISA 414 and also it is -- this system is installed in Comanche Peak. So there is some actual experience with the system and as far as resolving this, I think we will have to know a bit more about what the staff concerns are before we can come up with a specific approach on this item.

MR. CATTON: Could you go back to the previous slide for a moment?

MR. VAN DE VENNE: Yes.

[Slide.]

MR. CATTON: On item 46, what is the issue on the pressurizer safety valve sizing?

MR. VAN DE VENNE: The staff wanted us to commit that the pressurizer safety valves during a loss of load event would be based on ignoring the first safety grade trip signal. The first safety grade trip signal that occurs is high pressurizer pressure. So we confirmed to the staff that that indeed is the case. So when you do the loss of load analysis, the first signal is high pressure. You ignore it. You keep on going until you get the next trip signal.

MR. CATTON: So that's no longer an issue?

MR. VAN DE VENNE: I don't think so. I'm not sure.

MR. CATTON: On No. 55, the boron mixing natural circulation test; what's the problem there?

MR. VAN DE VENNE: There was a concern on the staff that during a natural circulation condition, there would be not sufficient boron mixing to get the reactor subcritical. We had previously committed that we would do a natural circulation test as part of the first plant that goes into operation. We extended that commitment in response to the staff concerns to state that included in this test would be an injection of boron into the loops and a measurement of how the boron mixes in the primary coolant system to make sure it doesn't -- I think the concern is you get --

MR. CATTON: I understand. It's denser and it could stratify in the bottom of the tank.

MR. VAN DE VENNE: Right, or it could be streaming or something like that.

MR. WARD: It's going to be a little late to find out; isn't it?

MR. VAN DE VENNE: I don't really know that this is a real concern. I think that it is good to demonstrate. I don't know whether it's ever been demonstrated in an operating plant. I know natural circulation has been demonstrated but I'm not sure about the boron mixing.

MR. CATTON: There have been some boron mixing simulator studies by Theophonus that might help you.

MR. VAN DE VENNE: Anyway, we've made the commitment that we would do them. So that should be resolved, I presume, but I'm not sure.

MR. CARROLL: Does staff have any comments they want to add to these open item issues on this chapter?

MR. LIANG: Yes, for the open issues, the Westinghouse response to all the open issues on that list, we have preliminarily reviewed and we find no major problems with it and some details may keep contact Westinghouse on resolving them but in general, we accept those responses and have no problem. The natural circulation boron mixing test is a confirmatory kind of test. It's already demonstrated in current PWRs. In CE plant, in Westinghouse plant, we already did the test and it was successful. So it's just a confirmatory kind of test.

MR. CARROLL: Okay, well, I guess we're at this point scheduled to take a break unless we want to move into the next chapter. Let's be back at 2:30.

[Recess.]

MR. CARROLL: Let us reconvene. Theo?

MR. VAN DE VENNE: Going sequentially, then, the next chapter is Chapter 6, "Engineered Safety Features."

Although the containment is really described in, I guess in Module 3, I just wanted to put these parameters up here, just for completeness sake. It is a spherical steel containment, diameter of 197 feet, 1.65-inch thickness, conventional SA-537 material. Design pressure is almost 47 psi. And the free volume is 3 million, a little bit over 3 million cubic feet.

The next item following the SRP would be the ECCS. And the ECCS function is one of the functions that is performed by the integrated safeguards system. The other functions are the containment spray and the residual heat removal functions that are also performed by this system.

The system consists of four subsystems which are identical, and each of these subsystems is shown in this picture. And you undoubtedly have seen this before.

The main features are, there are four high head pumps, or in each subsystem one; four low head pumps -- as I mentioned they perform the spray or the RHR function -- an in-containment refueling water storage tank that provides a continuous supply of water to both pumps; four accumulators, 600 psi conventional type but larger; and four low-pressure accumulators that we choose to call core reflood tanks.

The emergency core cooling takes suction from the in-containment refueling water storage tank through a valve that is normally open, and injects it into the reactor coolant system [indicating].

So on an "S" signal, the only action that has to take place is to start the pump. There are no valves to move at all.

MR. CARROLL: That is physically correct, the separate nozzle that it goes into?

MR. VAN DE VENNE: Right. It is a separate nozzle on the vessel that is located between the hot and cold legs, at approximately the same elevation as the hot and cold legs. Okay?

So it is a separate nozzle. It is a six-inch nozzle. Most of this piping is actually six-inch except the suction, I believe, which is eight-inch.

MR. CARROLL: And why is it that you didn't go into the cold leg piping?

MR. VAN DE VENNE: The advantage of going into the vessel is that you don't have a spilling line.

MR. CARROLL: Okay.

MR. VAN DE VENNE: So you can economize on pump size, and you get in general more delivered flow with a smaller pump.

On a best estimate case basis, we have done analyses to show that the core remains covered for breaks up to six inches. The Japanese MHI, our partner, has done analyses to show that the core does not uncover up to breaks of 12 inches. The code with which that analysis was done is, you know, it is not a code that we are very familiar with. So I cannot vouch for the accuracy of this result. But I am sure that we can sustain quite large breaks without even uncovering the core.

And one reason is that these pumps are generally sized, and if you have any loop break on a best estimate basis, all four pumps will deliver. There are no spilling line considerations, which has always been a problem in current analyses.

The high head pump has a mini-flow line which goes back to the emergency water storage tank, which is sized for continuous operation of the pump. The parameters that are provided in the SER are preliminary. When we buy the pump, we would specify to the manufacturer that the miniflow has to be, we would specify how much flow we want delivered and then the vendor would have to tell us how much miniflow he wants in order to allow the pump to run continuously without damage.

The value for miniflow that is currently in the book is our best estimate at this point in time.

The high head pump can also be tested over its full flow head curve via this line here. With the reactor at power, by opening these valves, and this being a throttling valve, you can actually test this pump at any point of the curve by providing a different amount of throttling at this particular point. And that includes full flow testing at runout conditions.

Another point worthy of note is that the shutoff head of this pump is about normally 1800 psi, which is below the low pressure trip setpoint for the reactor coolant system. So it cannot really inject into the reactor coolant system during any normal conditions. It will just not deliver, because its shutoff head is insufficient to do so.

MR. WARD: So, feed-and-bleed is with the charging pumps?

MR. VAN DE VENNE: No. It's just the high-head pumps, because in feed-and-bleeds, you open the PRVs, and the pressure comes down to about, based on the analysis of what we have done, in a range of 1,100 to 1,300 psi. It tends to hang up at the safety valve set point of the steam generators. When the steam generators are still hot, that's where you tend to hang up, then over the long term, pressure will continue to increase.

MR. WARD: It just hangs up because of the load?

MR. VAN DE VENNE: Yes.

MR. WARD: Let's see, the accumulators fire at 600 psig. What about the core reflood gates?

MR. VAN DE VENNE: The core reflood things fire at 200 psig.

MR. WARD: What have you based those two numbers on?

MR. VAN DE VENNE: The accumulators really -- the 600 psi is an historical or a traditional number. We have done some sensitivity studies at other values, but if you go lower, you may get into trouble in immediate breaks, where the pressure may want to hang up and where you want these accumulators to deliver. If you go to too high a pressure, they may empty too quickly when you have a large break. So, the 600 is a good number to use for those. Six-fifty would be okay, but 600 is our traditional design and it works well.

These really perform the function of a low-head pump, so the shut-off, where they start to deliver, is similar -- not quite the same, but in the similar range of where low-head pumps traditionally deliver, and these deliver over a period of about 15 minutes -- 15 to 20 minutes, and they take care of the reflooding of the core. Once the core is reflooded, one high-head pump has sufficient capacity to continue the core cooling. The high-head pumps, on their own -- two of them would not be sufficient to reflood the core, because they wouldn't provide enough flow.

MR. WARD: Now, when you have done those analyses, or you said the sensitivity analyses, what codes have you used? Have you used best-estimate codes?

MR. VAN DE VENNE: No. Basically, we use SATAN and BART, which is our traditional code.

MR. WARD: Those are evaluation model codes.

MR. VAN DE VENNE: Right. Those are evaluation models.

MR. WARD: That doesn't seem like a very good idea to me, to design the system based on biased codes.

MR. VAN DE VENNE: Well, the only code in best-estimate space that's really available is COBRA/TRAC.

MR. WARD: Yes.

MR. VAN DE VENNE: And that was not available when we did the system design. COBRA/TRAC is only something that's formalized or finalized in the last 3 years or so. Now, we have done some --

MR. WARD: What if a COBRA/TRAC calculation or some best-estimate calculation showed you there was a different optimum set-point for those accumulators in the core reflood tank?

MR. VAN DE VENNE: I don't know that we really could get a very different answer. About 2 years ago, we ran some COBRA/TRAC, at the special request of the Japanese, on the reactor. We only really ran the blow-down.

MR. WARD: Yes.

MR. VAN DE VENNE: But we did not find a large difference between COBRA/TRAC and SATAN, which is the normal blow-down code that we use. The big disadvantage of COBRA/TRAC is that it's horrendously expensive.

MR. WARD: But you said you haven't found much difference.

MR. VAN DE VENNE: No, we didn't see a large difference, for instance, in the pressure behavior or even in the temperature behavior, early on. Now, I don't know about the reflood, but we didn't see a large difference. It was slightly better, but not a whole lot.

This plant is a bit unusual in that it's blow-down limited. Our peak-load temperature occurs during blow-down, and that's not traditionally the case with PWRs. Our PWRs are generally reflood limited.

MR. WYLIE: So, you have four trains and two could do the job, right?

MR. VAN DE VENNE: Correct. Well, there is one special case, which is a break in one of the nozzles, which is the limiting small break for this plant, because if you break one of the nozzles and you fail two pumps because of an electrical failure, you have just one pump left, and that case was analyzed and provided acceptable results. In fact, it provided no core uncovery, also. So, from a small-break point of view, that is the limiting small break. Any break greater than 6-inch, by definition, is not in the injection lines.

The emergency core cooling parameters are shown here. The pump flow is about 1,000 gpm, which is bigger than most of our high-head pumps. Typically, our high-head pumps deliver more like 500 or 600 gpm at run-out. So, we have four bigger pumps than our traditional two smaller pumps.

The accumulators are 2,500 cubic feet. A typical accumulator, for instance, is 1,350 cubic feet. So, they're almost twice as big, and in fact, we've done analyses where we failed an accumulator, and we basically see very little degradation in ECCS performance. So, we can take a failure of an accumulator, which, traditionally, is not assumed, because it's a passive component, but if a check valve were to fail in an accumulator, it doesn't really hurt the ECCS performance during a large break.

MR. WARD: You mean that means --

MR. VAN DE VENNE: One spills, one fails, and two deliver.

MR. WARD: Okay.

MR. VAN DE VENNE: Okay?

The core reflood tanks are 2,000 cubic feet, and as I mentioned, the operating pressure, when it starts, is 200 psi. Of course, as time goes on, during the transients, that pressure will tend to drop.

Finally, the in-containment refueling water storage tank is 580,000 gallons. It's a large tank, and its size is basically determined by the need to fill the refueling cavity. It's not really an ECCS sizing. It's based on some other considerations. That's why it's so big. It probably could be smaller if that requirement didn't exist.

Going back to this picture and looking at the spray pump, or the low-head pump, the spray pump is also normally aligned to the in-containment refueling water storage tank and is set to deliver to the spray headers, except in this case, there is a normally closed valve located in the discharge line to prevent spraying the containment, in case of an inadvertent pump start. So, there is a normally closed valve that opens on a spray signal, and of course, the pump starts, also, on a spray signal.

The mini-flow on the low-head pump is taken by the mini-flow heat exchanger. Similar to the high-head pump, the low-head pump can also be tested at power, by opening this valve and, again, going through this pass here. So, the low-head pump can be tested at any time during plant life.

The containment heater removal spray pumps; there are four. Their design flow is about 3325 gpm and they have a fairly low design head, of course, of 155 psi. In addition to the containment spray pumps, we have safety grade containment fan coolers which also take care of post-accident heat removal. There are four of these fan coolers and their heat removal rate is 80 million BTUs per minute.

Now, in our containment analyses, we have assumed that only one unit is assumed to operate post-accident. In fact, only one unit is started in a post accident environment. The reason for that is the heat removal rate is so high that if you started both, you would tend to heat up the component cooling water system to a degree where you could run into problems with motor cooling and seal cooling.

On a high pressure containment signal, only one fan cooler in each string is started and if you then assume a single failure, you are left with only one fan.

[Slide.]

MR. VAN DE VENNE: I talked earlier about residual heat removal. The lower head pump is also used for residual heat removal. If you want to go to residual heat removal, this valve is closed -- this valve is closed; this valve is opened and these valves are opened and you take suction from the hot leg and inject it into the reactor coolant system. Cooling takes place in the residual heat removal heat exchanger.

MR CATTON: How much of that system is capable of having full system pressure?

MR. VAN DE VENNE: The design pressure of the suction piping is nominal 900 psi, but the actual design pressures are higher than that, because the piping is at a selected -- whatever the schedule is -- so the piping is about, I believe, about 1500 psi design pressure.

Now, it could take 2250 before you get to failure. The weak point will tend to be the seals of this pump, and there will probably be leakage from the seals if you would ever get to that kind of pressure.

MR. CATTON: And the heat exchanger?

MR. VAN DE VENNE: The heat exchanger has a 200 design pressure because all of this is like 2000 psi. They can take much more than 2250. I believe that this -- I have discussed the system aspects. Maybe a couple of minor items:

The high head pumps are also used for boration during a safety grade cold shutdown scenario. In that case, there are two letdown lines provided with a fixed orifice and you can let down flow from the reactor coolant system -- in this case, solid flow -- I mean, not steam, and you can inject with the high head pumps and this is an emergency boration type of situation, safety-grade boration situation.

The other thing that you can see here is that the overflow from the pressurizer relief tank also goes back into the emergency water storage tank, so any discharge, for instance, during a bleed-in feed from the pressurizer relief valves -- power operated relief valves -- will go to the PRT and when the rupture disk breaks on the PRT, it's piped down to this tank, so that in a bleed and feed scenario, you will not contaminate the containment with water. You will obviously get some steam from steaming in this tank, but you will not flood the containment during the bleed and feed, because it's what we call a semi-closed loop.

MR. CATTON: What about the steam generators? They -- do they dump to that?

MR. VAN DE VENNE: The steam generator overfill protection system also dumps to DWST, yes. That's a specific steam generator tube rupture feature. I guess we'll get to that in Chapter 10.

The combustible gas control --

[Slide.]

MR. VAN DE VENNE: It is here. We have redundant, in-containment electric hydrogen recombiners. We have hydrogen igniters with a Class 1-E power supply. At this point in time -- I will get back to this -- we have no Reg Guide 1.7 hydrogen purge system, but the operating purge system could perform this function if it was necessary.

The system is there and it has the required valves that can be opened. They are safety grade valves, so it could be used for that purpose. Then, of course, there is a containment hydrogen monitoring system and this provided for combustible gas control.

One of the open issues on this one. I will get back to that a little bit later when I talk about the open issues in this chapter.

MR. CATTON: What kind of igniters? No plug?

MR. VAN DE VENNE: At this point, you know, it's flow plugs, but there is available -- but apparently we haven't looked into that at this point in time.

MR. CATTON: How do you decide where to put them?

MR. VAN DE VENNE: Well, the igniters will have to be for local hydrogen control which means that they will have to be in the exit from the loop compartments where the loop compartments fit to the upper part. They will also have to be in the EWT, because there may be a hydrogen accumulation there and there will be hydrogen igniters for global hydrogen control which will tend to be in the top and that gets us to your concern about the qualification up there.

MR. CATTON: You're going to follow up on the paper I gave you?

MR. VAN DE VENNE: Right.

[Slide.]

MR. VAN DE VENNE: On fission power control which is also in Chapter 6, the only thing I want to mention here is that we do not have a spray additive system. That is a change that has been implemented on a number of operating plants, but I think this is the first time we did some detailed evaluation on what the benefit of an evaluation system is.

It turns out to be a rather small benefit in dose reduction. Then because we have a double containment, we have an annulus exhaust filtration system which uses charcoal filters to keep the annulus at a negative pressure and exhaust whatever releases there are to the stack.

MR. CARROLL: Your statement about spray additive assumes that you keep the pH at 7 or above?

MR. VAN DE VENNE: Right. Yes, I think so, yes. There still has to be an additive system just for long-term pH control, but it only has to be put into operation after several hours.

MR. CARROLL: Well, the baskets of trisodium phosphate, right?

MR. VAN DE VENNE: Right.

In terms of the open issues, I first may as well put this up here. There were a few Category 1 issues. I don't want to dwell on those unless you have any questions on them.

MR. CATTON: We would just like to know what the issue is for 1661.

MR. VAN DE VENNE: The first issue on low head pump deadheading, we stated in the SER that the low head pumps could be used for core cooling in long term, which is true, because if you do not need spray anymore, you can isolate this and you can use the low head pump as well as the high head pump for long-term core cooling because either one can deliver through this pass.

The staff was concerned that with these two pumps operating in parallel, the low head pump would deadhead because its shut-off head is much lower and it would damage itself. Our response was that there really is no intent to have both operating at the same time.

In other words, for long-term cooling, you only need one of eight pumps and you would not run both in parallel. However, in any case, the mini-flow is sized to allow this pump to run continuously so that there would be no damage in any case, but the operating instructions would have to state that you would only run one of these pumps for long-term recirculation.

MR. MICHELSON: Why doesn't that mini-flow protect when you're on shutdown cooling?

MR. VAN DE VENNE: Well, if you're in shutdown cooling, this valve is closed.

MR. MICHELSON: The other valves unfortunately aren't on that drawing.

MR. VAN DE VENNE: These are open. These are open and what happens, as soon as you close these valves, this pump is going to run dry because it has no suction.

MR. MICHELSON: Where is the water going to?

MR. VAN DE VENNE: You'll inject it into here.

MR. MICHELSON: Oh, no, no. Obviously you have to close the isolation on both sides, close the discharge and the suction and go on your mini-flow circulation and unless you've got a leak in a system, it works fine and that's what I thought it was all about. That's the heat exchange I was trying to explain before.

MR. VAN DE VENNE: Okay, I understand.

MR. MICHELSON: Because otherwise, you'd have a real argument if single failure, inadvertent actuation can knock out an RHR pump, then I guess if you just accidentally close the suction valve.

MR. VAN DE VENNE: As we mentioned, the power is removed from the suction valves during LTOP operation.

MR. MICHELSON: Yes, but during shutdown cooling, you certainly have control over them and if you inadvertently close one for whatever reason, you destroy the pump.

MR. VAN DE VENNE: That's why we move power.

The next question related to --

MR. MICHELSON: You missed my point. The point is on shutdown cooling, they have to be open. Obviously -- I don't think you remove power during shutdown cooling. I think only during normal operation.

MR. WARD: That's not what he said.

MR. MICHELSON: You mean you're going to remove power at all times except when you want to operate them?

MR. VAN DE VENNE: When these are used for LTOP, what we're saying is that power will be removed. There is a relief valve which is not shown here but these relief valves on this suction line here are used for LTOP. What we're saying is that when they are used for LTOP, this will be removed.

It's a relatively small window but it's only really during cooldown when you're at 350 to 200 and when you start up.

MR. MICHELSON: But during shutdown cooling, the valves are open.

MR. VAN DE VENNE: During shutdown cooling -- for instance during midloop, you would not remove -- you wouldn't have to remove the --

MR. MICHELSON: What happens is you inadvertently close one during -- you don't cutoff the power during shutdown cooling; do you?

MR. VAN DE VENNE: I guess we haven't really made that determination.

MR. MICHELSON: I think not, but because -- if you start pumping the reactor dry, you better be able to shut the valves real quick.

MR. VAN DE VENNE: If you shut this valve, I think you run this pump dry.

MR. CARROLL: I guess what Carl is saying is he doesn't see how that happens if you have --

MR. WARD: An interlock to close the suction -- the discharge valve.

MR. VAN DE VENNE: You've got to get them both then, yeah. So you'd have to define some logic that says if either of these valves close when the pump's operating, you close that valve.

MR. MICHELSON: You define water level in the reactor. If the water level gets too low and you're on shutdown cooling, you better isolate the RHR system until you figure out what happened. That's the logic I thougnt was normally used and apparently not on APWR.

MR. SHANNON: I think the experience in the industry has been that when you have those kind of interlocks, the risk of inadvertent closure of the valves due to spurious signals is just too great because it only takes one signal to close the valve and as soon as you close the valve, either the suction or the discharge or even both, then you lose RHR and we found that in certain shutdown modes, if you lose RHR, you can uncover the core very quickly.

MR. MICHELSON: Apparently that thing you call RHR cooling there doesn't work to that case. That's what you're saying, that a heat exchanger which I thought was there to protect the pump doesn't work then?

MR. VAN DE VENNE: This one is always operational.

MR. MICHELSON: But it doesn't do you any good --

MR. VAN DE VENNE: If you run dry. No. If you run dry, it doesn't do you any good. If you close this and this, it would be okay.

MR. MICHELSON: I think you missed the point. I think running dry sounds like a simple expression, but there is a problem, even if you are draining by gravity, which it's not. The reactor vessel which is still hopefully full of water --

MR. VAN DE VENNE: This pump is 3300 gallons a minute. I don't know how much water is in this line.

MR. MICHELSON: That pump is zero gallons a minute if you shut off the suction.

MR. VAN DE VENNE: And the discharge. I agree.

MR. MICHELSON: Even if you shut off the suction, you'll just stir it up and create a big steam void in it if you don't have that little heat exchanger, but it isn't going to pump -- you can't pump the piping dry. It just doesn't work that way. I can sure void part of the piping and there's no doubt of that.

MR. VAN DE VENNE: This is at a low point in this whole piping system.

MR. MICHELSON: Yes, the vessel's the high point. It's full of water. It's all a closed loop, a tank, a big tank up on top that closed loop. It's much higher than the pumps. Its much higher.

MR. VAN DE VENNE: But there are check valves here.

MR. CATTON: Is that pump below the storage tank?

MR. VAN DE VENNE: Yes.

Remember during RHR, this is closed. This is closed during RHR.

MR. MICHELSON: It starts spinning there and making steam inside the pump.

MR. WARD: You damage the pump.

MR. MICHELSON: No.

MR. WARD: I don't know if I would want to depend upon that little flow.

MR. MICHELSON: What do you suppose protects the pumps when you have an accident and you aren't ready to inject into the reactor and it's sitting there in the suction on the tank there ready to go? There's no water circulating in that system except through the heat exchanger. It is there to protect the pump.

MR. CARROLL: Discharge shut off.

MR. SHANNON: But it has suction available to it at that point.

MR. VAN DE VENNE: The normal test mode in fact is deadheading because normally when you test this pump, this is closed and you're correct, in that case when this valve is open, you are just circulating here and you can do that forever.

MR. CARROLL: Carl, I can see a situation where I fill this pump with steam and I don't have any differential pressure driving water through that mini-flow bypass.

MR. MICHELSON: I don't want it to get that far out of hand. It doesn't void the piping. It just voids the pump. That's where the heat input is.

MR. WARD: The pump can sure do that fast, though. Real fast.

MR. MICHELSON: Yeah, it does it in a matter of about 30 seconds or so but it doesn't pump the piping dry.

MR. CARROLL: That can create a situation where the suction and the discharge of the pump are at about the same pressure and you're not going to get any flow through the little mini's.

MR. MICHELSON: Yeah, that's right.

MR. VAN DE VENNE: The other question of the staff related to the analysis assumption because in the document, we mentioned in several cases that the system could take more than one failure. I mentioned, for instance, the accumulators and we confirmed that the SER type Chapter 15 analysis was done with a single failure but we have done initial analyses which are not reported in the document on that same best estimate basis where we would assume two failures. Then the open issue 61 asks us about the required minimum flow for each break size and I guess the explanation there was that generally, we do not design an ECCS in that manner.

We establish a required large break flow and we establish a required small break flow and then verify that given these two boundary conditions, that in between, the system performs adequately and, in fact, it would be possible and these are not by any means minimum flows because, as I mentioned, we can sustain more than one failure. So we obviously deliver too much flow, but it would be impractical to run so many analyses to establish exactly what the minimum flow is that's required for each condition.

The next item relates to, comes from Chapter 3, where we talk about in-service testing of these pumps. And I would like to briefly open this up.

During quarterly testing of the pump, you would normally verify the suction pass. If you want to, you can verify the injection pass up to beyond the heat exchanger, but you cannot verify the operability of this part, because the design pressure of the pump is such that you cannot really inject into the reactor vessel.

MR. MICHELSON: What flow rate roughly can you return back to the storage tank?

MR. VAN DE VENNE: The miniflow is normally a small flow, but you can go full flow in this pass here.

MR. MICHELSON: Is that a full flow test return?

MR. VAN DE VENNE: That is a full flow test line. Yes.

MR. MICHELSON; How about on the RHR? Is that the same thing?

MR. VAN DE VENNE: Same. Full flow test line.

MR. MICHELSON: That must be what, a 12-inch pipe or so, then?

MR. VAN DE VENNE: No. This is six-inch pipe.

MR. MICHELSON: Six-inch?

MR. VAN DE VENNE: Yes.

MR. MICHELSON: Oh. That's right. These are small RHRs.

MR. VAN DE VENNE: This are not so big RHRs.

Now, the other comment that we made is that this part of the injection line gets "de facto" tested as part of the RHR operatior.. Because with the RHR operation, you use this flow pass to inject into the vessel. So once a year during RHR or whatever it is, you test this flow pass here.

The spray pump really, you do not test this part here with water, for obvious reasons. So the discharge of the spray can only be tested really up to say here. And normally I understand some tests are done with smoke or some kind of device to verify that there is no blockage here. But obviously, the capability of testing the spray discharge line is limited.

All valves can be stroked at power. There is no valve that cannot be exercised over its full range in this system during quarterly, or whatever testing is required.

And I guess these points are summarized on this slide.

[Slide.]

MR. MICHELSON: I think the important point, though, that you should emphasize, when you say valves can be stroked at power, I'm not sure what that meant. I assume you meant really the valves can be stroked when the plant is at full power. Is that right?

MR. VAN DE VENNE: Right.

MR. MICHELSON: The problem you get into, of course is, depending on how you set up the test to stroke it at power, you may or may not have any differential pressure across the gate at the time you stroked the valve, and of course that differential pressure is creating a significant portion of the total load. So if you don't have it, you have a nominal load test of power.

MR. VAN DE VENNE: Right.

MR. MICHELSON: Even though you do the stroke.

What are your intentions on in situ testing? It is going to be nominal differentials or full differentials?

MR. VAN DE VENNE: Well, one thing to remember of this system is that there are very few valves that -- first of all, no valve has to operate to perform the ECCS function.

MR. MICHELSON: They are all already open?

MR. VAN DE VENNE: They are already open. That needs to be open. So this is really a containment isolation valve, and that is why you would test it. There is on reason to test if from a --

MR. MICHELSON: If you can isolate with it, it might very well be because there is a large flow that you are trying to interrupt. The assumption here is, of course, that the check valve for some reason has failed and now you are getting a large reverse flow, and you have to interrupt it with your gate valve.

MR. VAN DE VENNE: There are two valves here.

MR. MICHELSON: Well, whichever one you use is where the differential pressure will appear.

MR. VAN DE VENNE: Yes. But this is a globe valve.

I think this is more easy to close against flow.

MR. MICHELSON: Depends on which way it was mounted. If it was mounted for normal flow it would be wrong for it to be extra loaded for reverse flow.

MR. VAN DE VENNE: I grant that. But the primary function of this valve is a containment isolation valve, and that is what it would be tested for, normally.

MR. MICHELSON: But it has to open against the full head of the pump when it is waiting to inject. Is that right?

MR. VAN DE VENNE: No, because it is normally open.

MR. MICHELSON: Wait a minute. Excuse me.

MR. VAN DE VENNE: This valve would never be closed under any condition that I can think of, because even if you had a containment isolation case, you would still want to use the high head pump to inject.

MR. MICHELSON: How about your RHR pumps? That valve is normally closed until you get down to some 500 pounds pressure or something?

MR. VAN DE VENNE: This valve is a, this is like a 150 pound pump.

MR. MICHELSON: The flooder. Yes. Is that only a 150 pounds of pressure?

MR. VAN DE VENNE: Pump. Yes.

MR. MICHELSON: Extremely low head, then.

MR. VAN DE VENNE: Well, it is a spray pump.

MR. MICHELSON: It is the RHR Pump that is also injecting into the vessel, isn't it?

MR. VAN DE VENNE: Right. But on the RHR, the suction pressure and the -- You know, you've got a high suction pressure.

MR. MICHELSON: Post-accident, I don't know what I have down in the containment. You are designing for no containment pressure as the worst case in terms of your NPF.

MR. VAN DE VENNE: No. This pump is a containment spray pump. And it is designed --

MR. MICHELSON: Then I am misreading the drawing. I thought it was RHR as well.

MR. VAN DE VENNE: It is also the RHR. But the RHR pump is not used during ECCS. It is purely an RHR pump.

MR. MICHELSON: Okay. Not at all.

MR. VAN DE VENNE: These things are used for low pressure injection.

MR. MICHELSON: You will never crank it up on an ECCS signal, that sort of thing, just for containment spray?

MR. VAN DE VENNE: Right.

MR. MICHELSON: Now, you have to open it against the head of the pump.

MR. VAN DE VENNE: Right.

MR. MICHELSON: Still has to be opened against whatever the head of that is. And that is something more than

150 pounds.

MR. VAN DE VENNE: Yes.

MR. MICHELSON: That doesn't mean that the valve is in high cotton, because the operator has to account for some 500 or something. 150-pound valves fail to open, too, if the operator is not big enough.

MR. VAN DE VENNE: I guess the summary of all of these points that I made is shown here.

In addition, as part of this thing, we will commit to, at the FDA stage, to provide the frequency of pump testing and valve testing as well as disassembly and inspection. We will also include valve and pump diagnostic systems, whatever is available at that time, and information on pump and valve prototype or insitu testing.

So these are some of the things that we have. Now, I think our response to this item was probably not sufficient, and this is probably new information to the staff. And I guess they will have to review that.

We will change our description, whatever we provide, in response to the DSER.

The staff requested detailed descriptions on how various pump and valve tests will be performed, and that is, the detailed test description is something that we feel should be deferred to the FDA stage.

MR. VAN DE VENNE: Another thing is --

MR. MICHELSON: At the FDA stage you'd have to comply with whatever the version of Section 11 of the Code requires at that time, anyway.

MR. DONATELL: Right, that's correct. It's certainly too early in the design, I think, to really get into the hard parts of ISI and IST.

MR. VAN DE VENNE: I should mention that the emergency feedwater pumps also include the full flow test capability. That'll come up during Chapter 10.

The other question from the staff was on the minimum containment pressure that we assumed during LOCA analyses and this refers to Appendix K. We provided the response that the containment pressure was above the minimum pressure that we assumed, which is conservative, and I guess the staff is reviewing our response.

The next item refers to containment pressure 24 hours after the accident. The background here is that GDC-38 requires that containment pressure be reduced rapidly following a postulated design basis accident and the staff's position probably has been -- although it's really maybe never come up in any detail -- is that the containment pressure be reduced to 50 percent to peak calculated pressure for the design basis LOCA.

Our position has been that it should be 50 percent of design pressure and not 50 percent of peak calculated pressure.

The rationale for this is that this really relates back to leakage assumptions for those calculations where you generally assumed that at 24 hours leakage is down to half of design leakage. Now if you assume that design leakage occurs at design pressure, then half of design leakage would occur at half of design pressure. That is why we feel this position is reasonable.

Now we have a design pressure of 46.9. We have a calculated peak pressure of 36.4 and we have a calculated pressure at 24 hours, the maximum of all the cases we ran of 23.5, so we would meet the half of design pressure but we would not meet the calculated peak pressure.

The staff has requested us to justify the deviation from the staff position. I guess if the staff insists on their original position, there are several approaches that we could take. We could provide more heat removal capability obviously, which would get the pressure down. The strange situation that you get into then is that you could also reduce containment design pressure because it would no longer be governed to meet this (indicating) but you could reduce this margin between peak pressure and design pressure and still meet the staff criteria.

MR. CARROLL: No, you can't, because there's a policy statement that says you've got to be at least 45 pounds.

MR. VAN DE VENNE: A policy statement of at least 45, is that correct?

MR. DONATELL: Correct.

MR. WARD: Does that apply in this case?

MR. DONATELL: I don't know. I don't have a containment person with me here. The upshot of this particular issue, I believe this is also a point in contention on the EPRI requirements document. As far as the staff is concerned right now with the Westinghouse application, the intent is to let the EPRI requirements document lead this issue, which means that it will be resolved at that point in time and Westinghouse will have to revisit it one way or the other at the next stage.

MR. VAN DE VENNE: I guess the reason this has come up on this particular design and I don't think it's ever come up on our other plant is that we really only take credit for one fan cooler. If we took credit for two fan coolers, I think this issue would go away, although we have no analysis to confirm that but I believe that would be the case.

MR. WARD: But you probably need more component cooling water?

MR. VAN DE VENNE: No, because the problem of the fan cooler is a very short term problem. It's initially when you have this tremendous peak that you remove so much heat that you tend to overload the CCW system but after a few hours, two or three hours, if you manually start the second fan cooler you really would have no problem, so that could be an easy way to resolve it but we wanted to give I guess the utility some flexibility in fan cooler tech specs, et cetera. That was the main reason for -- was another reason for assuming only one fan cooler.

Referring to the EPRI requirements from our point of view is certainly acceptable and we'll accept whatever resolution is achieved at that point in time.

I think there is enough alternative ways of meeting this criteria that we don't have a problem with that.

The last item is Open Issue 58, which relates to hydrogen purge and vent system. The Regulatory Guide 1.7 really requires you to have a hydrogen purge system. Our position was that since we have igniters, we could use the igniters as a backup to the in-containment electric hydrogen recombiners instead of having a purge system.

That wouldn't say the purge system was not available but it would not necessarily be designed in accordance with Reg. Guide 1.7.

I guess one reason Reg. Guide 1.7 doesn't really talk about hydrogen igniters is because it is a relatively old Regulatory Guide and I don't think at the time when it was issued, which was maybe 15 years ago, I don't know that there were igniters.

The staff position however has been that the operating purge system should be designed in accordance with

Reg. Guide 1.7. In addition, the staff indicated that they would provide guidance regarding the need to a hardened venting capability, which I believe is a different issue, so our proposed resolution approach is: one, if the staff does consider the igniters to be really not acceptable, we will commit to design the operating purge system in accordance with the regulatory guidance provided in Reg. Guide 1.7.

The hardened venting capability is an issue that is part of the containment performance, long term over-pressurization issue that is also under discussion with the staff and that is one that we would like to defer to the EPRI requirements, if possible.

MR. DONATELL: The staff agrees that there are two different issues here, the Reg. Guide 1.7 issue and the hardened vent are two separate issues. This particular open item is related to the Reg. Guide 1.7 design. This is the first time that we've seen Westinghouse's commitment. That will have to be reviewed by the reviewer before we can handle that.

MR. VAN DE VENNE: That concludes Chapter 6.

The last chapter here is Chapter 8, which relates to electric power.

[Off the record discussion.]

MR. VAN DE VENNE: Basically continue?

MR. CARROLL: Sure.

MR. VAN DE VENNE: The main one line diagram, I just want to mention the major points here. We have a main generator breaker. We have two large transformers, an auxiliary transformer and a standby transformer. In addition we have an ESF transformer that can provide backup to one of the ESF buses only. It's not connected to any other part of the plant.

There are two Class 1E buses, and each Class 1E bus has one diesel generator, which is rated at about eight and a half thousand kilowatts.

Then there are the voltage levels that we use: 13.8 KV in the turbine island and the reactor coolant pumps are also fed from 13.8 KV and then we also used 4160 volt and of course 480 volts.

MR. WYLIE: I guess I'll have to ask the question. You went to four trains and four steam generators or four everything? Then you go back to two electrical trains?

MR. VAN DE VENNE: When we evaluated the difference between two and four trains in PRA space we found very little improvement really.

MR. WYLIE: What about maintenance?

MR. VAN DE VENNE: Maintenance -- the ability to take one out for maintenance, you say?

MR. WYLIE: Long term maintenance.

MR. VAN DE VENNE: At the time we did the evaluation we did take into account the tech spec violations that could occur from the diesels and penalize the two train system for having more outage but the database that we used at the time, and I do not know whether this is still true, indicated that the outages as a result of diesel generator problems is really very minor. Now that may have changed over the last five years and I really -- I don't really know, you know, whether that is true or not.

MR. WYLIE: Yes, but, you know, you throw a rod on a diesel or something -- basically you have to rebuild the silly thing and you could have that out for weeks.

MR. VAN DE VENNE: Correct, yes.

At the time availability credit for a four diesel system was on the order of a day per year and the cost penalty was on the order of, if I remember well -- it's many years ago -- 25 million dollars and we polled the utilities on this particular issue, U.S. utilities, and I guess we didn't get a strong feeling that they would like -- you know, some utilities, the thing the utilities had is if you have twice as many diesels, you have twice as many problems.

MR. MICHELSON: The PRA you did that helped you in this decision, did it include fire and other external events?

MR. VAN DE VENNE: No. It was an internal events PRA.

MR. MICHELSON: But you might get quite a different answer when you start postulating fire and flood and so forth,, particularly fire because diesel compartments are one of the larger potential fire hazards.

For decisionmaking, I think you would want to include fire situations, a fire that was in the diesel compartment.

MR. WYLIE: It seems strange, that's all, at least in the so-called "advanced plants" coming across the board.

MR. VAN DE VENNE: Right now, this system is not quite, but as far as the number of Class 1E diesel generators, there's also the EPRI consensus, I guess, that's reached, again, by the utilities, after 5 years of haggling.

MR. MICHELSON: You mean EPRI requirements will just define a two-train electrical system and that includes, perhaps, only two diesel generators. ABWR, of course, has three.

MR. WYLIE: A hundred percent.

MR. MICHELSON: A hundred percent each.

MR. VAN DE VENNE: The system we evaluated really had four 50s. The system we evaluated some 5 years back had four 50-percent diesels.

In addition, from an electrical power point of view, there is an alternate AC power source which is used in a station blackout scenario, which feeds a reactor coolant pump seal injection pump and which can also be used to feed the INC, to continue long-term monitoring, post-accident monitoring of the plant.

MR. WYLIE: Didn't the staff ask for additional capacity to supply some other loads?

MR. VAN DE VENNE: The staff, as far as we know, in a meeting that we had in July, made a comment that they were concerned about the environmental control of the INC rooms and that they would like to see the diesel generator increased in size to provide such environmental control, and we will make a commitment that we will do that.

MR. WYLIE: Okay.

MR. VAN DE VENNE: The other part of the electrical system is the arrangement of the DC and instrument AC buses, or vital AC buses, and this is shown for one train here. There is another one like this. There are four batteries, two more in "B" train. There are also four chargers, and there will be six inverters -- three here and three in the other train.

In addition, there will be separate, non-Class 1E batteries, inverters, chargers, and panels. So, all the non-Class 1E -- the computer, the control system -- all of that will be handled from separate buses and separate supplies.

The protection system is not only fed from the batteries, but also from a transformer and from another transformer, directly. So, there are, for each major INC cabinet -- Class 1E INC cabinet, there generally are three independent supplies -- two of them coming from the 480-volt bus, one of them coming from the batteries through inverters.

The alternate AC power source is shown here, and it has its own charger that can feed either battery in Train "A", and of course, the same is true in Train "B".

MR. WYLIE: I noticed you showed disconnects there. Is that locked out some way so that you can't tie all that stuff together? This is one train and you've got four trains, right? And that alternate power supply connects to all four of them?

MR. VAN DE VENNE: That alternate power supply can be -- in order to prevent interconnection of Train "A" and "B", it can really only feed "A" or "B". It says "interlocked such that one division can be connected at any one time", and that's to prevent some spurious interconnection of the two safety trains' electrical systems and causing a common mode failure.

MR. MICHELSON: In the unlikely event that you have a fire in that cabinet, how does that prevent the two from being interconnected?

MR. VAN DE VENNE: Which cabinet?

MR. MICHELSON: The cabinet containing the interconnection. It looks like there is a cabinet somewhere. Maybe there isn't, but I thought that there would be, between the two devices.

MR. VAN DE VENNE: This is merely a backup. You should remember that the batteries are fed from the Class 1E diesel, obviously, also.

MR. MICHELSON: So, the connection of the "B" charger and the "A" charger, is that two breakers or is that common panel somewhere?

MR. VAN DE VENNE: This would be a common panel, but if there was a fire here, I would have two more diesels, then, as backup.

MR. MICHELSON: The fire would potentially interconnect the two chargers? The problem with those usually occurs during a fire.

MR. VAN DE VENNE: But they are also isolated here and normally open here.

MR. MICHELSON: Isolation at both ends, you are saying?

MR. VAN DE VENNE: Yes. These are normally open, also.

MR. DONATELL: I would like to take this opportunity to clarify something. I got the impression that it was the understanding that the staff had requested an increase in the physical generating capacity of your small diesel.

MR. WYLIE: Yes.

MR. VAN DE VENNE: When we had a meeting with Ashok Thadani in July --

MR. DONATELL: July 14th

MR. VAN DE VENNE: -- we were under the impression that this arrangement would satisfy the station blackout rule. One of the reviewers in the meeting said, well, I'm worried about the environmental control. You have provided the power to the INC, but the rooms may heat up, and we are concerned that the INC will not survive the environment over the long term, and that was the first time we heard that, and he said, you know, I think we should require a larger unit, so that you can maintain the environmental control with the additional capacity that you would have. Ashok Thadani, in the meeting, said, well, you know, we should discuss this internally before we formally request that. I think that was the position that OSHA took.

Now, we haven't heard, since that time, from the staff. However, when we reviewed the issue, we feel that there is probably a legitimate concern here about long-term heat-up of these rooms and failure of INC. So, what we're doing here, I guess, after our review, we're saying we'll somehow address the environmental control issue. We have not had a formal request from the staff to increase the size, but we know it's a concern.

MR. DONATELL: As part of the station blackout issue.

MR. VAN DE VENNE: Right, as part of the station blackout issue.

MR. DONATELL: All right. The reason I bring that up is there is an ongoing question because of the EPRI requirements document on the third power source --

MR. VAN DE VENNE: Right.

MR. DONATELL: -- and I wanted to make sure that we weren't confusing or possibly integrating those two issues or exactly which direction we're going here.

MR. VAN DE VENNE: The EPRI is requesting that the Class 1 source will back up the Class 1 diesel generator. And, frankly, I'm not so sure that that's a good idea. Because if it can back it up, it means it should be able to back up those, and I'm starting to worry about interconnections of Class 1-E buses.

So I think a third power unit is a good idea, but exactly what its size and what its function should be, I'm not so sure that I agree at this point with the EPRI requirements. We have made our concerns known to EPRI.

MR. TREHAN: My name is Trehan, Electrical Systems Branch. EPRI has recommended the third power source which should be a gas turbine.

MR. VAN DE VENNE: Yes.

MR. TREHAN: You are going to put only a third diesel with a 300 kilowatt --

MR. VAN DE VENNE: It will be bigger, but I don't know how big.

MR. TREHAN: Are they going to give one-fifth of the shutdown system and a little bit non-Class 1-E systems on this alternate AC source, but you are talking 100 kilowatt has to be much bigger so that it can supply a little bit Class I load as well.

MR. VAN DE VENNE: I do not believe that in order to resolve the station blackout rule it's necessary to be able to get a whole train of safe shutdown equipment on this diesel because I believe we can keep the plant in a safe condition with something of this order. So I'm not ready to commit to a unit of the size that EPRI has.

The other thing is that there has been a meeting with the Canadians on their experience with gas turbines on the Canda units and I understand some of the Canda units use gas turbines. And their experience in starting reliability and so on was far below what EPRI specified.

So I'm also not ready to commit to a gas turbine until I know for sure that the gas turbine is going to be as reliable. The understanding I had from the staff that a diesel generator, also from the meeting in July, that a diesel generator of a substantially different size and different design as the main Class 1-E diesel generators would be acceptable. That was my understanding.

MR. DONATELL: Don't misunderstand me. I'm just trying to separate the issues. We obviously have to see -- the staff has to see your commitment and review that in light of the other concerns.

MR. VAN DE VENNE: And that is really summarized on this page here, which is toward the end of your handout. The background is the station blackout and how it was resolved and our proposed resolution was SP-90 plan small diesel generator, powered and also maintain the Class 1-E batteries.

The staff was concerned about the environmental issue at that particular meeting, and what we're saying is we'll take care of the environmental issue. We may, at some later point, decide to increase this unit even more, but that's not part of this PDA. This PDA we have to look at, can the plant be maintained in a safe condition for the required number of hours if we take care of these specific concerns, and we can stay at hot standby using the equipment here that we have provided with assurance that there will be no failures.

I think that is the intent at this point in time. At some later point in time, we may decide this unit is going to be ten megawatt, for all I know. But I would like to have some kind of review to see whether this is acceptable to meet the 155 requirements.

MR. DONATELL: Well, as I said, it's the first time we've really seen this and the staff will have to take a look at it.

MR. VAN DE VENNE: And we promise to send you a revised position on station blackout which puts this in there. The other item in Chapter 8 were some open issues, most of which were all, in our opinion, Category 1 or 2. The staff asked which MOVs had power locked out to them and we provided that information.

The staff was concerned about the reliability of the load sequencer when offsite power was available and we explained that the load sequencer as a separate piece of equipment does not really exist. The load sequencer is a part of the protection system.

As such, there is no separate device as traditionally a timer or something like that as you see in today's plants. I think when we get to the -- this is really now an INC question. And when we get to the instrumentation and control in the next meeting, we can spend some time on exactly how this device works.

MR. MICHELSON: There is, though, some kind of load sequencing of the large pump loads onto the diesels, isn't there?

MR. VAN DE VENNE: There is a sequencing, but what I'm saying is part of the ESF function.

MR. MICHELSON: During an accident that you have to sequentially load, isn't it?

MR. VAN DE VENNE: It's during an accident, yes.

MR. WYLIE: I think the point here is that the sequencer doesn't really care whether it's sequencing on the normal power supply or the off-site power supply or the diesels.

MR. MICHELSON: But there is a safety grade sequencer then.

MR. VAN DE VENNE: But you are not quite right in your statement. It does make a difference whether there's power on the bus or not because if there's power on the bus, the loads are not stripped. So the protection system will sense the bus situation and if there is power, continuing power, the loads will remain and only loads will be added. If there is loss of off-site power, it will wait for power to be restored and then sequence the loads on.

MR. MICHELSON: So why is an issue of 65 a problem. That's the part I guess I missed.

MR. VAN DE VENNE: The staff said that if you have a single load sequencer, from the description that we have provided, there was the understanding there was a separate load sequencer and there was only one. I guess the staff was concerned about sneak circuits and --

MR. MICHELSON: One for each emergency bus.

MR. VAN DE VENNE: Yes. One for each emergency bus. They were concerned about sneak circuits between -- you know, not being able to distinguish between loss of off-site power or not, and I guess that relates more to current plans than it would relate to this design.

MR. MICHELSON: I'm just trying to figure out what's different because that's the current plan.

MR. VAN DE VENNE: The current plan is really a separate box or a device. In our case, it's integrated into the protection system itself and it's really a digital type system.

MR. MICHELSON: It is still a function that's got to be performed.

MR. VAN DE VENNE: Yes. And during the failure mode and the analysis of the IPS, this will have to be addressed.

MR. WYLIE: So really the question is the reliability and what power is on what bus. That is really the question.

MR. VAN DE VENNE: Right. It is a reliability issue.

MR. MICHELSON: It has to do with decision making logic.

MR. VAN DE VENNE: It is a validation and verification issue.

MR. MICHELSON: It is also an environmental control issue, also, which goes back to our earlier discussion.

MR. VAN DE VENNE: The other two items, the staff required that the fast transfer scheme be able to be tested, and we committed to that. And the staff requested some commitment on containment on electrical designs to prevent short circuits in the electrical penetrations which could lead to possible failure of containment integrity. And we made some commitments on that.

I don't know whether -- we have had no feedback on whether they're sufficient or not.

MR. MICHELSON: Let me ask you. Since you have integrated now the load sequencing function into the reactor protection function, where is the reactor protection cabinets? Where are they located, that are performing this decision making?

MR. VAN DE VENNE: Well, they are located in --

MR. MICHELSON: They are somewhat remote in another area.

MR. VAN DE VENNE: They are out of the control room, if that's what you infer. Yes. They are separate rooms.

MR. MICHELSON: They're not in the electrical board area.

MR. VAN DE VENNE: No. They are separate INC or protection system rooms, two of them.

MR. MICHELSON: You have to provide this environmental protection for certain buses, even on this blackout case. You also have to provide protection for this equipment, wherever it's located. The environment around that equipment has to be protected during the blackout or this thing here can generate all kinds of bad for you. It starts misbehaving.

MR. VAN DE VENNE: Environmental control relates to battery rooms, inverter rooms and the IPS or integrated protection system rooms, and the emergency control room.

MR. MICHELSON: So it is fairly extensive then as far as the heat removal problem.

MR. WYLIE: In general, where you've got your four trains of engineered safety features located, they are independent. Now, are they independent in two trains or are they independent in four trains?

MR. VAN DE VENNE: Independent in two.

MR. WYLIE: In two. So really you've got redundancy in a two-train system.

MR. VAN DE VENNE: Yes, right.

MR. WYLIE: And the HVAC and the ventilation and everything for that train is independent --

MR. VAN DE VENNE: Of the other ventilation, yes.

MR. MICHELSON: Do you have also a common safety grade ventilation system serving the same areas for routine ventilation?

MR. VAN DE VENNE: No.

MR. MICHELSON: It will all be safety grade ventilation?

MR. VAN DE VENNE: The normal ventilation is safety grade.

MR. MICHELSON: Okay. So it means there are no ducts going from train A to train B or go to another ventilation.

MR. VAN DE VENNE: No. They are all separate.

MR. TREHAN: Those sequences are a part of the electrical system, electrical power system, should be in the electrical power system, not in the IPS system.

MR. VAN DE VENNE: I still think that currently is still shown in Chapter 8. The only thing I'm saying is that the people that can discuss that particular feature are the INC people, and we didn't bring anybody specifically for this item today. But the person that will be here to discuss the INC hardware will be able to address this particular item in more detail than I could. That's all I'm saying.

MR. MICHELSON: How integrated is this center reactor protection control -- what else is integrated?

MR. VAN DE VENNE: The main integration -- the integration really refers to the fact that there is a single protection system for the total plant.

MR. MICHELSON: A single cabinet, I think.

MR. VAN DE VENNE: No, no, no. It's not a single cabinet. A single type of cabinet. In the past, you've had NSSS cabinets, BOP cabinets.

MR. MICHELSON: It's a single type of cabinet, yes. But is it a single cabinet that we're talking about that has the load sequencer as well as reactor protection? There may be two sitting side by side cabinets.

MR. VAN DE VENNE: No.

MR. MICHELSON: You mean it's different functions in different --

MR. VAN DE VENNE: There are a lot of cabinets, actually. We will look at it.

MR. VAN DE VENNE. Integration referred to a plant-wide protection system, rather than NSSS, BOP, excore detectors, load sequencers, and all kinds of different pieces that have to work together, is that we have a single system that takes BOP inputs, NSSS inputs, and provides BOP outputs and NSSS outputs.

MR. MICHELSON: Those are apparently several cabinets located in various parts, giving those inputs and those outputs?

MR. VAN DE VENNE: Yes.

MR. TREHAN: The sequencer cabinets are located in the switchgear rooms, like Train A, Train B, Division 1, Division 2, they are two separate sequencing cabinets. But the reactor protection systems cabinets are located in the reactor protection system where they have this 120 volt AC power supply. They are different rooms.

MR. MICHELSON: I thought the sequencer was integrated, I mean right physically into the reactor protection cabinet.

But you just said that the sequencer was in a cabinet in the switchgear room.

MR. TREHAN: Yes.

MR. MICHELSON: But the reactor protection isn't --

MR. TREHAN: Different room.

MR. MICHELSON: Well, then, reactor protection is not integrated into the same cabinet with the sequencer. Which I thought earlier you had said.

Then I have no problem. I thought you were, and you could, you could package the whole thing --

MR. TREHAN: The reactor protection system is a four-train system. So each cabinet is in a different room, different place.

But this Class 1(a) system which is at the four cable level, they are in different rooms and there are only two sequences.

MR. MICHELSON: And those are not in the same cabinets with the reactor protection.

Okay. I thought they were. Then I won't have a problem.

MR. WYLIE: Is that all you have?

MR. VAN DE VENNE: This is all I was prepared to discuss at this point.

MR. WYLIE: Okay. Let me ask a question.

I believe you have indicated or stated that all motors are sized such that they cover the runout or the maximum horsepower of the driven load. Just for a flavor of how you are applying the motors, is that the nameplate rating of the motor is such that that is the case, that the nameplate is greater than the maximum load? Or is the service factor used to make that?

MR. VAN DE VENNE: I don't know the answer to that question. I would think that on safety-related motors, the nameplating should be larger than the runout power, than the largest power we could do.

Now, in the reactor coolant pumps, that is not the case. The reactor coolant pumps operate for a short time in what we call a minimal overload condition.

MR. WYLIE: I notice you have stated that the motors will be capable of doing that at 75 percent, or accelerating the loads at 75 percent voltage.

What about sustained operation? Under certain conditions, your terminal voltage could be as low as 90 percent of whatever the nominal value is when it is running.

MR. VAN DE VENNE: All safeguards motors are designed for degraded conditions.

MR. WYLIE: Which would be around 90.

MR. VAN DE VENNE: Both in terms of voltage and frequency.

MR. WYLIE: For continuous operation?

MR. VAN DE VENNE: For continuous operation, yes.

Now, in some cases, and this is a bit utility-dependent, and I guess for a standard plant, we will have to think about this a little bit. But sometimes utilities specify degraded conditions for a limited period. For instance, they will say frequency could be plus or minus 1 percent continuous but it could be plus or minus 3 percent for say 30 minutes. And then we would have to specify, and the specification would have to address that. The motors would actually have to be sized for that.

MR. WYLIE: Well, your voltage --

MR. VAN DE VENNE: And this tends to vary from utility to utility.

MR. WYLIE: And the voltage varies also, because --

MR. VAN DE VENNE: The voltage varies also, right.

MR. WYLIE: because your grid floats up and down.

MR. VAN DE VENNE: Right.

MR. WYLIE: Some grids flow plus or minus 2 percent --

MR. VAN DE VENNE: Right.

MR. WYLIE: -- or something of that nature.

MR. VAN DE VENNE: Yes.

MR. WYLIE: But in this case also you are set up so that your normal power supply, and I don't disagree with it, I think it is a great way of doing things, is to use the generator breakers.

But that also inherently has a voltage drop associated with it when you are feeding back from the grid through the stepup transformer.

MR. VAN DE VENNE: All of that has to be addressed in the specifications.

MR. WYLIE: All of that has to be looked at.

MR. TREHAN: These Class 1A motors which are like needed for the reactors, they should be able to start at 75 percent of the voltage. It is not the running of the motor which is important, it is the starting the motor, when you take about six and a half times the load current, that is a problem, starting. So they are qualified to start at 75 percent of the voltage on Class 1A motors, and 90 percent of the voltage at non-Class 1A motors like reactor coolant pumps. Starting is a problem, not running.

MR. WYLIE: I understand the starting. It is 75 percent. But what about running voltage on say an injection pump or an RHR pump?

MR. TREHAN: See, they should be able to run for a longer time.

MR. WYLIE: Oh, yes, they should.

MR. TREHAN: But the starting is --

MR. WYLIE: Oh, I understand the starting. But my question was, there are certain degraded voltage conditions you have to meet on a continuous operation basis.

MR. TREHAN: Right.

MR. WYLIE: And have they taken this into account when they say that the motor rating will still meet the full load or max load?

MR. VAN DE VENNE: That has been taken into account in rating the motors. But I am not sure that we have taken the widest possible swings that could exist on some grids.

MR. WYLIE: You still have to develop some criteria for the application of motors and cables and all this stuff?

MR. VAN DE VENNE: Well, the one thing we have to decide is whether we are going to take an envelope condition, a very severe envelope condition, or buy motors on a case by case basis, and we would have to look at the standardization policy.

MR. WYLIE: In general, all your motors are air-cooled? Or they don't have water cooling?

MR. VAN DE VENNE: No. Some of the safety motors are water cooled.

MR. WYLIE: Water cooled, totally enclosed?

MR. VAN DE VENNE: Yes. Water jacket cooling.

MR. WYLIE: Okay.

MR. MICHELSON: My concept of standardization, I thought, and perhaps I am wrong, but I thought that the motor requirements have to be specified ahead of time no matter who you buy the motor from, and it isn't a case by case basis as to what kind of motor you buy, that is pre-prescribed. Who supplies it is not. But the requirements of the motor I thought were pre-prescribed for standardization.

MR. WYLIE: Well, I would think so. You can do it.

MR. MICHELSON: When you ge. to the FDA stage --

MR. WYLIE: You can do it. It is just a matter of setting the criteria.

MR. MICHELSON: I don't think under the policy though, that sort of thing was envisioned.

MR. VAN DE VENNE: The only reason I make this comment is because we have seen a lot of standard site specifications. But in the ones that I have seen, this particular item I have never seen covered. Like, you know, what at that site is the, for instance, the variation.

MR. MICHELSON: You haven't hit any standard designs yet.

MR. WYLIE: I would think that you need to develop that kind of criteria.

MR. VAN DE VENNE: Right. You need to.

MR. WYLIE: And I think that you need to develop what insulation systems you are using, whether it is a Class F, and you are using Class B rises, or whatever.

MR. VAN DE VENNE: My only concern on this issue would be, and I don't know that it is real, is that if you buy a motor say that is designed for 57 hertz and it runs at 60, it would deliver more, it would have more capability. And I don't know that you could take a wide swing and still meet all your other functions.

MR. WYLIE: Well, I wouldn't expect you would have to run continuously at a reduced frequency. That would be impractical, I think. But I think the voltage consideration is a real one.

MR. VAN DE VENNE: Yes.

MR. SHANNON: I would also agree that we will have to find a way if we don't know a way to specify the motor in an FDA design certification application in such a way that the manufacturer of the pump is transparent to that. The requirement for the motor would have to be specified, I think.

MR. WYLIE: Let me ask one other question. You have established certain design requirements for the balance of plant, such as the electric power system.

MR. VAN DE VENNE: Right.

MR. WYLIE: You are establishing that design criteria.

Are you doing anything on station grounding and lightning shielding and protection? It is a very important part of station design that, in my opinion, has not been done very well.

MR. VAN DE VENNE: The lighting and the communications in the nuclear power block, which is all the safety seismic category on buildings, would be, should be in the SAR, and there is some writeup on it, although --

MR. WYLIE: Lightning?

MR. VAN DE VENNE: Lighting and communications.

MR. WYLIE: Lightning.

MR. VAN DE VENNE: Lighting. Oh, you are talking about lightning.

MR. WYLIE: Lightning.

MR. VAN DE VENNE: Okay. I don't know whether that is in there or not. It's not in there.

MR. WYLIE: Well, this has presented a lot of problems in plants. Most recently, Braidwood. Braidwood in early October had a strike on the containment building. They say containment. It got into the control rod drive system. They dropped all the rods. But that is the third time this Summer that happened on that same plant.

MR. VAN DE VENNE: Is that right?

MR. WYLIE: But it has happened on numerous plants in the country. And it is an area that really needs some attention.

MR. WYLIE: I think that our view on that has been that that is a site characteristic up until this point, although I understand that --

MR. WYLIE: Well, not necessarily.

MR. VAN DE VENNE: -- maybe it is something that needs to be --

MR. WYLIE: Not necessarily. You can talk to your Japanese friends, because they wrote a standard about two years ago on lightning protection for nuclear power plants.

It is not just lightning protection. It is tied into the overall grounding protection being provided. It's as important as the lightning shielding and the lightning protection. They go hand in hand.

MR. TREHAN: Lightning protection is provided only at the main power transformer.

MR. WYLIE: Yes, but that doesn't do the job. That doesn't do the job in shielding against transient voltages in the plant, and that's where the problem is. I think you've made a major move in putting in the generator breaker, because you've located that connection between the step-up transformer and the main generator, which acts as a buffer against lightning interferences, but that's not the whole story.

MR. TREHAN: Every station has a ground grid. They have to do the calculation.

MR. WYLIE: I know, and how that's designed has a great influence on how well you protect against lightning.

MR. TREHAN: They don't have any requirements for that.

MR. WYLIE: No, they don't. That's my point.

MR. TREHAN: I understand your point.

MR. WYLIE: Okay. Anything else? Any other questions?

[No response.]

MR. WYLIE: Well, I'd like to thank Westinghouse for a very informative presentation, and I think we have a pretty good idea of what you're about, and with that, I'll call the meeting adjourned.

[Whereupon, at 4:00 p.m., the meeting was adjourned.]

REPORTER'S CERTIFICATE

This is to certify that the attached proceedings before the United States Nuclear Regulatory Commission

in the matter of: ACRS

NAME OF PROCEEDING: Subcommittee on Advanced Pressurized Water Reactors

DOCKET NUMBER:

PLACE OF PROCEEDING:

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.

Dean A. Robinson

DEAN A. ROBINSON
Official Reporter
Ann Riley & Associates, Ltd.

W ADVANCED PWR

BRIEFING ON

RESAR-SP/90

ACRS SUBCOMMITTEE

ON ADVANCED PWRs

November 3, 1989

W RESAR-SP/90
ACRS SUBCOMMITTEE ON APWRs

PURPOSE

- REVIEW THE STATUS OF THE NRC SAFETY EVALUATION OF RESAR-SP/90 PARTICULARLY WITH RESPECT TO THE STANDARD REVIEW PLAN FOR FSAR CHAPTERS 3, 4, 5, 6 & 8, AND THE DSER OPEN ISSUES RELATIVE TO THOSE CHAPTERS.

- CHAPTERS 7, 9, 10, 11, 12, 15, 17 & 18 WILL BE COVERED AT THE NEXT SUBCOMMITTEE MEETING.

- COVERAGE OF CHAPTERS 1, 2, 13, 14 & 16 IS NOT ANTICIPATED AS PART OF THE ACRS REVIEW FOR THE PDA.

W RESAR-SP/90

ACRS SUBCOMMITTEE ON APWRs

LIST OF ACRS/W RESAR-SP/90 MEETINGS

3/23/82	SUBCOMMITTEE ON SAFEGUARDS AND SECURITY (ALBURQUERQUE)
5/5/83	WESTINGHOUSE SUBCOMMITTEE
8/10/83	WESTINGHOUSE SUBCOMMITTEE
9/25/86	WESTINGHOUSE SUBCOMMITTEE
11/6/87	FULL-COMMITTEE -ACRS 12 RECOMMENDATIONS OF JAN. 15 LETTER
4/6/88	ADVANCED PLANT SUBCOMMITTEE -REVIEW OF DRAFT SER ON PROBABILISTIC SAFETY STUDY
9/28/89	ACRS SUBCOMMITTEE ON APWRs -REVIEW OF DRAFT SERs -SEVERE ACCIDENT ISSUES
11/3/89	ACRS SUBCOMMITTEE ON APWRs -REVIEW OF DRAFT SER CHAPTERS 3, 4, 5, 6 & 8
*12/x/89	ACRS SUBCOMMITTEE ON APWRs -REVIEW OF DRAFT SER REMAINING SRP SECTIONS
*1/x/90	ACRS FULL COMMITTEE -REVIEW OF DRAFT SER

* - NOT SCHEDULED, SUBJECT TO CONFIRMATION BY STAFF & ACRS

N3:14

W RESAR-SP/90

ACRS SUBCOMMITTEE ON APWRs

DRAFT SAFETY EVALUATIONS REPORTS

		RESPONSE STATUS
PRA FRONT END (MARCH 21, 1988)	• ACRS SUBCOMMITTEE MEETING ON APRIL 6, 1988	8/31/89
	• PDA OPEN ISSUE 107	
AUXILIARY REVIEW (JUNE 10, 1988)	• 7 OPEN ITEMS	
SYSTEMS REVIEW (MARCH 9, 1989)*	• 40 PDA OPEN ISSUES PLANT/REACTOR/AUXILIARY SYSTEMS	6/9/89
	• 41 PDA OPEN ISSUES STRUCTURAL/MECHANICAL SYSTEMS	6/28/89
	• 26 PDA OPEN ISSUES TRANSIENT ANALYSES/SINGLE FAILURE	8/31/89
PRA BACK END	NOT RECEIVED	
USIs/GSIs	• USIs & HIGH/MEDIUM GSIs SUBMITTED	5/23/88

* INCLUDES 7 OPEN ISSUES FROM JUNE 1988 DSER

MEETING AGENDA
NOVEMBER 3 ACRS SUBCOMMITTEE

RESAR-SP/90 PDA OPEN ISSUES

8:30 - 8:40	ACRS OPENING REMARKS	J.C. CARROLL
8:40 - 8:50	STAFF INTRODUCTION	L. DONATELL
8:50 - 9:00	W INTRODUCTION	M.H. SHANNON
9:00 - 10:00	CHAPTER 3 DESIGN OF STRUCTURES, COMPONENTS, EQUIPMENT & SYSTEMS	R.S. ORR
10:00 - 10:15	--BREAK--	
10:15 - 11:15	CHAPTER 3 (CONTINUED)	R.S. ORR
11:15 - 12:00	CHAPTER 4 REACTOR SYSTEM	J.V. MILLER
12:00 - 1:00	--LUNCH BREAK--	
1:00 - 2:30	CHAPTER 5 REACTOR COOLANT SYSTEM	T.VAN DE VENNE R.M. WILSON
2:30 - 2:45	--BREAK--	
2:45 - 3:45	CHAPTER 6 ENGR. SAFETY FEATURES	T.VAN DE VENNE
3:45 - 4:15	CHAPTER 8 ELECTRIC POWER	T.VAN DE VENNE
4:15 - 5:15	STAFF DISCUSSION OF OPEN ISSUES	

N6:14

W RESAR-SP/90
ACRS SUBCOMMITTEE ON ADVANCED PWRs

CATEGORIZATION OF DSER OPEN ISSUES

1) W HAS PROVIDED ADDITIONAL CLARIFICATION

   o W BELIEVES RESPONSE PROVIDES ADEQUATE BASIS TO RESOLVE ISSUE.

2) W HAS REVISED APPLICATION TO REFLECT NRC STAFF POSITION

   o ISSUE SHOULD THEREFORE BE RESOLVED

3) W HAS ADOPTED CURRENT INDUSTRY CODES AND STANDARDS THAT DIFFER FROM PAST PRACTICE. NRC HAS NOT TAKEN POSITION ON THESE NEW CODES AND STANDARDS

   o NRC IS REVIEWING W POSITIONS ON A CASE BY CASE BASIS; THIS REVIEW NEEDS TO BE COMPLETED

4) NRC HAD NOT COMPLETED REVIEW OF INFORMATION IN RESAR-SP/90 AT TIME OF ISSUE OF DSER

   o NRC REVIEW NEEDS TO BE COMPLETED TO DETERMINE IF THERE IS ANY ISSUE TO BE RESOLVED

5) W HAS PROVIDED ADDITIONAL INFORMATION TO JUSTIFY APPROACH

   o POTENTIAL DISAGREEMENT WITH NRC STAFF

Categorization of DSER Open Issues 1 - 107

Categories:

1)	Clarification provided by W	62
2)	Revised to reflect NRC Staff position	22
3)	New methods not reviewed by NRC	2
4)	NRC review not completed at DSER issuance	13
5)	Potential disagreement with NRC Staff	8
		Total=107

Categorization[1]:

Open Issue	Category	Open Issue	Category	Open Issue	Category
1	1	37	1	73	1
2	4	38	1	74	1
3	3	39	5	75	1
4	5	40	1	76	1
5	1	41	1	77	4
6	2	42	4	78	4
7	4	43	4	79	2
8	4	44	4	80	2
9	2	45	2	81	1
10	2	46	2	82	1
11	2	47	1	83	1
12	5	48	1	84	1
13	5	49	2	85	1
14	2	50	2	86	1
15	2	51	1	87	1
16	1	52	1	88	1
17	2	53	1	89	1
18	2	54	1	90	1
19	1	55	2	91	1
20	1	56	4	92	1
21	1	57	4	93	1
22	1	58	5	94	1
23	4	59	1	95	1
24	1	60	1	96	1
25	3	61	1	97	2
26	1	62	2	98	1
27	1	63	2	99	1
28	1	64	1	100	1
29	2	65	1	101	1
30	1	66	5	102	1
31	2	67	2	103	1
32	1	68	1	104	4
33	1	69	2	105	4
34	1	70	1	106	1
35	1	71	1	107	5
36	5	72	1		

1) This list represents Westinghouse's perception of what category best reflects the current status of each open issue.

ACRS ADVANCED PWR SUBCOMMITTEE MEETING

NOVEMBER 3, 1989

REVIEW OF WESTINGHOUSE SP/90

CHAPTER 3
STRUCTURAL/EQUIPMENT DESIGN

B2:15

Chapter 3 - Design of Structures, Components, Equipment and Systems

Categorization of DSER Open Issues 1 - 41

Categories:

1)	Clarification provided by W	20
2)	Revised to reflect NRC Staff position	10
3)	New methods not reviewed by NRC	2
4)	NRC review not completed at DSER issuance	4
5)	Potential disagreement with NRC Staff	5
	Total=	41

OPEN ISSUE NUMBER 4 Category 5

SAFETY CLASSIFICATION OF SAFETY RELATED INSTRUMENT LINES

DSER (March 1989) Section 3.2.2, page 3-4

BACKGROUND

Regulatory Guide 1.151 requires that instrument sensing lines that are connected to ASME Class 2 and 3 process piping and are used to actuate or monitor safety related systems should be constructed to ASME Class 2 or 3 requirements.

Since issue of the DSER Westinghouse have committed that safety related instrument lines will be designed and constructed to ASME III requirements.

Westinghouse has proposed that supports will be designed and constructed to requirements for Seismic Category I structures and not to ASME-NF. This position is identical to that taken in the EPRI ALWR Requirements This eliminates the need for ASME certified Material Suppliers for tube supports as well as the Authorized Nuclear Inpector and N-5 Data Reports.

WESTINGHOUSE POSITION

Westinghouse's position is the same as that taken in the EPRI ALWR Requirements Document being reviewed by NRC. Westinghouse have committed to adopt final NRC/EPRI resolution and will revise position if necessary in the FDA application.

NRC POSITION

Not known

RESAR SP90 RESOLUTION APPROACH

It is proposed that this issue be deferred to the FDA stage, at which time the NRC and EPRI are expected to have agreed on a resolution.

OPEN ISSUE NUMBER 12. Category 5

POSTULATED BREAKS IN ASME CLASS 1 PIPING

DSER (March 1989) Section 3.6.2, page 3-16

BACKGROUND

Standard Review Plan 3.6.2 was revised in 1987. The 1981 and 1987 editions require that pipe breaks are postulated to occur at intermediate locations in Class 1 piping runs as follows:

> "...where the maximum stress range as calculated by equation (10) and either (12) or (13) exceeds 2.4 Sm." (SRP, July,1981)
>
> "...where the maximum stress range as calculated by equation (10) exceeds 2.4 Sm." (SRP, June, 1987)

The 1987 revision was published as a draft for comment in the Federal Register of 12/3/86. Based on discussions with the staff and their consultants at the time, the revision was intended to simplify the engineering calculations without resulting in more pipe rupture locations. It also incorporated reference to revised ASME code equations.

By deleting "... and either equation (12) or (13).." from the requirement, the revision results in requiring more pipe rupture locations since there are cases where the stresses exceed 2.4 Sm in equation (10) but not in equation (12) or (13).

Comments on the draft by Westinghouse identified that the revision increases the conservatism and recommended that the former requirements should be retained. The response was included in the Federal Register of 6/19/87. It acknowledged that the revision could lead to more pipe rupture locations. The response goes on to say that the revision would have minimal impact since it will apply only to Class 1 piping in future designs where demonstration of leak-before-break is expected to be successful in many situations.

Westinghouse expects to be able to demonstrate leak-before-break for all ASME Class 1 piping greater than 6 inches in diameter. It is not expected that the smaller piping will be qualified to LBB. Thus, the SRP revision is significant for piping equal or less than 6" in diameter. Imposition of the new criterion will result in more pipe rupture locations and corresponding increases in the pipe rupture protection analyses and hardware.

WESTINGHOUSE POSITION

Westinghouse believes the criteria in the 1981 SRP to provide adequate assurance and therefore have not committed to the more stringent requirements of the 1987 SRP which were provided to simplify the pipe rupture evaluations.

NRC STAFF POSITION

NRC staff are requiring use of the 1987 SRP.

RESAR SP90 RESOLUTION APPROACH

NRC should take a position on whether the requirements of the 1981 SRP represent an acceptable alternative to the 1987 requirements.

OPEN ISSUE NUMBER 13. Category 5

CLASSIFICATION OF NON-ASME CLASS PIPING

DSER (March 1989) Section 3.6.2, page 3-16

BACKGROUND

SRP 3.6.2 permits locations in non-ASME high energy piping to be defined at intermediate locations based on the results of stress analyses including seismic loads.

A typical example of piping that could be evaluated in this manner would be the steam generator blowdown system, portions of which are classifed as NNS and would normally be designed and constructed to ANSI B31.1.

WESTINGHOUSE POSITION

Westinghouse position is that the ANSI B31.1 piping code supplemented by dynamic seismic analyses provides a sufficient basis to predict the potential locations of pipe rupture and that it is not necessary to impose full Seismic Category I requirements on the piping. Such systems are classified as Seismic Category II and are designed to maintain their structural integrity during the SSE.

NRC STAFF POSITION

NRC staff's position is that piping should be classifed as Seismic Category I if credit is taken for the seismic analysis in determining pipe rupture locations.

RESAR SP90 RESOLUTION APPROACH

To be determined.

OPEN ISSUE NUMBER 36 Category 5

PIPE SUPPORT BASEPLATE AND ANCHOR BOLT DESIGN (IE Bulletin 79-02)

DSER (March 1989) Section 3.9.3.1, page 3-40

BACKGROUND

IE Bulletin 79-02 addresses non-ductile expansion anchors (wedge and sleeve anchors). This requires a safety factor of 4.0 on SSE loads.

Ductile expansion anchors (undercut) have been developed that assure a steel failure rather than the concrete pull-out or slip that occurs in non-ductile expansion anchors. The ductile expansion anchors thus perform in the same manner as a cast-in-place anchor bolt. These anchors were not in use in nuclear power plants at the time that IEB 79-02 was issued.

DSER Open Issue applies to all expansion anchors. Since issue of DSER, Westinghouse have committed to meet IEB 79-02 for non-ductile expansion anchors. Remaining issue relates to the ductile expansion anchors.

WESTINGHOUSE POSITION

Westinghouse have proposed use of ACI-349 Appendix B for ductile expansion anchors. Appendix B uses strength design and limits load in steel to 0.81 times yield. The allowable limit of 0.81 times yield is more conservative than that permitted for Category I steel structures (0.96 times yield), and that permitted by ASME III, Subsection-NF (lesser of yield or 0.70 times ultimate).

NRC STAFF POSITION

The staff position is currently that ductile expansion anchors should meet the safety factor of 4.0 required by IEB 79-02. This position discourages use of the ductile anchor which is generally recognised to be a significant design improvement and should be encouraged.

RESAR SP90 RESOLUTION APPROACH

This issue is a generic issue that needs to be resolved for new plants as well as for modifications being performed at operating plants. Westinghouse will continue to support industry attempts to get this issue resolved and will adopt the industry resolution. If no resolution is reached at the time that Westinghouse would commence utilization of these anchors in plant construction, Westinghouse will follow NRC's requirement of a safety factor of 4.0 on both non-ductile and ductile anchors, if used.

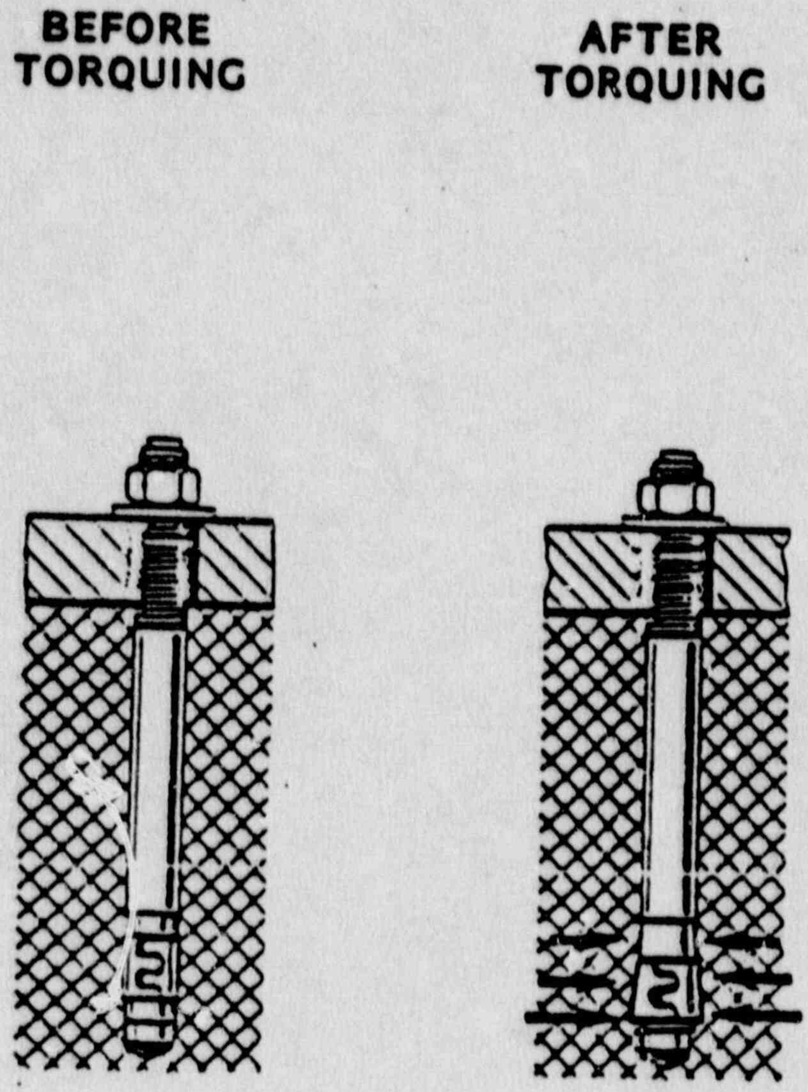


FIGURE 2.15

WEDGE ANCHOR

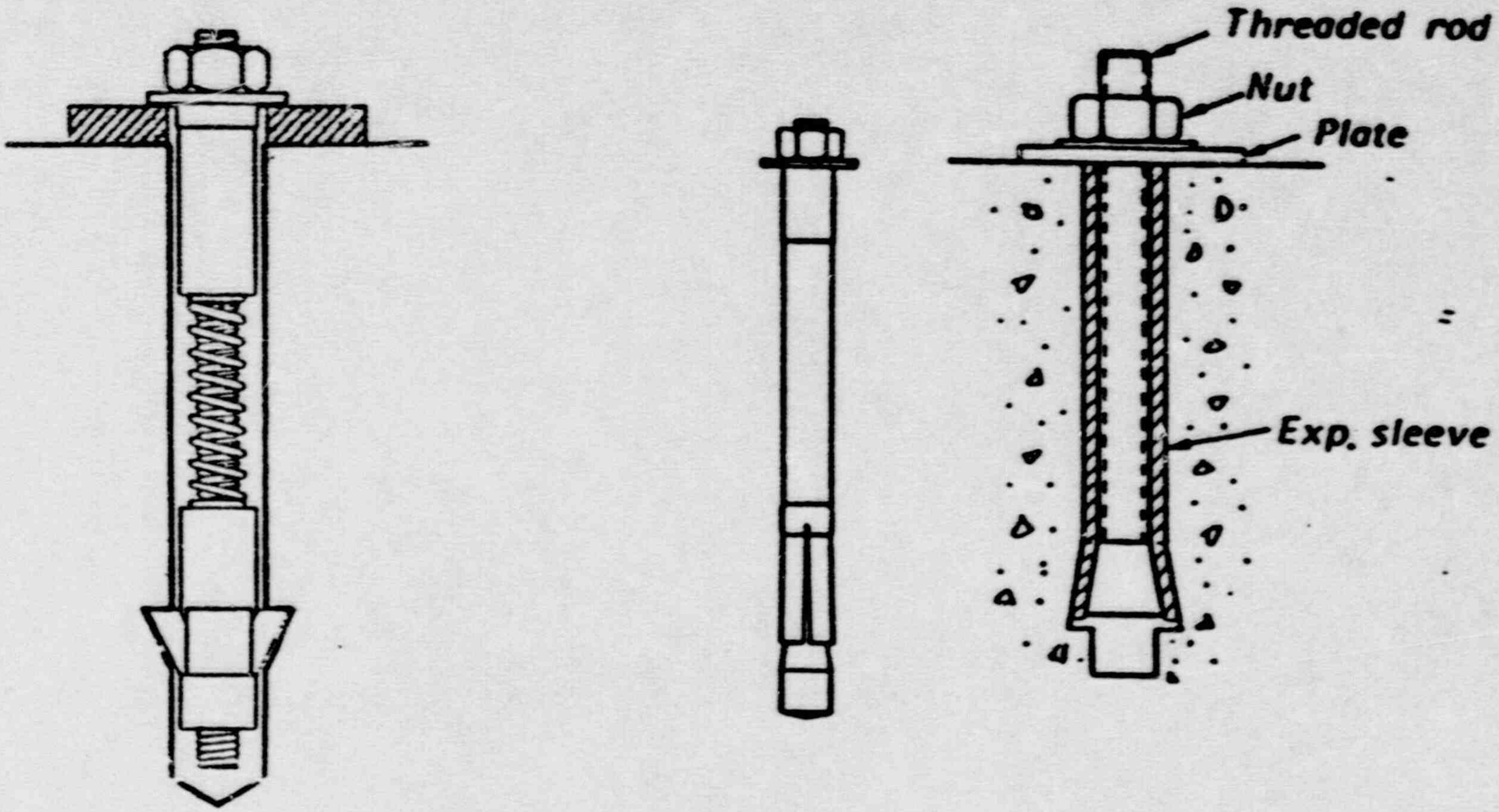


FIGURE 2.20

UNDERCUT ANCHOR

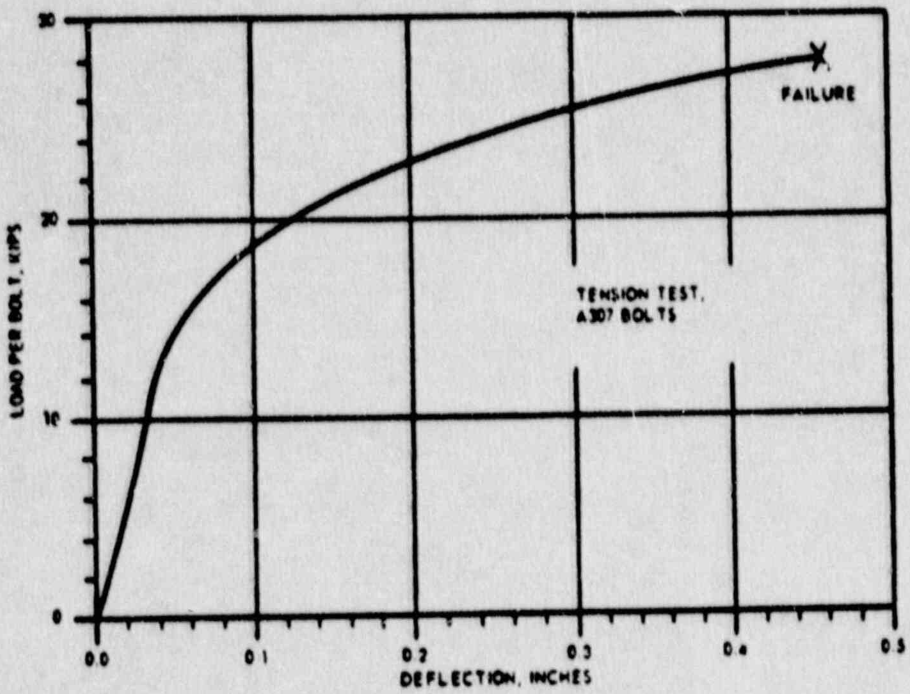


Fig. B-8—Ductile load deflection behavior

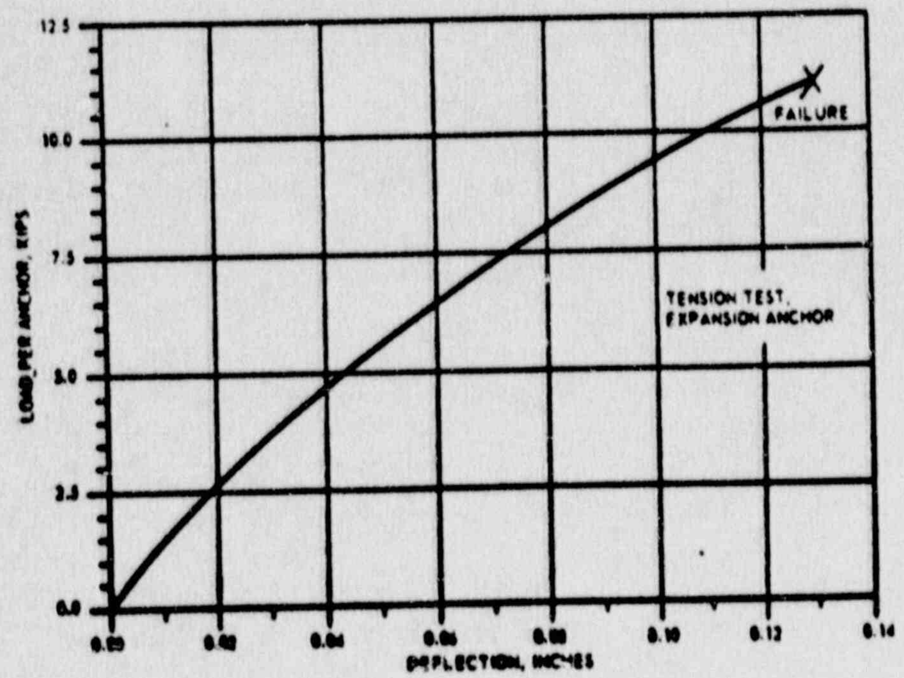
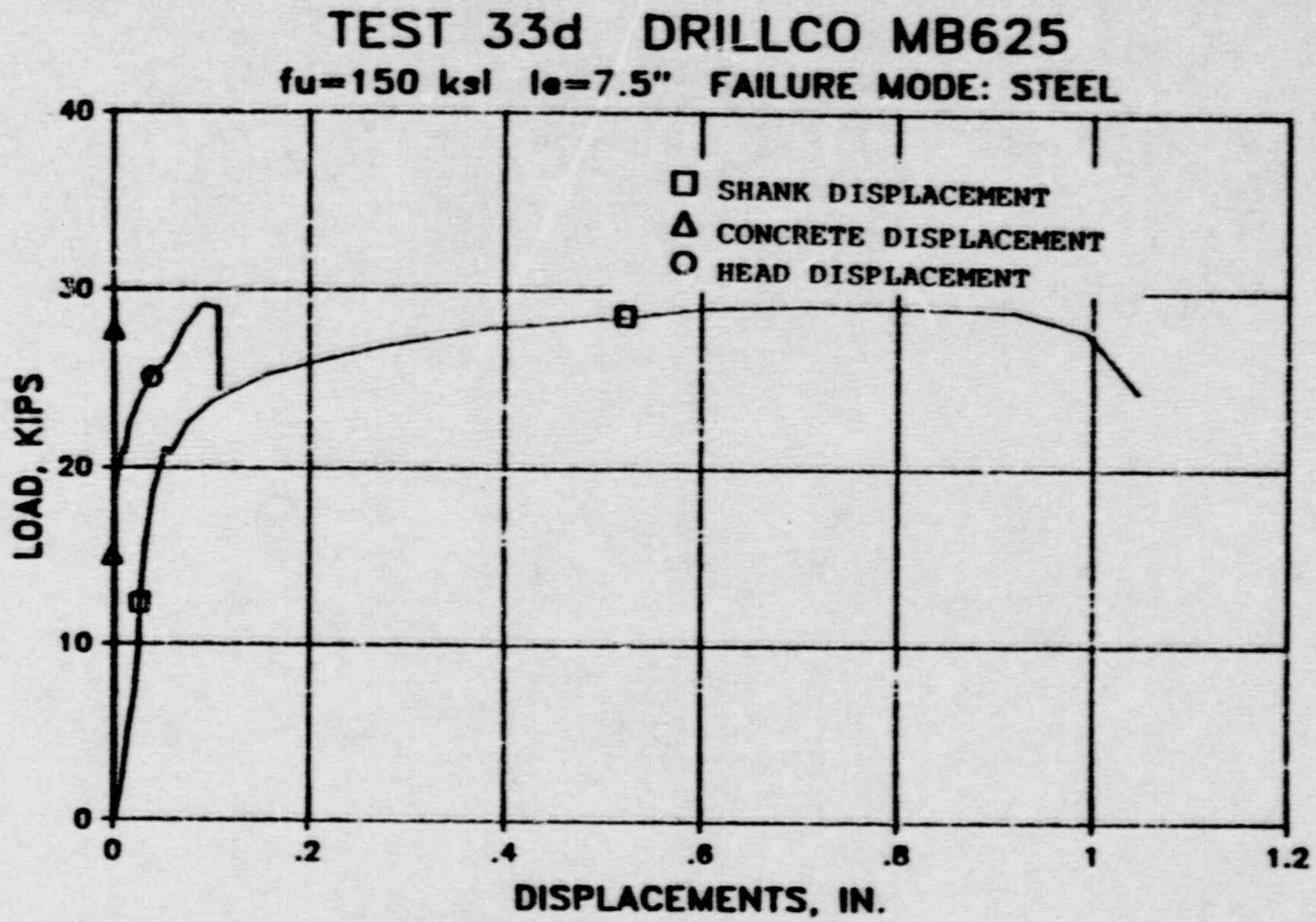


Fig. B-9—Non-ductile load deflection behavior


TEST 33d DRILLCO MB625
fu=150 ksi le=7.5" FAILURE MODE: STEEL
SHANK DISPLACEMENT
CONCRETE DISPLACEMENT
HEAD DISPLACEMENT
LOAD, KIPS
DISPLACEMENTS, IN.
0
10
20
30
40
.2
.4
.6
.8
1
1.2

ACI APPENDIX B
DESIGN STRENGTH OF DUCTILE EXPANSION ANCHOR

- TYPICAL UNDERCUT ANCHOR USES A 193-B7 MATERIAL
  - MINIMUM ULTIMATE TENSILE STRESS = 125 KSI
  - MINIMUM YIELD STRESS = 105 KSI
- ACI 349 APPENDIX B REQUIRES THAT ANCHORAGE DESIGN BE CONTROLLED BY THE STRENGTH OF THE EMBEDMENT STEEL (NOT BY THE CONCRETE)
- PULL OUT STRENGTH OF THE CONCRETE MUST EXCEED THE MINIMUM TENSILE STRENGTH OF THE STEEL
- DESIGN LOAD IS LIMITED TO 0.9 x 0.9 x YIELD = 85 KSI FOR A 193-B7 MATERIAL
- FACTOR OF SAFETY ON MINIMUM SPECIFIED TENSILE STRENGTH = 125 ÷ 85 = 1.47

OPEN ISSUE NUMBER 2 AND 3 Category 3 AND 4

REVIEW OF FLOW DIAGRAMS SHOWING QUALITY GROUP CLASSIFICATIONS
QUALITY GROUP CLASSIFICATIONS OF STRUCTURES SYSTEMS AND COMPONENTS

DSER (March 1989) Section 3.2.1 & 2, page 3-2 & 3

BACKGROUND

Westinghouse have submitted an application for a plant satisfying current codes and standards. In particular, the application utilizes ANSI/ANS 51.1-1983 "Nuclear Safety Criteria for the Design Of Stationary Pressurized Water Reactor Plants" which has replaced the prior standard ANS 18.2. This new standard has not been reviewed and endorsed by the staff.

Following discussions NRC agreed to the use of the latest standard for pressure-retaining systems and components. Westinghouse agreed to use the prior classifications for non-presssure retaining systems and components. Clarifications have been provided to the staff based on this agreement.

WESTINGHOUSE POSITION

Westinghouse intend that the SP90 plant should meet current codes and standards, and will continue to work with NRC staff and industry standards committees to resolve the issue.

NRC STAFF POSITION

NRC staff have no resources assigned to determining generic positions on new or revised codes and standards and continue to review changes on a case by case basis. In many cases this means that they use positions that are inconsistent with the latest codes.

RESAR SP90 RESOLUTION APPROACH

Westinghouse will continue to work with NRC staff and industry committees to resolve this issue. NRC review of the proposed classification and flow diagrams should be completed.

OPEN ISSUE NUMBERS 7 and 8 Category 4

INTERNALLY GENERATED MISSILES INSIDE AND OUTSIDE CONTAINMENT

DSER (March 1989) Section 3.5.1.1 & 2, page 3-9 & 10

BACKGROUND

NRC staff requested additional information (QU.430.4-7). Westinghouse submitted a response in their letter of June 14, 1988 and included this response in the January, 1989 amendment to RESAR SP90. At the time of the DSER, NRC was reviewing this information and stated that the evaluation would be given in the final SER.

WESTINGHOUSE POSITION

No action required until NRC review is completed.

NRC STAFF POSITION

Not known

RESAR SP90 RESOLUTION APPROACH

To be determined.

OPEN ISSUE NUMBER 23 Category 4

LIMITED DESIGN AUDIT OF CONTAINMENT DESIGN

DSER (March 1989) Section 3.8.1, page 3-23

BACKGROUND

The SP90 containment is a spherical steel containment vessel. Containment design has been performed sufficiently to establish the overall dimensions and general plate thickness. These overall parameters will be incorporated in the ASME Design Specification together with the design criteria documented in RESAR SP90 and all design loadings. As identified in RESAR SP90, it is Westinghouse's intention that the containment be constructed in accordance with ASME requirements. Thus, the design as well as the construction will be performed by a containment vessel supplier.

WESTINGHOUSE POSITION

Westinghouse proposes that the limited design audit be deferred until there is sufficient design information to demonstrate the design configuration and details. This would occur a few months after placement of the purchase order for the containment vessel.

NRC STAFF POSITION

The DSER states: "The staff cannot accept a standard design of containment without performing a design audit or reviewing a structural integrity test. The staff will perform a limited design audit before the PDA is issued."

RESAR SP90 RESOLUTION APPROACH

The limited design audit should be performed prior to FDA and/or the first plant specific Construction Permit.

OPEN ISSUE NUMBER 25 Category 4

ANALYSIS STANDARD FOR TIME HISTORY SOLUTIONS AND RESPONSE SPECTRUM ANALYSIS

DSER (March 1989) Section 3.9.3.2, page 3-31

BACKGROUND

Westinghouse have submitted an application for a plant satisfying current codes and standards. In particular, the application utilizes ASCE 4-86 "Seismic Analysis of Safety Related Nuclear Structures" which provides requirements for seismic analyses of structures. This new standard has not been reviewed and endorsed by the staff. Generally the requirements are compatible with those in the Standard Review Plan, but there are a few areas where the requirements differ from existing staff positions.

Following discussions with NRC staff, the staff agreed to further review the standard to determine a final position in the SP90 design.

Some of the areas where the standard does not match existing staff positions are being changed by the staff generally following the requirements incorporated in the ASCE 4-86 standard. Changes are in process of being incorporated in the Standard Review Plan. It is believed that these changes will make it easier to resolve this issue.

WESTINGHOUSE POSITION

Westinghouse wish to use the latest industry standard for seismic analysis since it provides a comprehensive set of requirements.

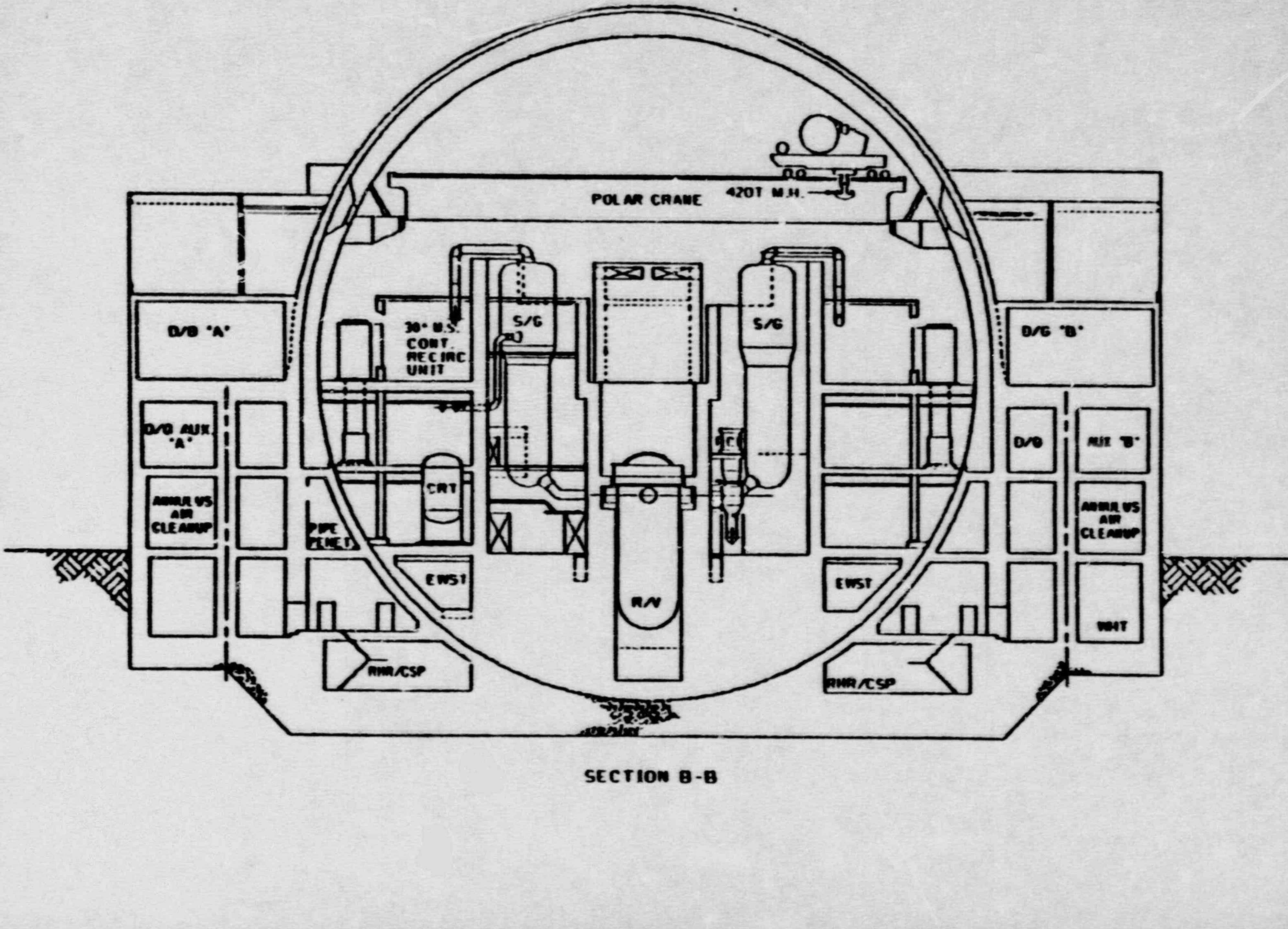
NRC STAFF POSITION

NRC staff have no resources assigned to determining generic positions on new or revised codes and standards and continue to review changes on a case by case basis. In many cases this means that they use positions that are not consistent with the latest codes.

RESAR SP90 RESOLUTION APPROACH

Westinghouse will continue to work with NRC staff and industry committees to resolve this issue. Westinghouse will address those areas of the standard that are identified by teh staff as unacceptable for the SP90.

W APWR



SECTION B-B

Category 2 Open Issues - RESAR Revised to Reflect NRC Staff Position

DSER Open Issue 6: Tornado loadings--maximum wind speed (3.3.2).

DSER Open Issue 9: Local and overall damage predictions (3.5.3).

DSER Open Issue 10: Maximum concrete thickness for barrier design (3.5.3).

DSER Open Issue 11: Ductility ratio (3.5.3).

DSER Open Issue 14: Compliance with Branch Technical Position (BTP) MEB 3-1 (3.6.2).

DSER Open Issue 15: Pressure test of guard pipe (3.6.2).

DSER Open Issue 17: Dynamic load factor for pipe whip restraints (3.6.2).

DSER Open Issue 18: Design of pipe rupture restraints (3.6.2).

DSER Open Issue 29: Combination of inertial responses and seismic anchor movements (3.9.2.3).

DSER Open Issue 31: Flow-induced vibration testing for non-prototype plants (3.9.2.3).

Chapter 3 - Design of Structures, Components, Equipment and Systems

Category 1 Open Issues - Clarification Provided by W

DSER Open Issue 1: Interface criteria for structural design features (3.1).

DSER Open Issue 5: Quality group classification of reactor internals (3.2.2, 3.9.5).

DSER Open Issue 16: Limits of break exclusion area for ASME Class 2 piping (3.6.2).

DSER Open Issue 19: Synthesized time histories (3.7.1).

DSER Open Issue 20: Soil damping model (3.7.1, 3.7.2).

DSER Open Issue 21: Inservice inspection program for seismic instrumentation (3.7.3).

DSER Open Issue 22: Containment design criteria (3.8.1).

DSER Open Issue 24: Description of FATCON and WESAN computer programs (3.9.1).

DSER Open Issue 26: Combination of closely spaced modes in seismic response analysis (3.9.2.2).

DSER Open Issue 27: High-frequency modes in seismic response analysis (3.9.2.2).

DSER Open Issue 28: Representative maximum modal response in seismic response spectrum analysis (3.9.2.2).

Chapter 3 - Design of Structures, Components, Equipment and Systems

Category 1 Open Issues - Clarification Provided by W

DSER Open Issue 30: Damping values for systems with flexible in-line building-mounted equipment (3.9.2.2).

DSER Open Issue 32: Flow-induced vibration testing without dummy core (3.9.2.3).

DSER Open Issue 33: Design of reactor internals (3.9.2.3).

DSER Open Issue 34: Stress limits for Class 2 and Class 3 valves (3.9.3.1).

DSER Open Issue 35: Design criteria for heating, ventilation, and air conditioning (HVAC) ductwork and supports (3.9.3.1).

DSER Open Issue 37: Thermal stratification in unisolable piping (3.9.3.1).

DSER Open Issue 38: Preservice/Inservice pump and valve test program (3.9.6).

DSER Open Issue 40: Conformance with Institute of Electrical and Electronics Engineers (IEEE) Standard 344-1987 and Regulatory Guide 1.100, Revision 2 (3.10.1, 3.10.2).

DSER Open Issue 41: Equipment qualification (3.11)

ACRS ADVANCED PWR

SUBCOMMITTEE MEETING

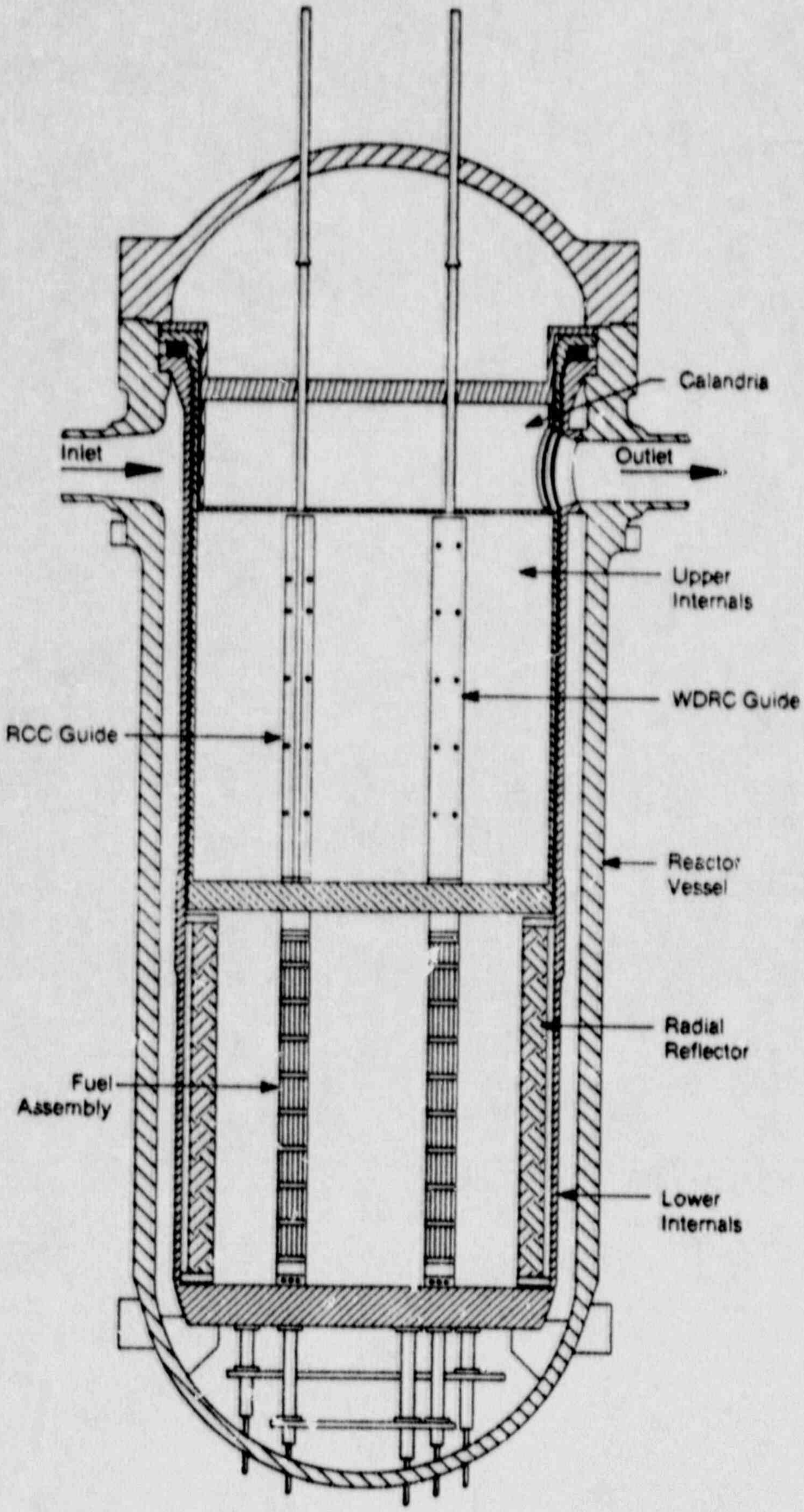
NOVEMBER 3, 1989

REVIEW OF WESTINGHOUSE SP/90

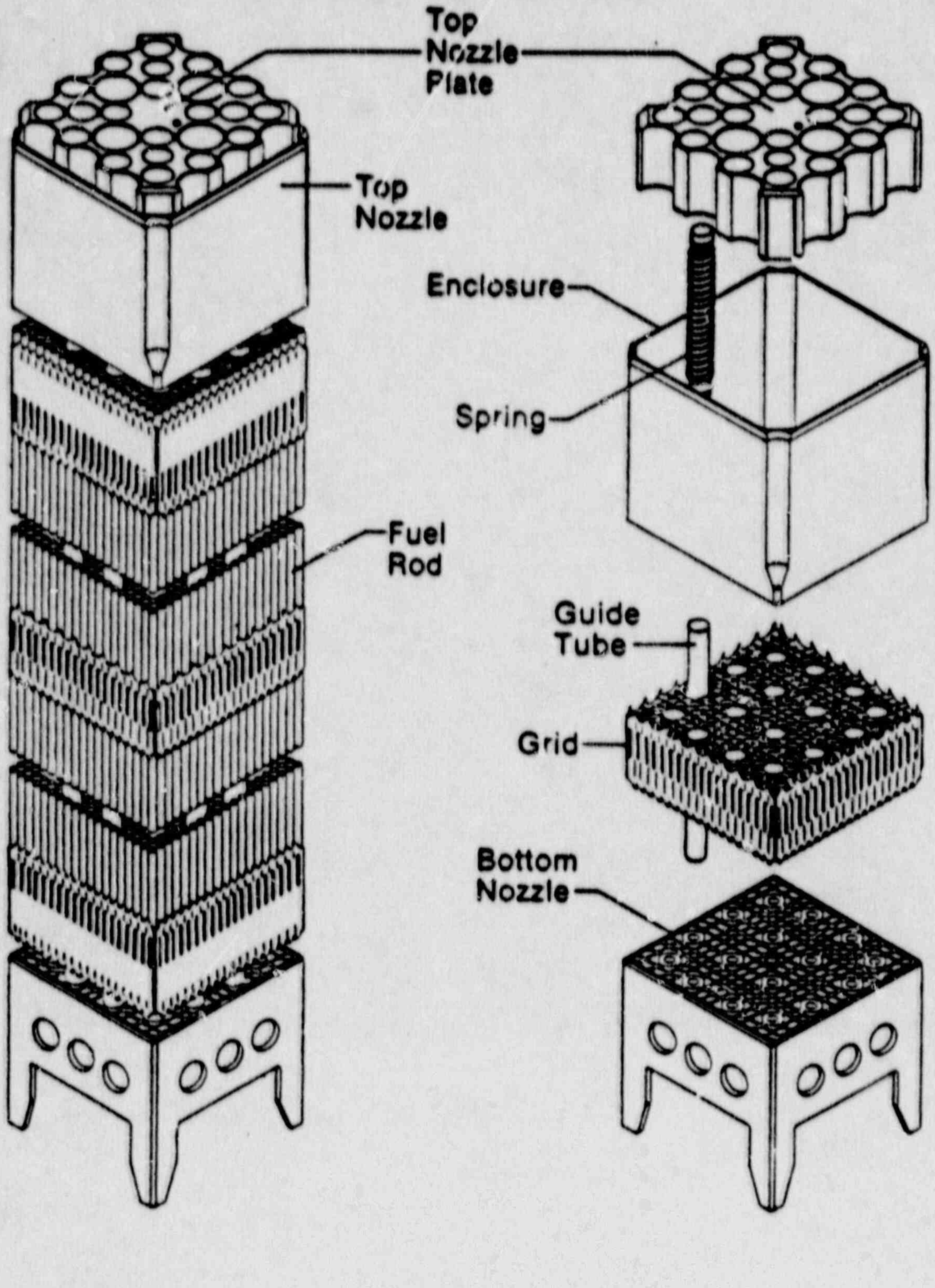
CHAPTER 4 - REACTOR SYSTEM

B2:15

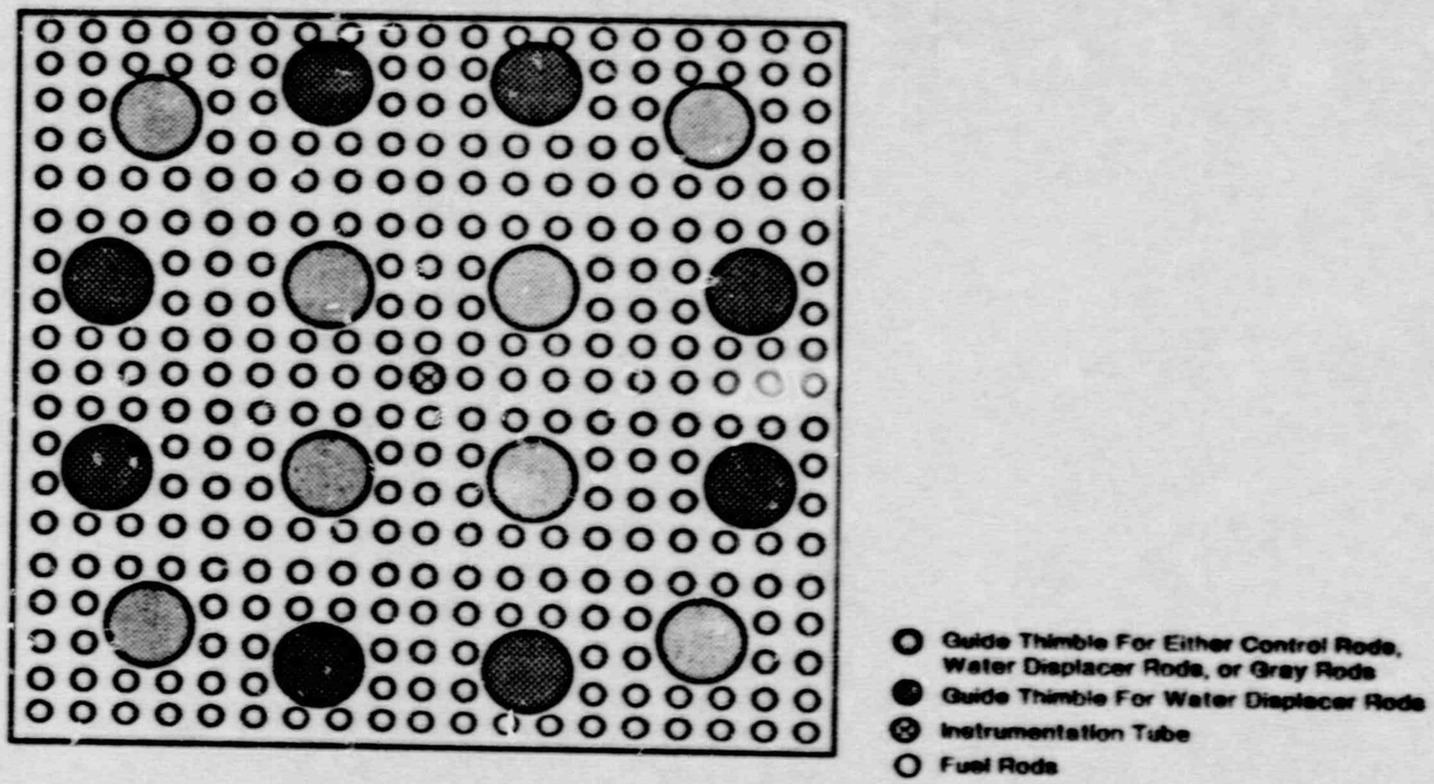
APWR REACTOR



APWR
FUEL ASSEMBLY

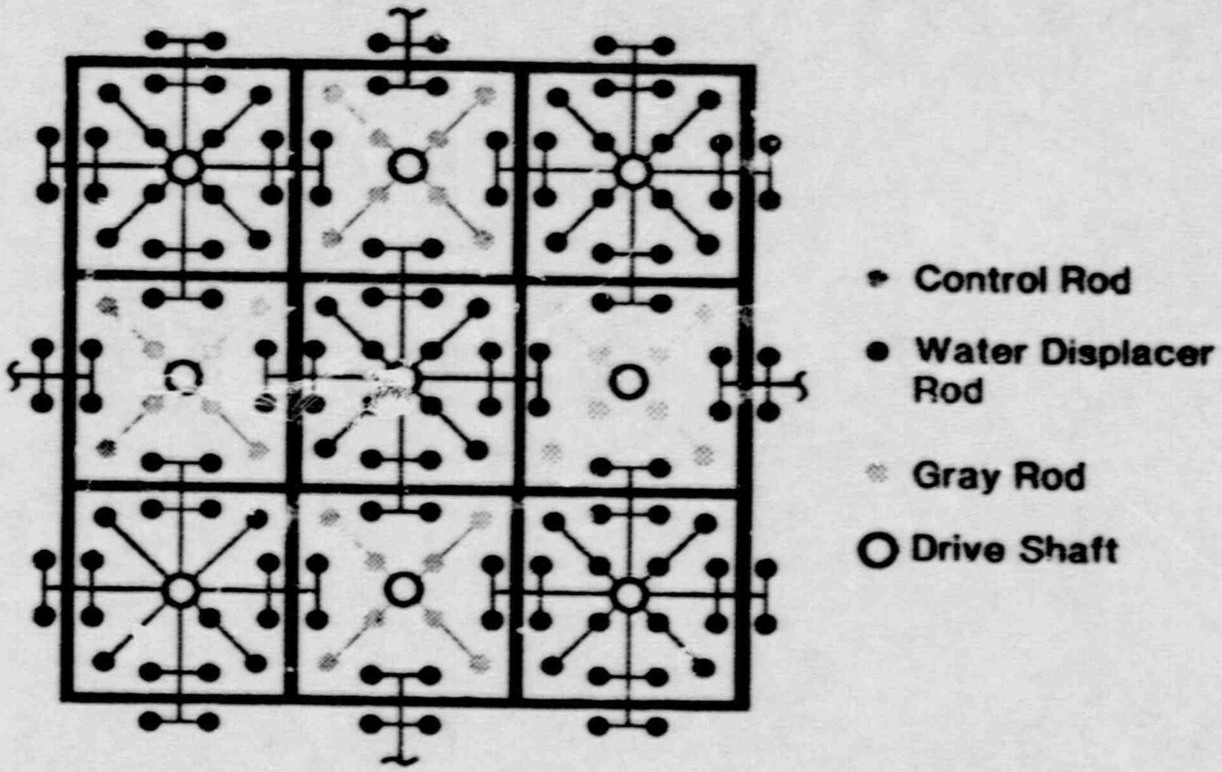


FUEL ASSEMBLY CROSS SECTION
19 x 19 / 16 (2x2)



OCT 92

TYPICAL ROD CLUSTER ARRANGEMENT
19x19/16 (2x2)



656 D009274.001

APWR REACTOR

- Reduced specific power (kw/kg)
  - Fuel cost
  - Design margins
- Moderator control
  - Fuel cost
  - Availability (long fuel cycles)
- Radial neutron reflector
  - Fuel cost
  - Reactor vessel fluence
- Gray rods
  - Load follow
  - Fuel cost

1067 D19862.001

REDUCED SPECIFIC POWER (KW/KG)
(Low Power Density)

- Number of fuel zones is increased for same discharge burnup
- Feed fuel loading (MTU) is maintained, while feed enrichment is reduced
- Allows 3-zone core for 18 month cycles
- Increases design margins (LOCA, DNB, NVT)
- Higher margins provide operating flexibility

POWER DENSITY COMPARISON

	412	APWR
Core thermal power (MWt)	3411	3823
Number of fuel assemblies	193	193
Fuel rods per assembly	264	296
Active core length (in)	144	153.5
Core loading (MTU)	81.8	119.2
Equivalent core diameter (in)	133	157
Average linear power (kW/ft)	5.4	5.1
Average specific power (kW/kg)	41.7	32.1

1160 D23240.002

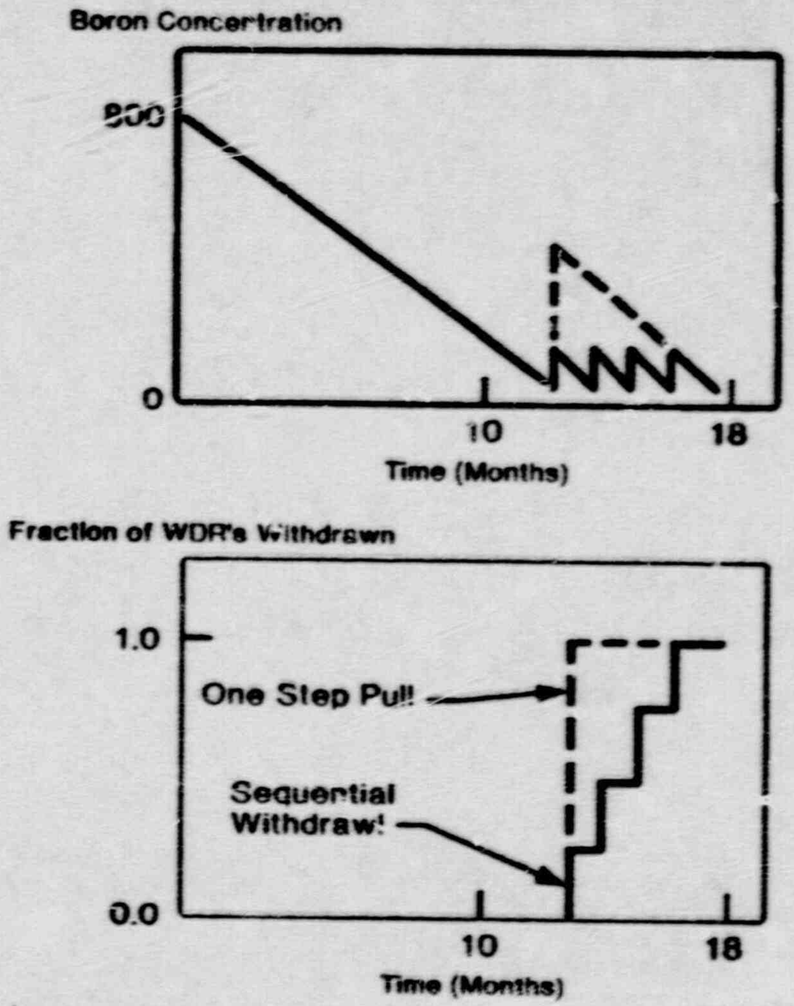
MODERATOR CONTROL
GENERAL CONCEPT

- A portion of the core water volume is displaced during the first part of the cycle
  - Decreased neutron moderation
  - Increased neutron absorption in U-238
  - Increased PU production
- When the boron concentration nears 0 PPM, the displaced water is returned either gradually or at one time
  - Increased neutron moderation
  - PU production rate slows
  - Fissile material burned more efficiently
- Feed enrichments are reduced for the same energy output

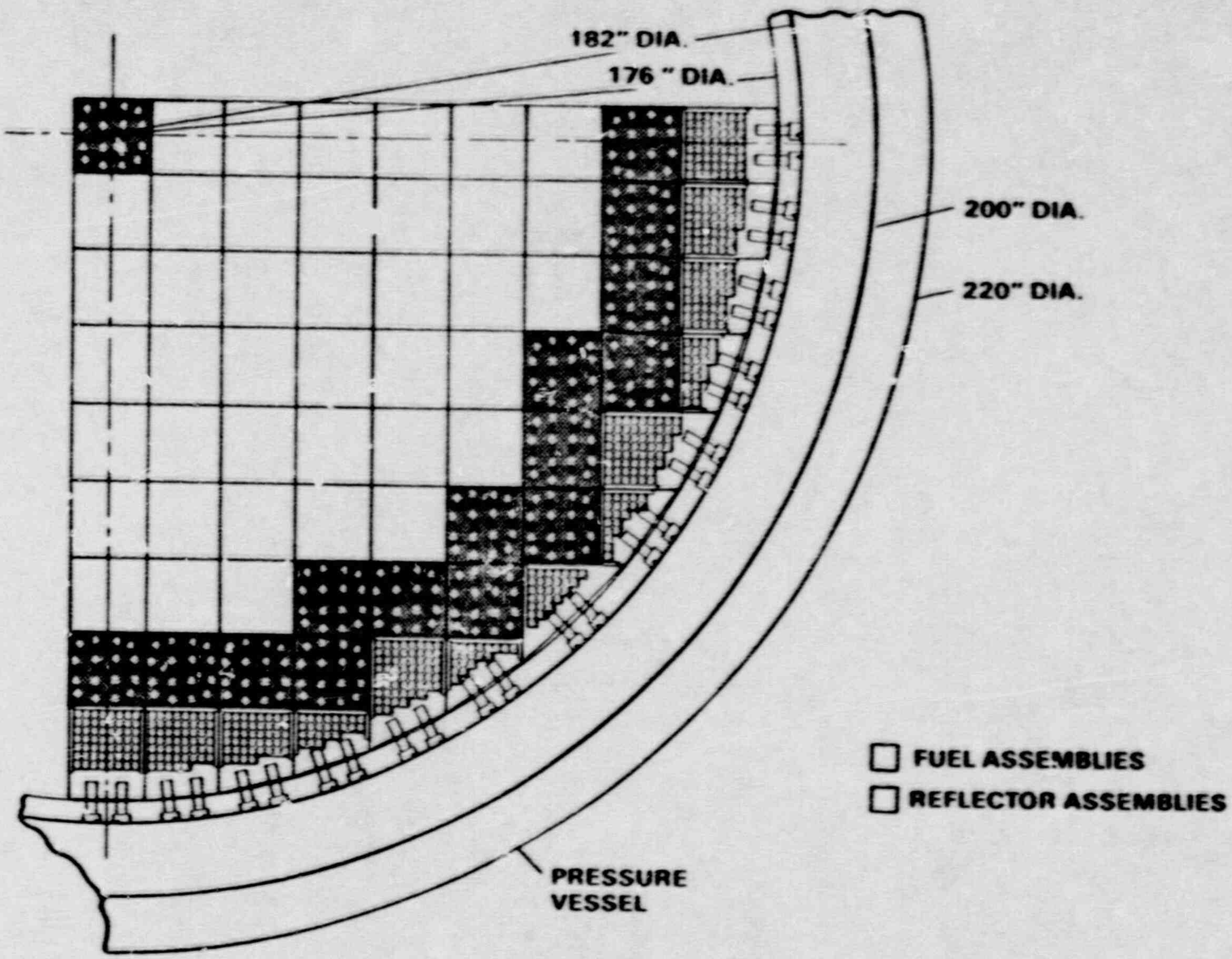
MODERATOR CONTROL
SPECIFIC CONCEPT

- Low neutron absorbing rods called water displacer rods fully inserted prior to startup displacing 13% of the core water volume
- They remain inserted until the boron concentration nears 0 PPM, (70% of cycle)
- Over the remainder of the cycle, the rods are sequentially and fully withdrawn in groups
- During refueling shutdown, the rods are reinserted into the core for the next cycle

BORON CONCENTRATION AND WDR WITHDRAWAL SEQUENCE VERSUS TIME

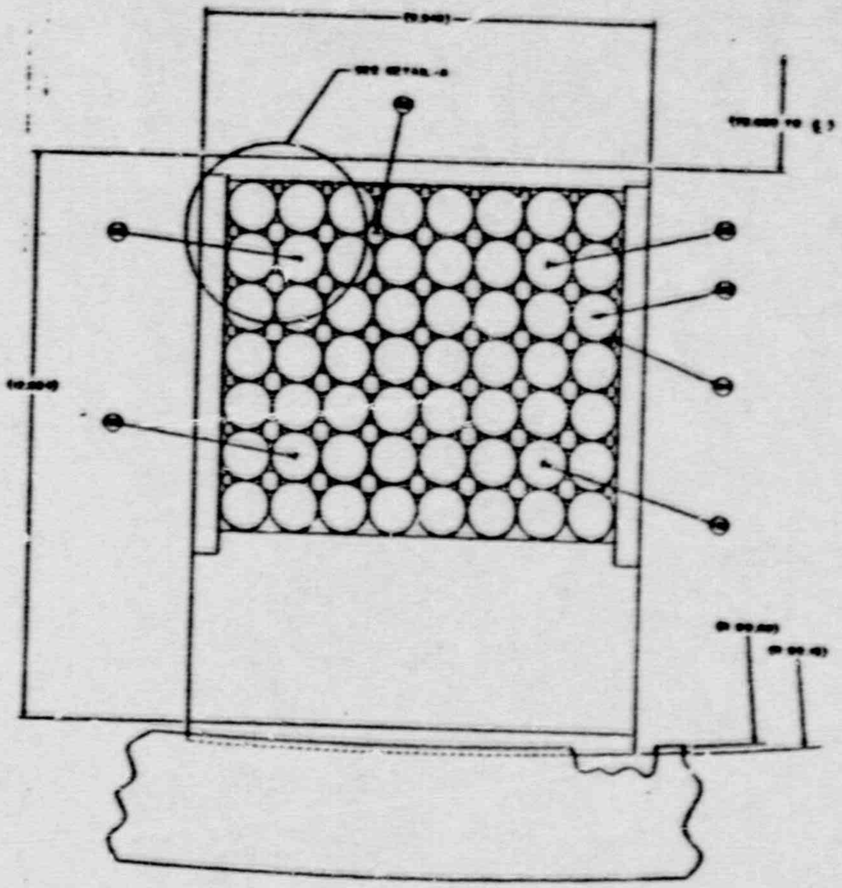


428A DW02829.16

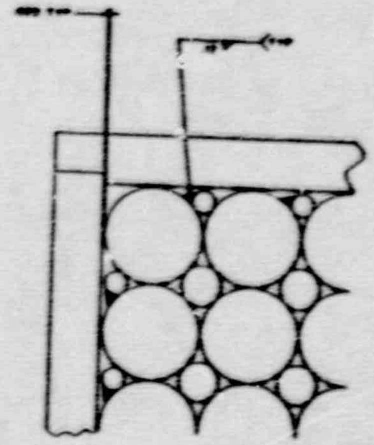


APWR Core/Reflector Cross Section

48/40/9274-2

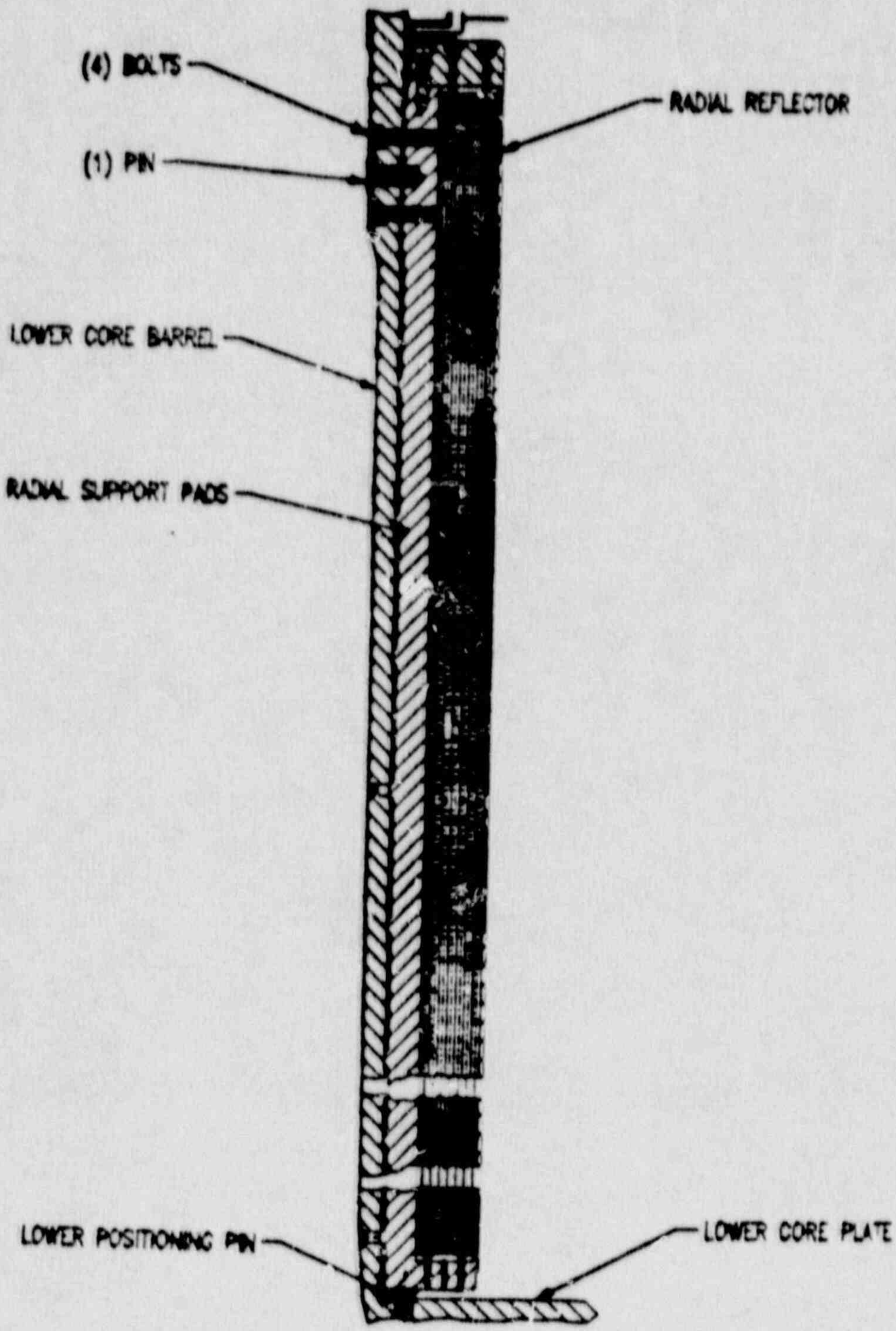


SECTION B-B



DETAIL A

APWR REFLECTOR ASSEMBLY



URANIUM, SWU AND FUEL CYCLE COST SAVINGS ASSOCIATED WITH EACH OF THE APWR CORE FEATURES

Core Feature	U_3O_8 Savings(1) (%)	SWU Savings(1) (%)	Fuel Cycle Cost Savings(1) (%)
Zirc Grids + Increased H/U	3.2	4.1	4.1
95.4 ---> 119.0 MTU	9.2	12.2	5.6
Moderator Control	7.2	9.3	7.1
Radial Reflector	3.1	4.0	3.2
Total	22.7	29.6	20.0

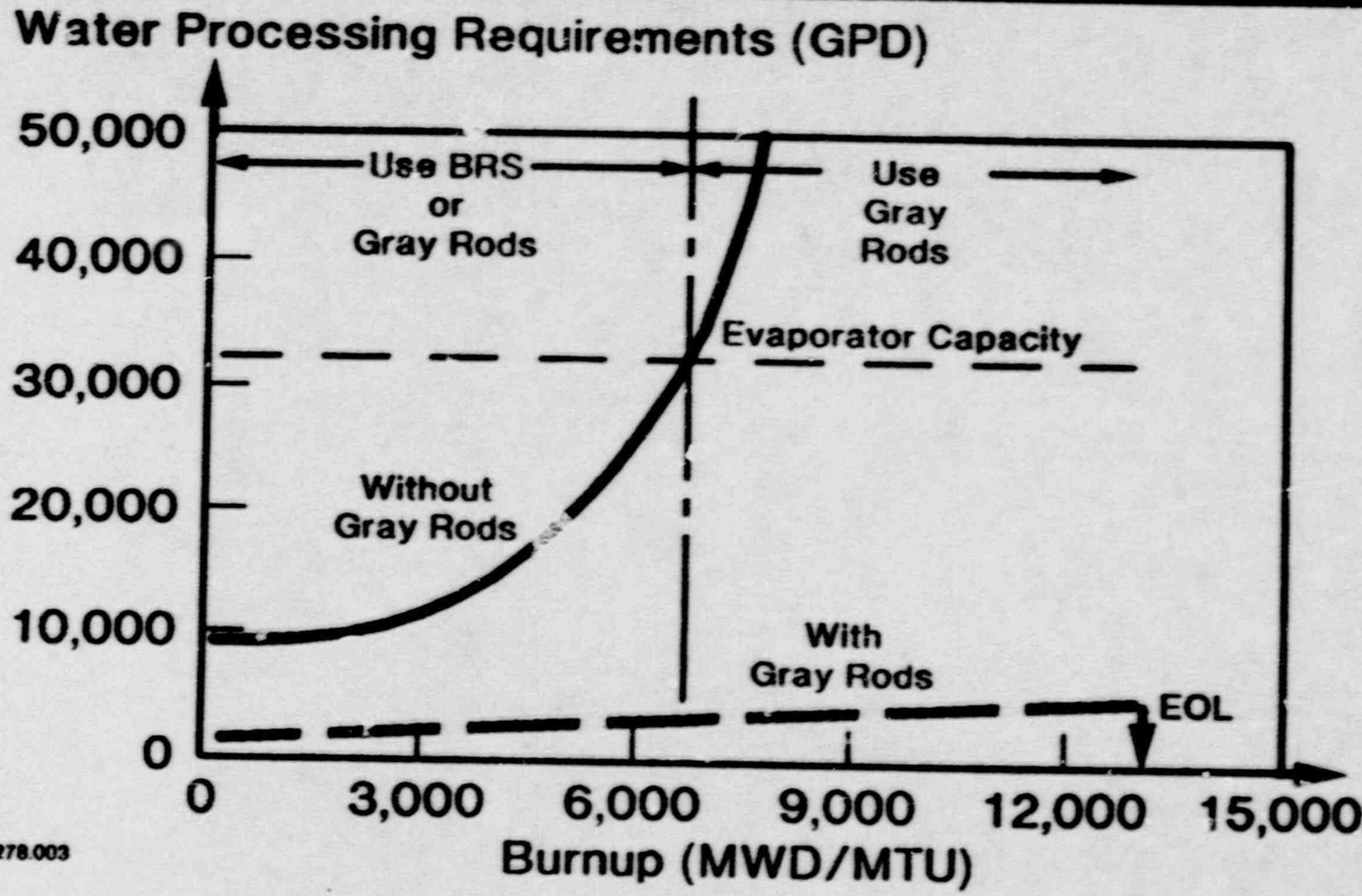
(1) Relative to a 193, 17 x 17 fuel assembly core with a 14 foot active length, inconel grids. Assuming 18 month fuel cycles, 75% capacity factor and 39,450 MWD/MTU discharge burnup

ADVANCED REACTOR GRAY RODS

- Functions:
  - Xenon reactivity control during load follow
  - Water displacement
- Normally inserted during base load operation
- At low boron concentrations, replaces boration/ dilution operations during load follow
  - When power is reduced, gray rods are withdrawn in sequence to compensate for xenon buildup
  - When power is increased, gray rods are re-inserted in sequence to compensate for xenon burn-out
- Reduces water processing requirements
- Extends load follow capability to 95% of cycle

1067 D19882.003

WATER PROCESSING REQUIREMENTS



990 D016278.003

OPEN ISSUE NUMBER 43 CATEGORY 4

Review of critical heat flux (CHF) tests (4.4.2.2)).

DSER (March 1989) Section 4.4.2, page 4-22

BACKGROUND

DNBR's are calculated using the WRB-2 critical heat flux (CHF) correlation. The coupled THINC-IV/THINC-I computer code is used to determine the flow distribution in the core and the local conditions in the hot channel for use in the DNB correlation. Critical heat flux tests modeling the SP/90 fuel assembly were performed at the Columbia University Heat Transfer Laboratory.

WESTINGHOUSE POSITION

It was concluded from evaluation of the data that the CHF characteristics of the SP/90 fuel assembly are not significantly different from those of the current 17 x 17 standard designs, and can be adequately described by the WRB-2 CHF correlation. Additionally, the data derived from the SP/90 tests can be incorporated in the data base without changing the DNBR design criterion of 1.17. In response to staff question 492.1, Westinghouse provided results of the aforementioned CHF tests in November 1984.

NRC STAFF POSITION

The submittal is under review and the results of the staff's review will be addressed in the final SER.

RESAR-SP/90 RESOLUTION APPROACH

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OPEN ISSUE NUMBER 44 CATEGORY 4

Departure from nuclear boiling ratio (DNBR) safety limit (4.4.3.1)

DSER (March 1989) Section 4.4.3, page 4-23

BACKGROUND

The phenomenon of fuel rod bowing, described in Revision 1 of WCAP-8691, is accounted for in the DNBR safety analysis of Condition I and Condition II events for each plant application. Applicable generic credits for margin resulting from the evaluation of DNBR and/or margin obtained from measured plant operating parameters, that are less limiting than those required by the plant safety analysis, are used to offset the effect of rod bow.

WESTINGHOUSE POSITION

The safety analysis for RESAR-SP/90 maintained sufficient margin between the safety analysis limit DNBR and the design limit DNBR to accommodate full flow and low flow DNBR penalties. The amount of fuel rod bow, and its associated DNBR penalties, is predicted to be less for RESAR-SP/90 fuel than that for Westinghouse 17x17 fuel because SP/90 fuel has a larger fuel rod diameter, thicker cladding, and smaller spacing between grids.

NRC STAFF POSITION

WCAP-8691, Revision 1, has been reviewed and approved by the staff for existing Westinghouse cores. The staff has concluded that rod bow penalties have been properly offset by the DNBR margins calculated by Westinghouse for the RESAR-SP/90 application. The staff states, however, that conclusion is contingent on the approval of the 1.17 DNBR safety limit for WRB-2 with the RESAR-SP/90 fuel.

RESAR-SP/90 RESOLUTION APPROACH

The resolution of this open issue along with that of Open Issue 43 will be based on the staff's final review of the critical heat flux test data provided in response to staff' question 492.1. The results of the staff's review will be addressed in the final SER.

FIGURE 1

APWR BOWED ROD DNB TEST

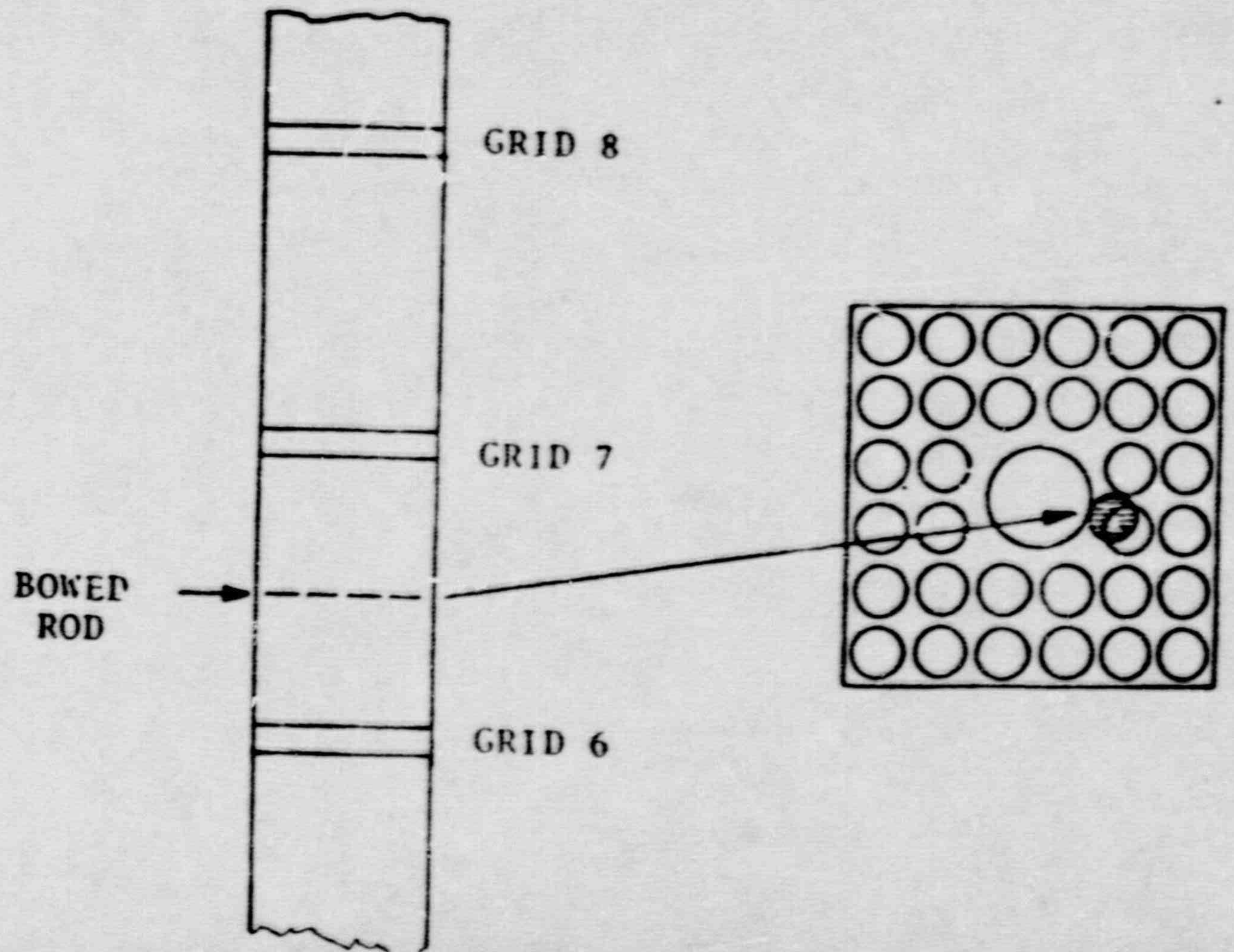
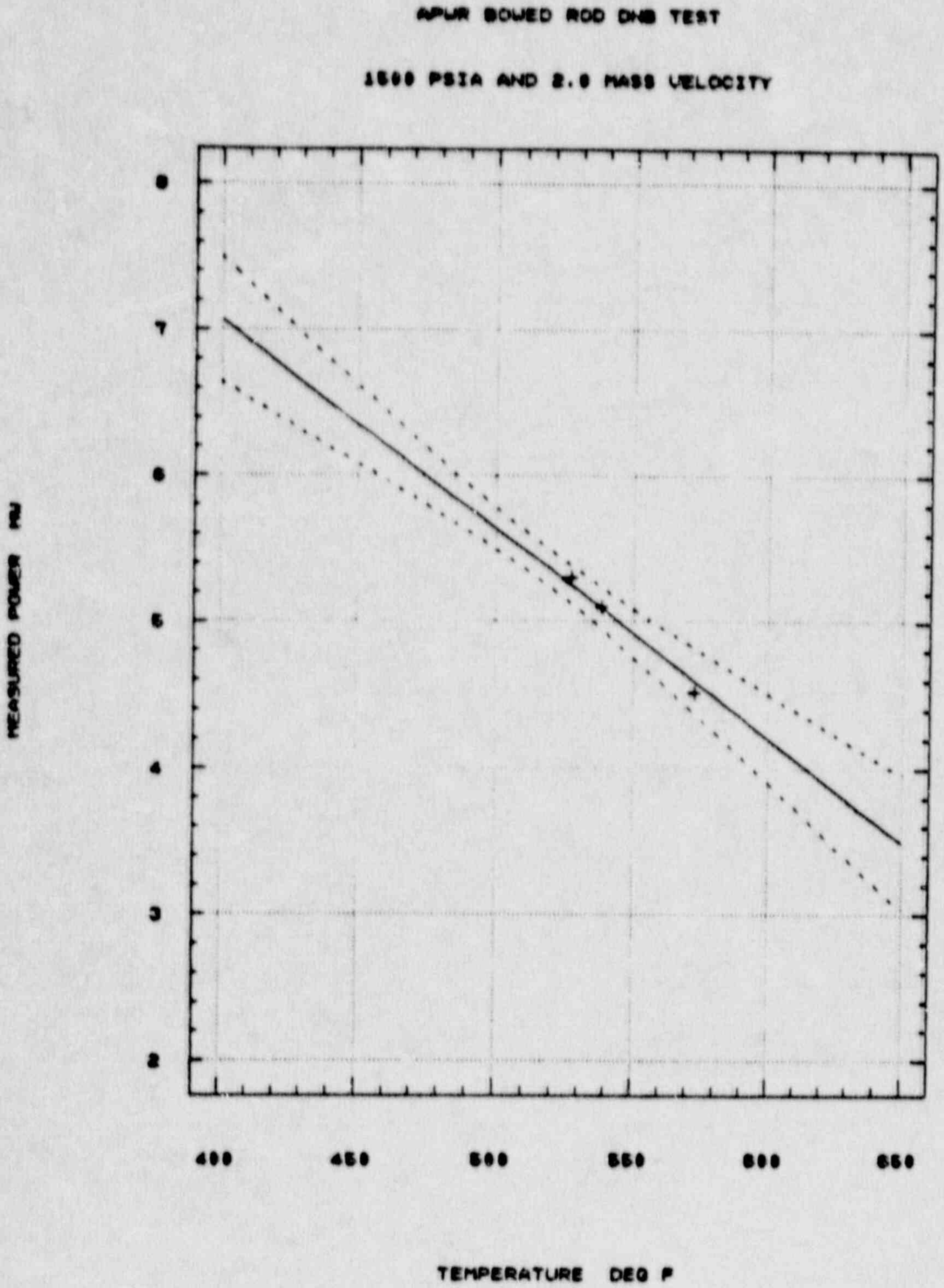


Figure 3



____ Straight Rod DNB Data

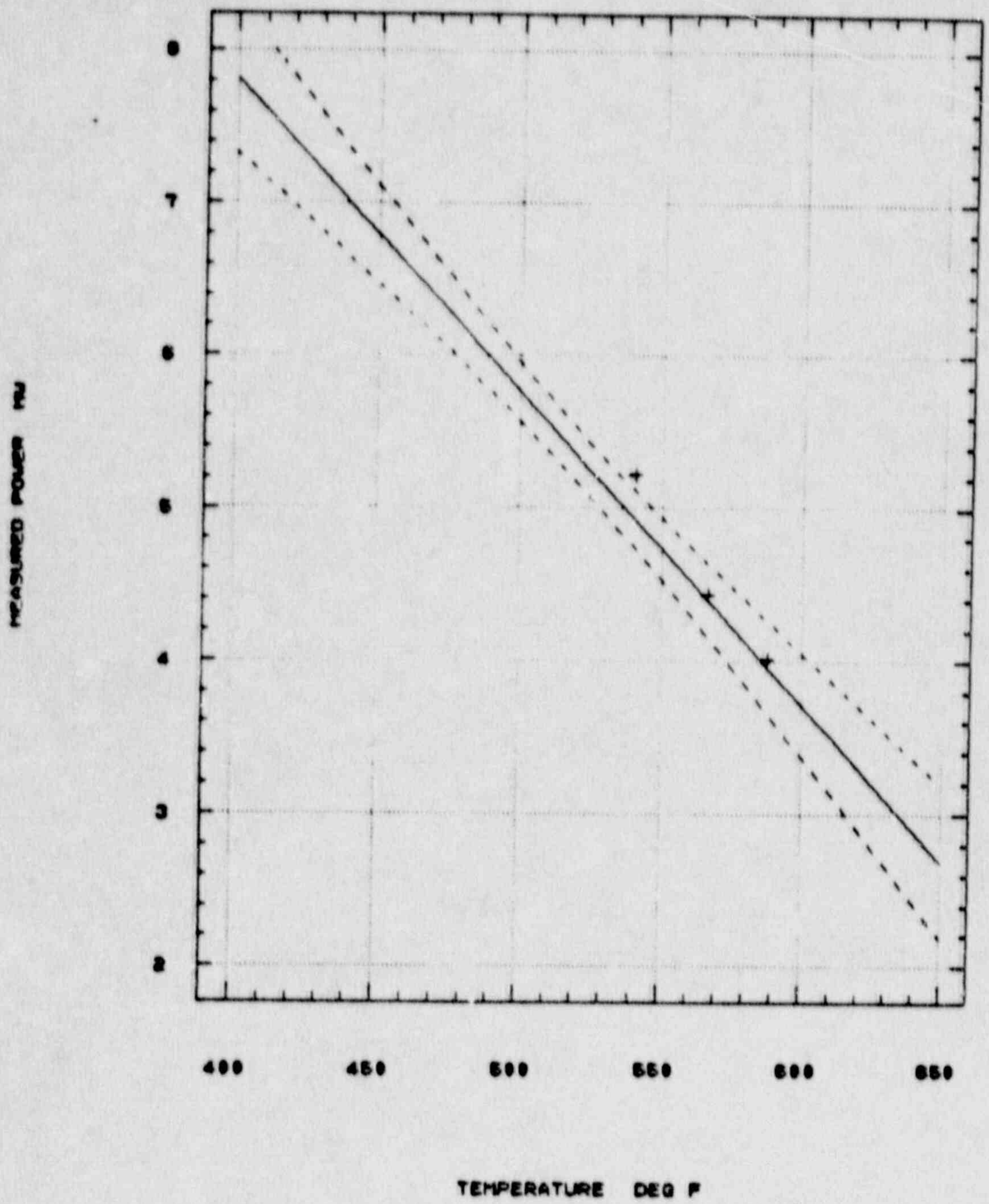
---- 95% Confidence Limits

\+ Bowd Rod DNB Data

Figure 6

APWR BOWED ROD DNB TEST

1000 PSIA AND 2.0 MASS VELOCITY

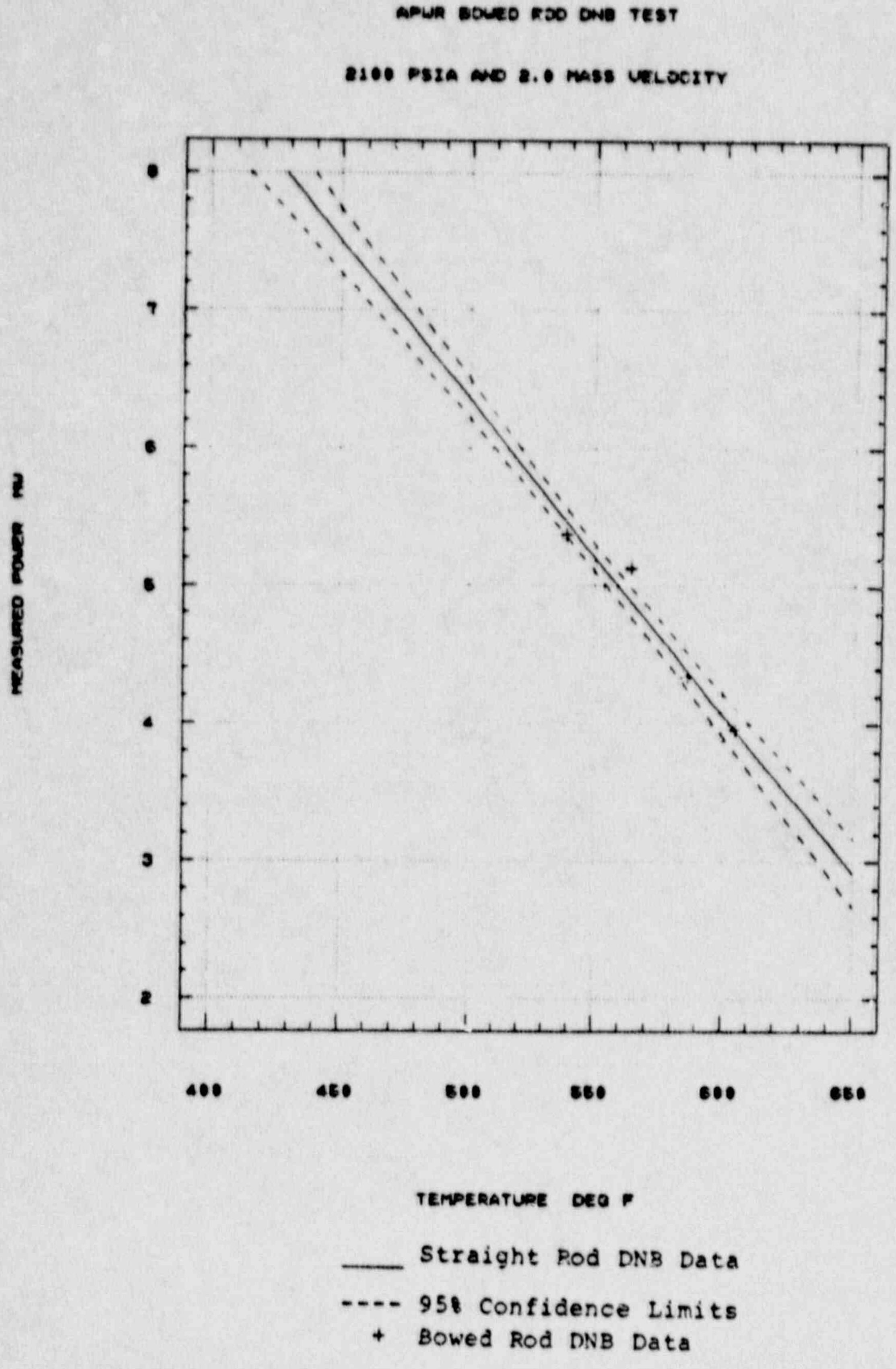


_____ Straight Rod DNB Data

----- 95% Confidence Limits

+ Bowed Rod DNB Data

Figure 8


APWR BOWED ROD DNB TEST
2100 PSIA AND 2.0 MASS VELOCITY
MEASURED POWER MW
8
7
6
5
4
3
2
400
450
500
550
600
650
TEMPERATURE DEG F
Straight Rod DNB Data
---- 95% Confidence Limits
+ Bowed Rod DNB Data

RESAR SP/90

CHAPTER 5

REACTOR COOLANT SYSTEM

NSD-SGT-SGDD-9490

Key Words:
Presentation
ACRS

Advanced PWR Steam Generator

by Robert M. Wilson

November 1989

Steam Generator Technology & Engineering
Nuclear Services Division
Westinghouse Electric Corporation

Westinghouse
Steam Generator Overview

SG Model	Number of Units
13	4
15	8
27	7
33	4
44	29
51	86
D2/D3	45
D4/E	32
D5	16
F	53
44F	19
51F	10
	307

Key Design Objectives

Maximize Plant Availability

- *Emphasize Design Simplicity*
- *Emphasize Reliability*

Minimize Occupational Radiation Exposure

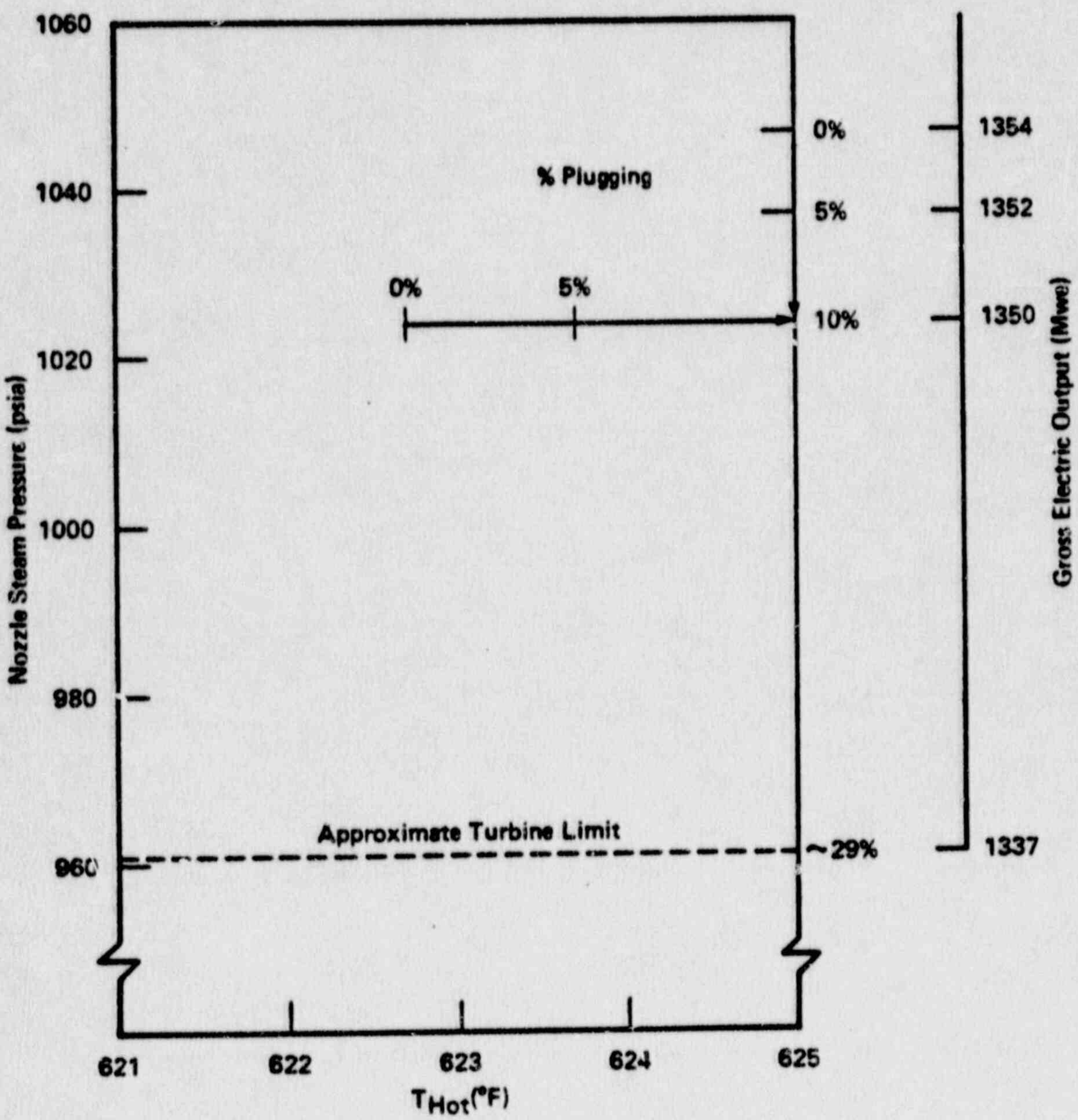
- *As Low As Reasonably Achievable (ALARA)*
- *Ease of Maintenance*

SP/90

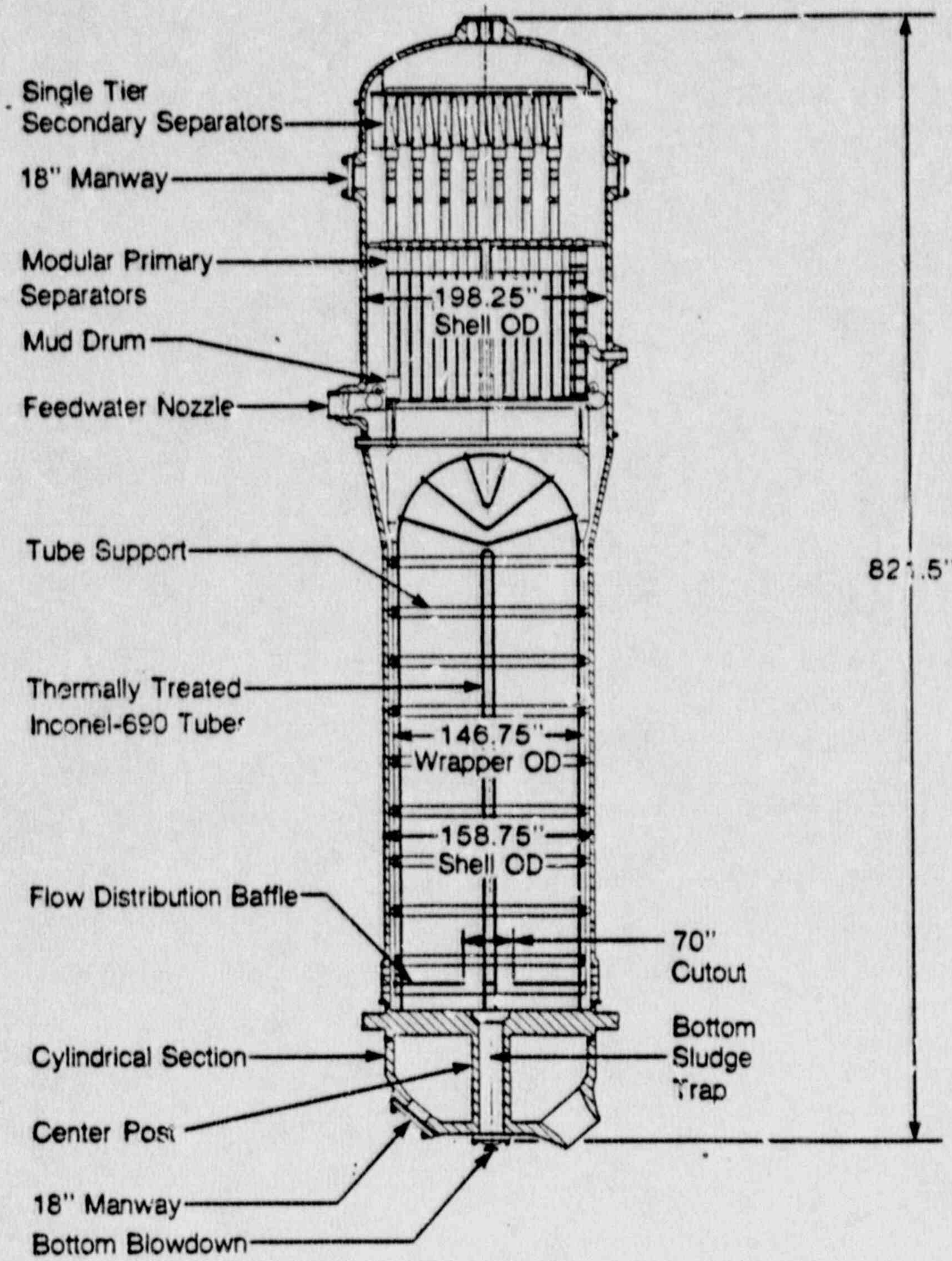
REACTOR COOLANT SYSTEM

NSSS POWER (MWT)	3816
NUMBER OF LOOPS	4
OPERATING PRESSURE (PSIA)	2250
DESIGN LOOP FLOW (GPM)	100,100
HOT LEG TEMPERATURE (^{o}F)	625
STEAM PRESSURE (PSIA)	1024

APPROXIMATE VARIATION IN STEAM PRESSURE AND GROSS ELECTRICAL GENERATION WITH TUBE PLUGGING



ADVANCED PWR
STEAM GENERATOR



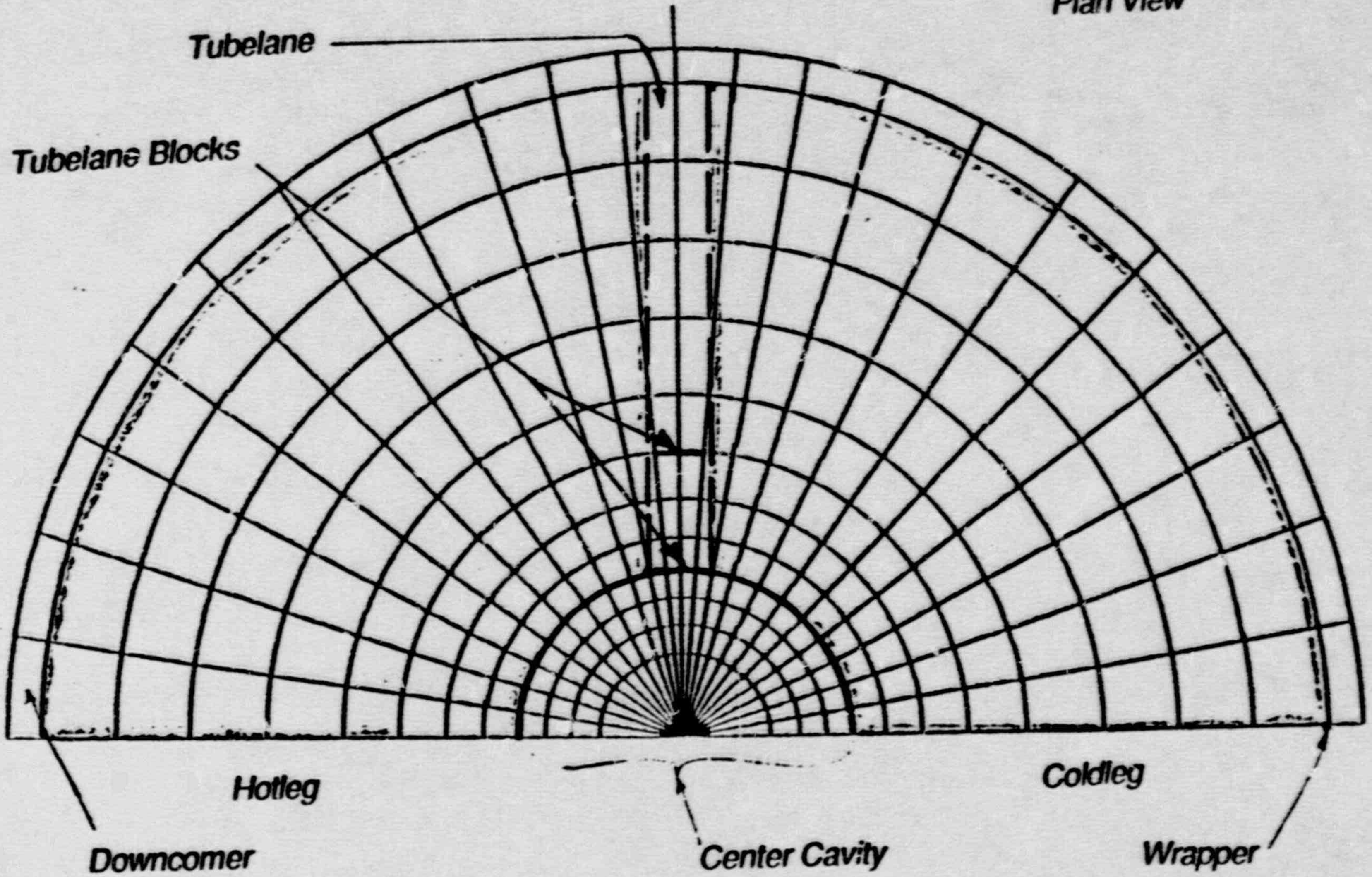
THERMALLY TREATED INCONEL 690
POTENTIAL BENEFITS

- Lower primary water release rates
- Superior pure and primary water SCC resistance
- Better high temperature caustic SCC resistance
- Improved SCC resistance in dilute caustic solutions
- Superior SCC resistance in acid sulphate environments
- Improves SCC performance in oxygenated chloride environments

Advanced PWR Steam Generator

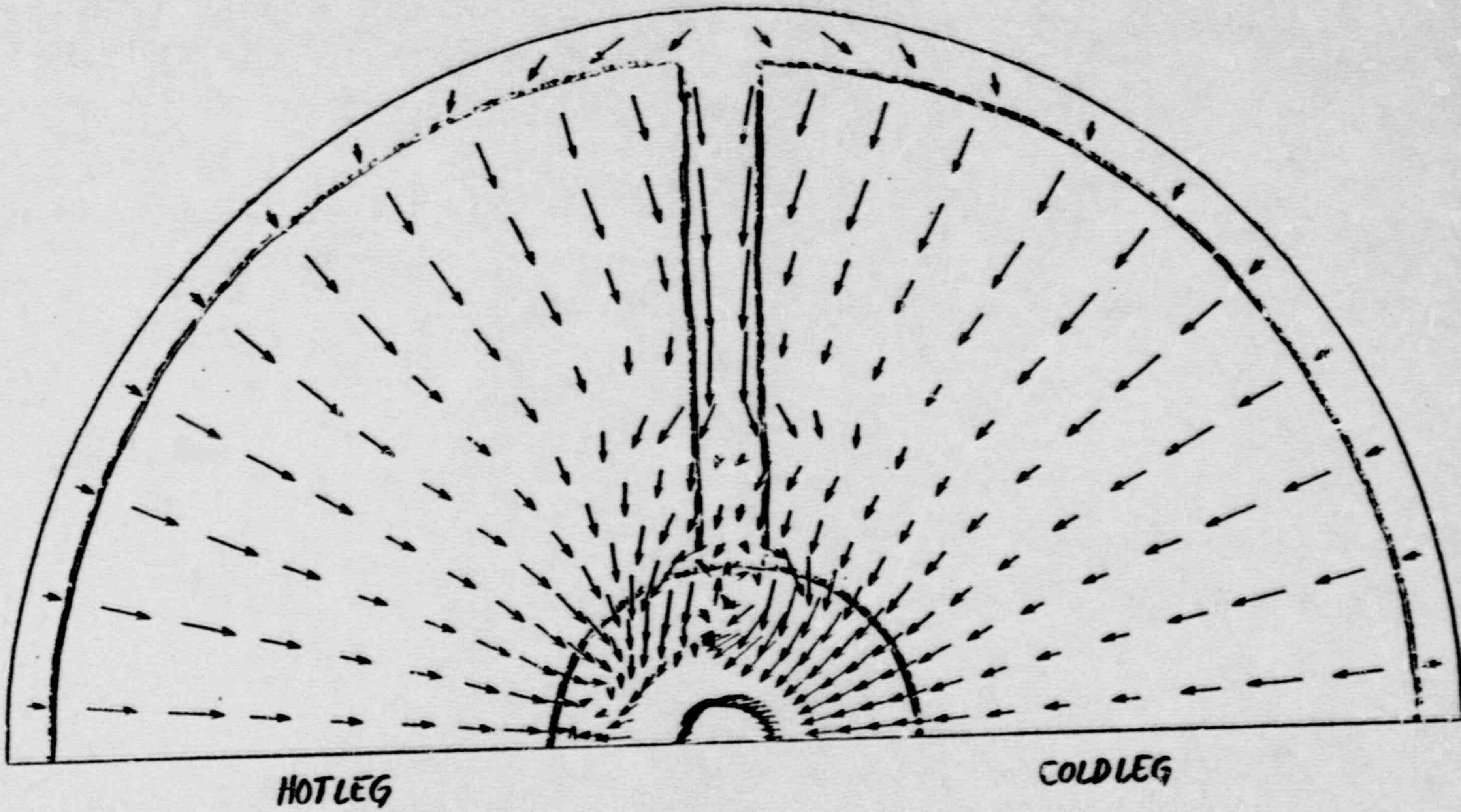
ATHOS Model

Plan View



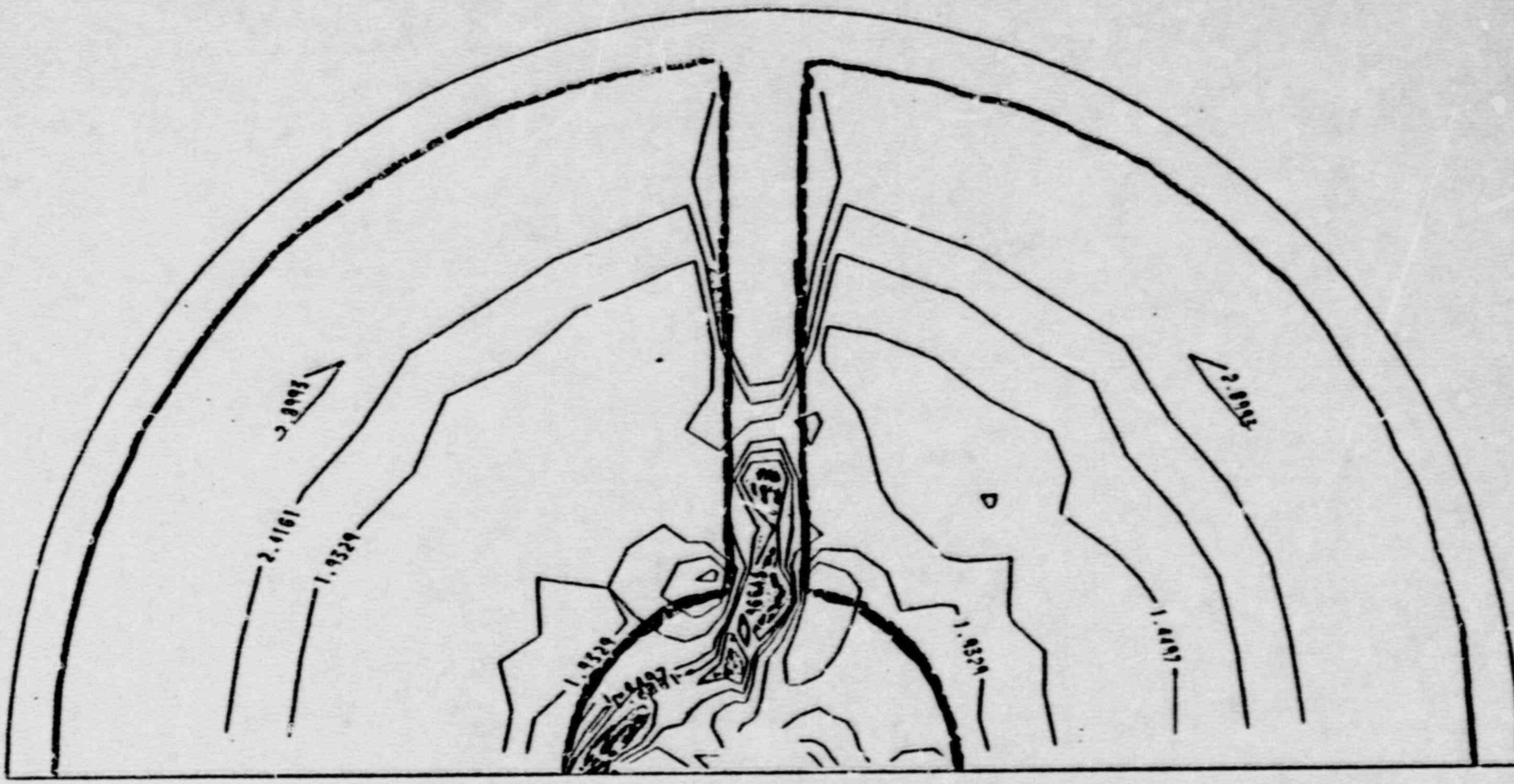
Advanced PWR Steam Generator

Plan View



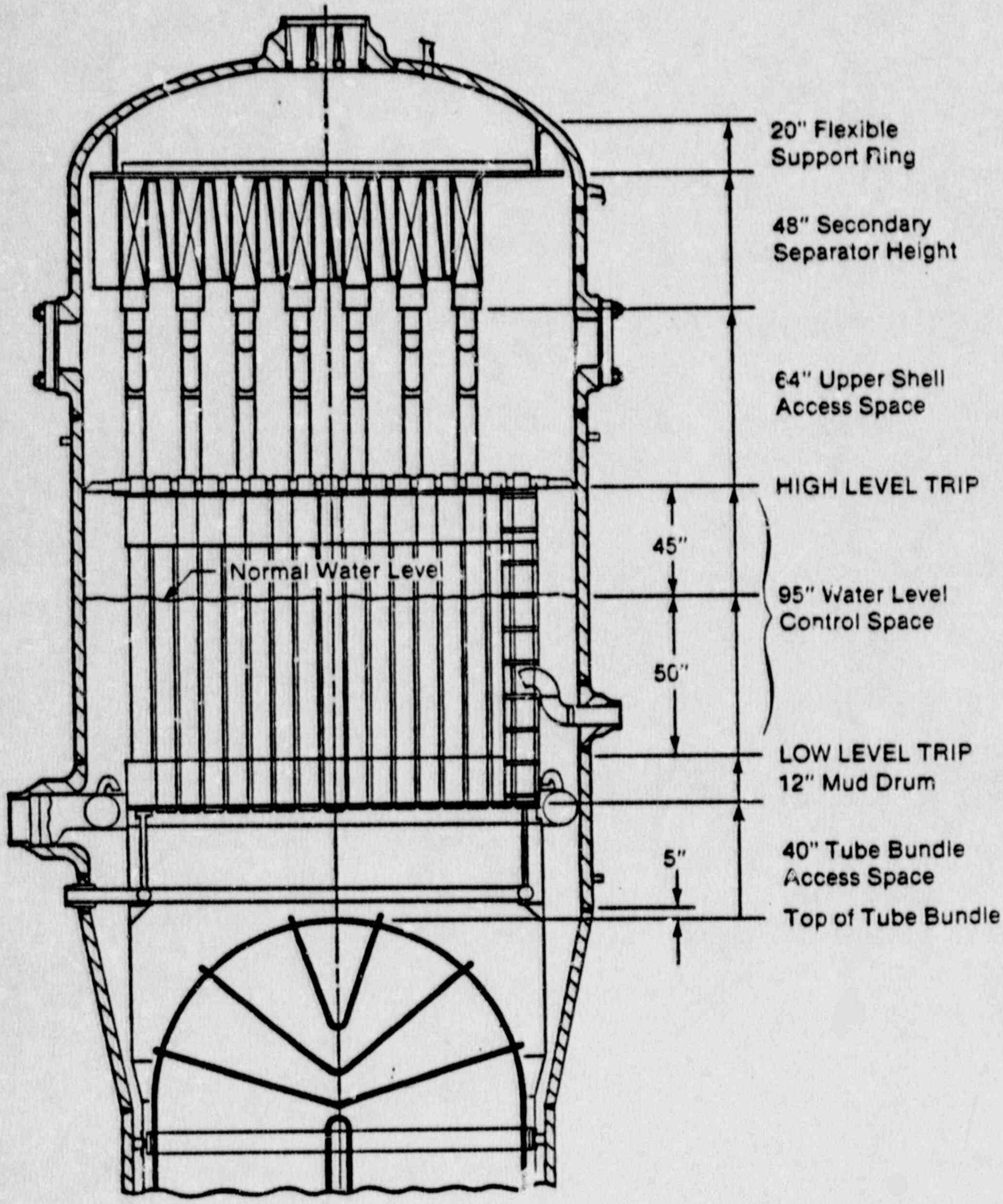
Advanced PWR Steam Generator

Plan View

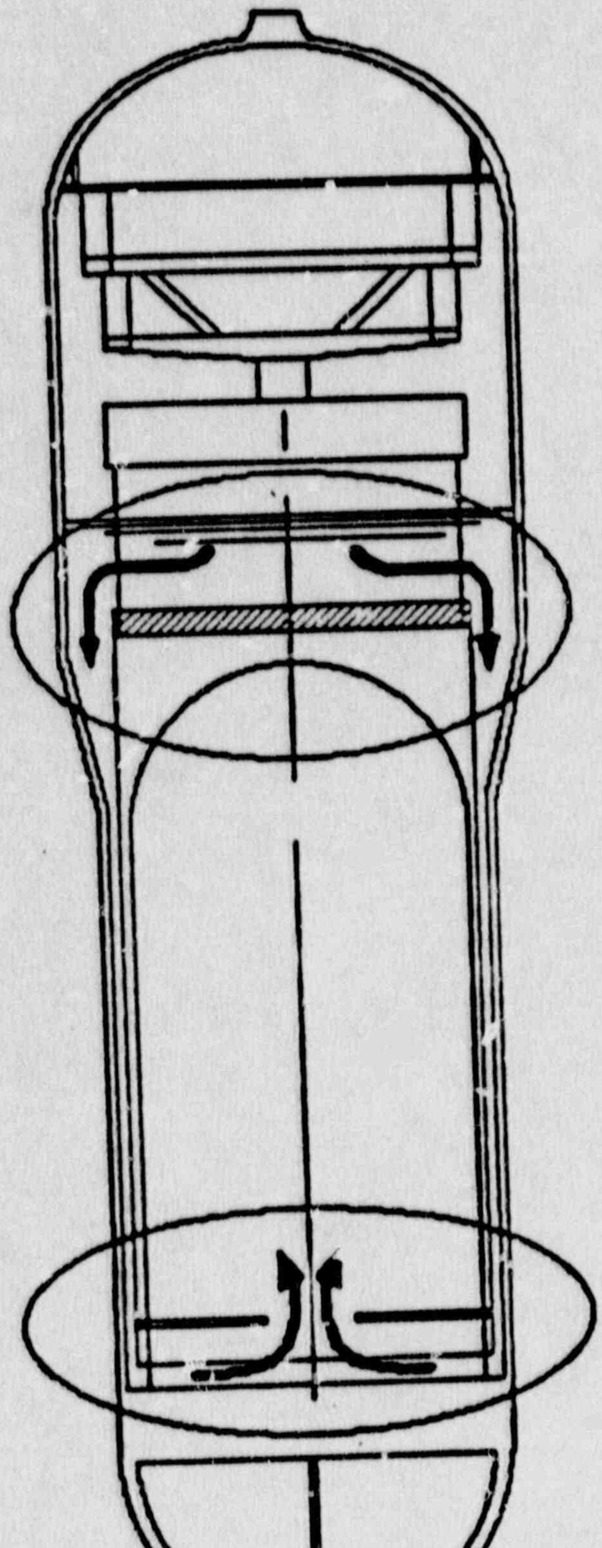


CROSSFLOW VELOCITY CONTOURS
(MULTIPLY BY 2, fps)

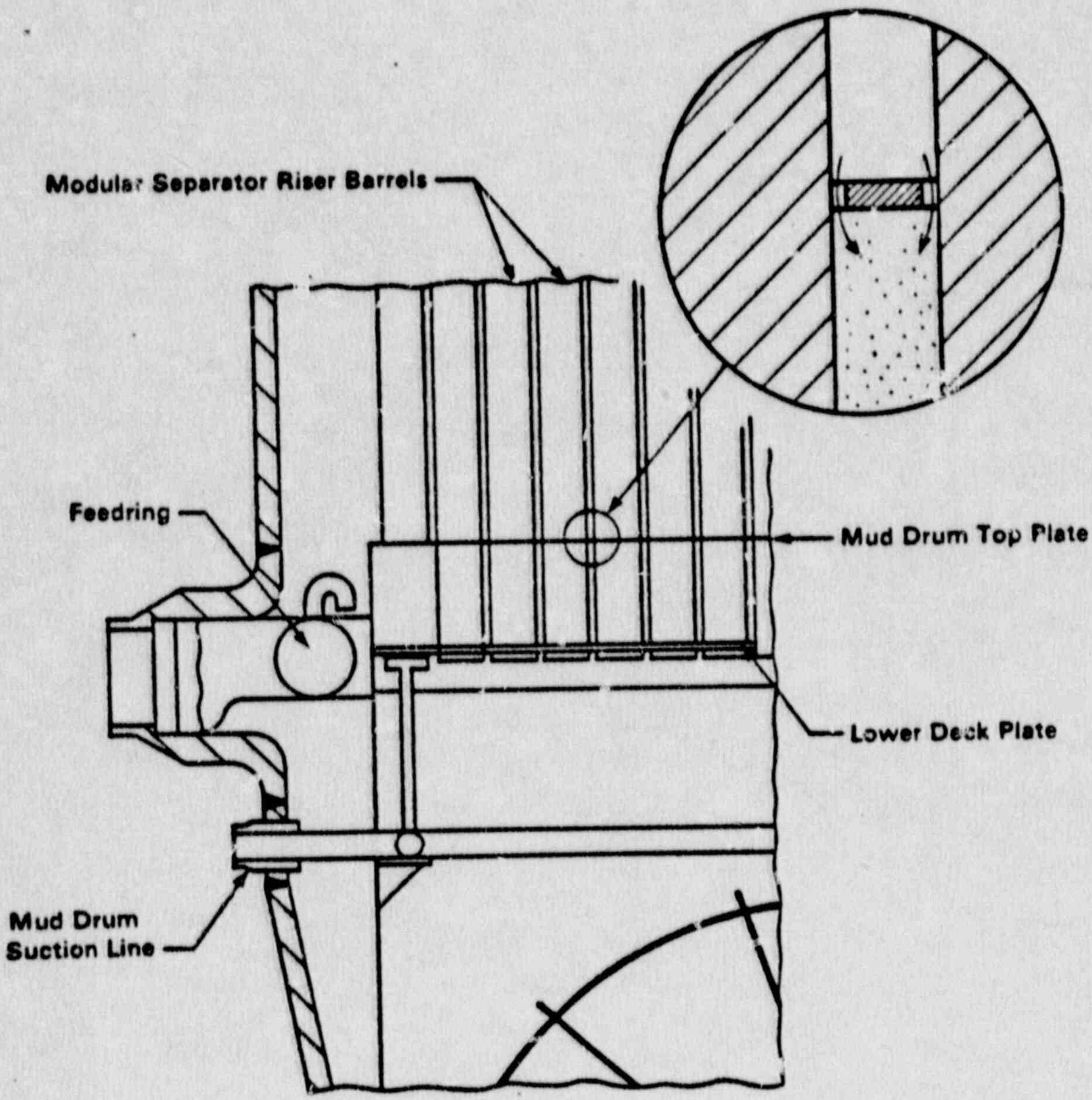
BASIS FOR STEAM GENERATOR HEIGHT



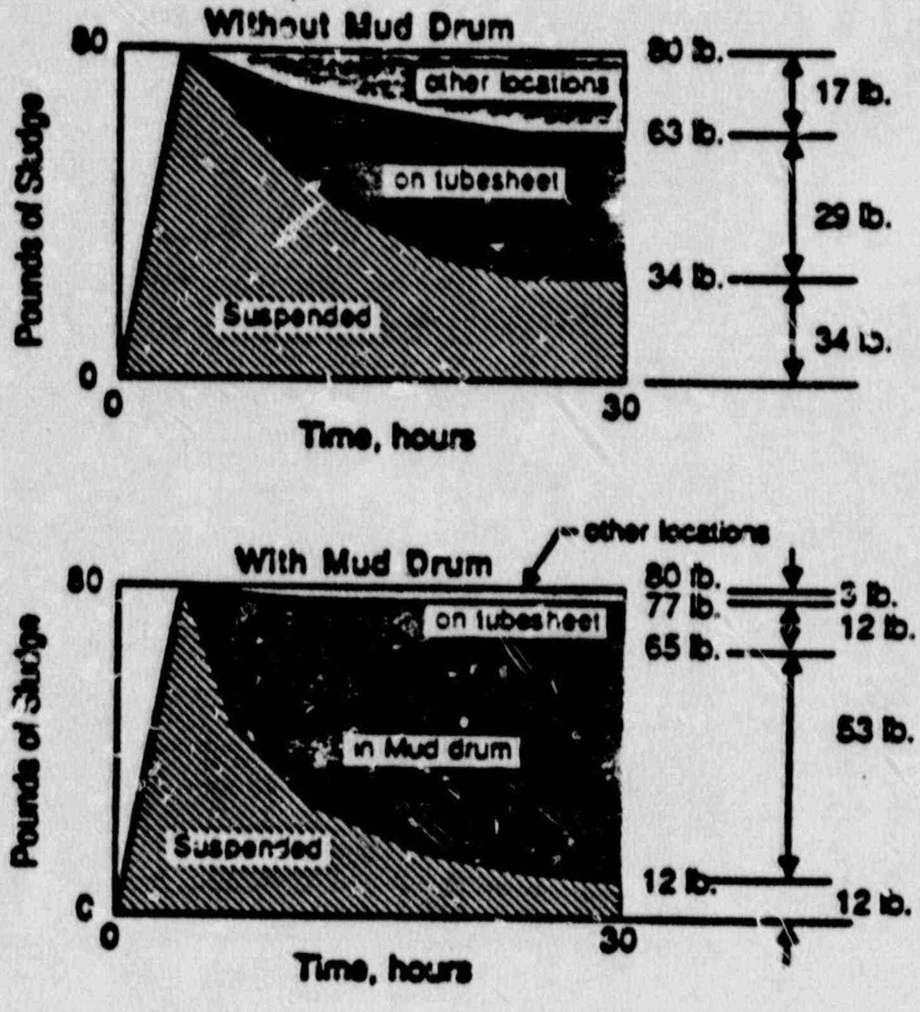
Sludge Control



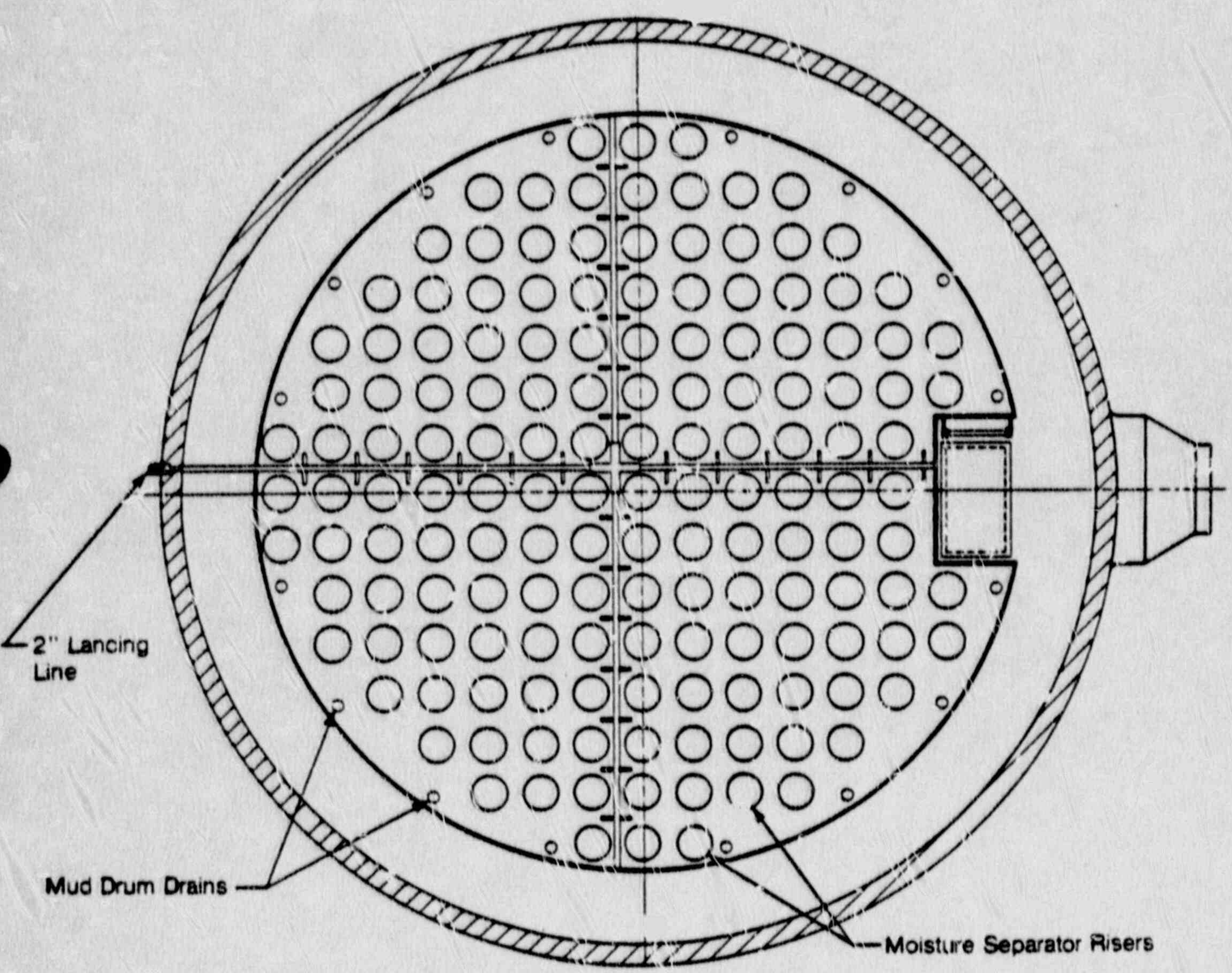
APWR MUD DRUM



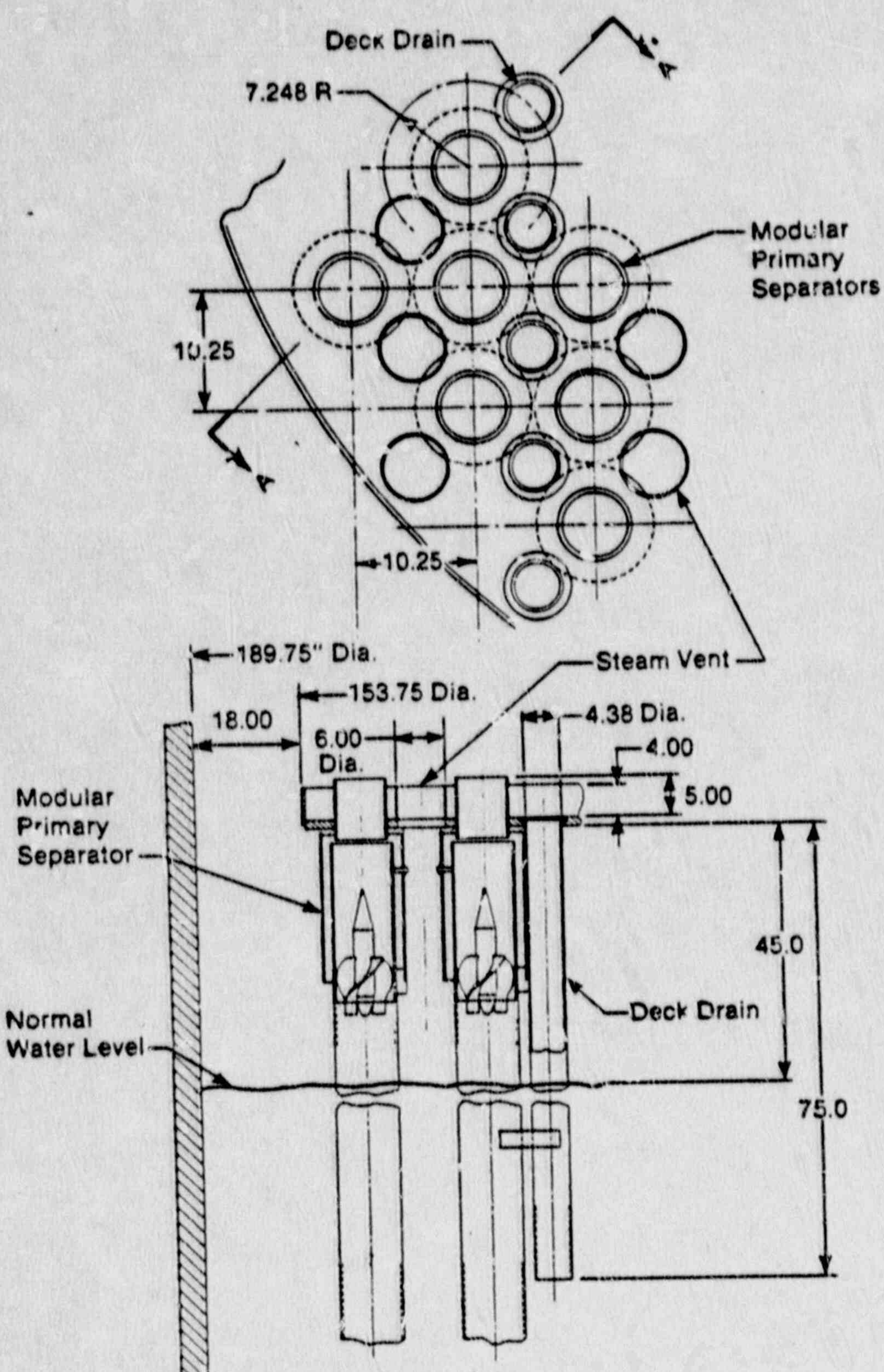
SG Mud Drum Performance



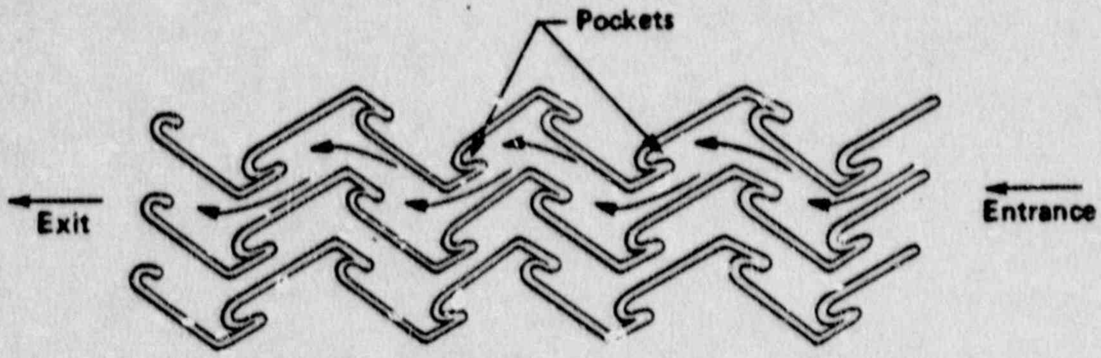
MUD DRUM SLUDGE REMOVAL SYSTEM



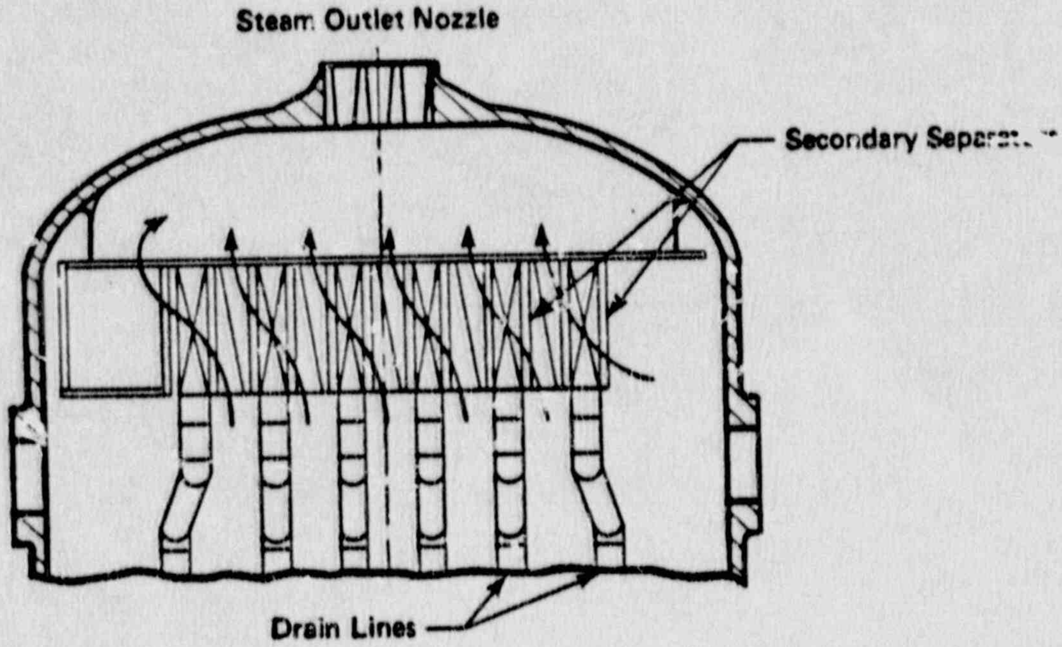
APWR
PRIMARY SEPARATOR PACKAGE ARRANGEMENT



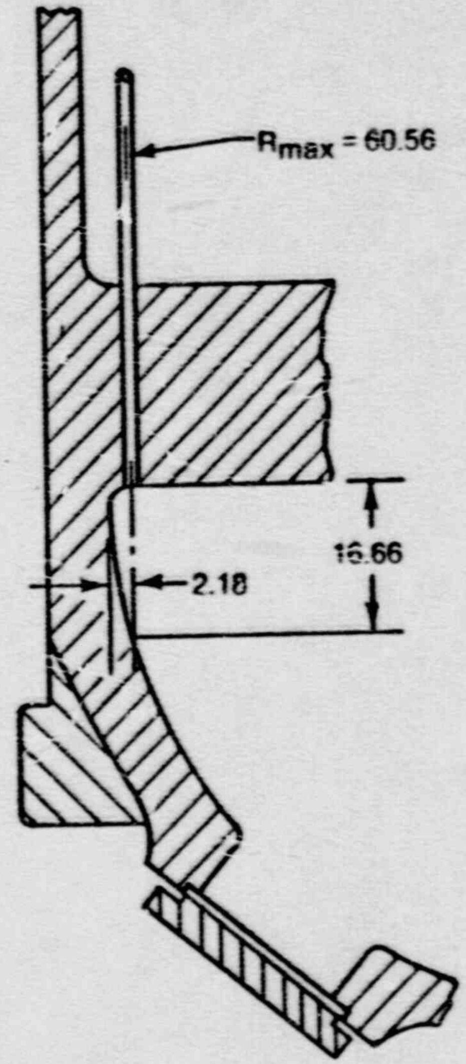
Section A-A



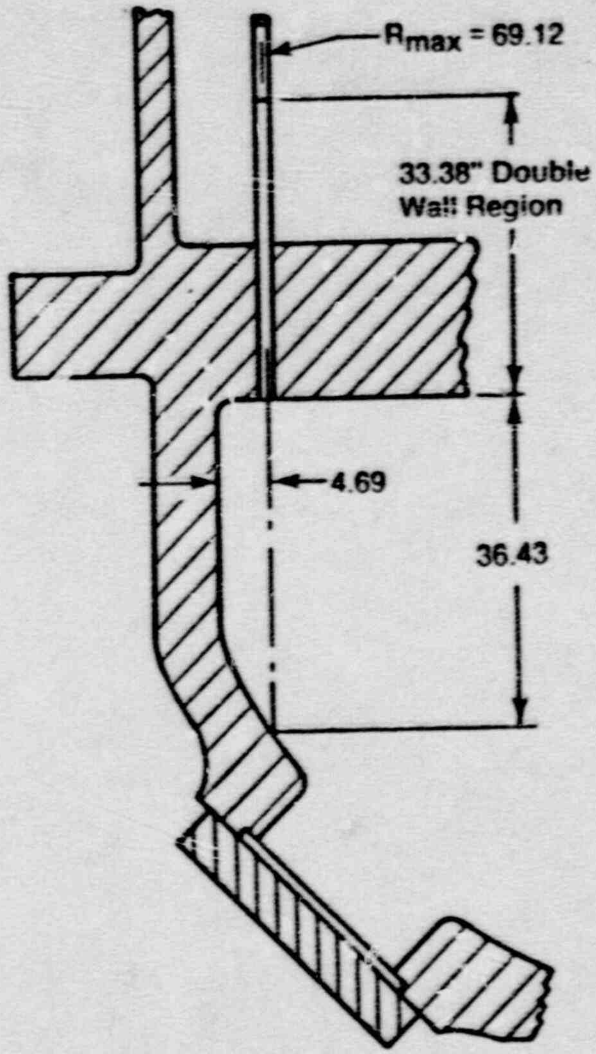
Secondary Separator Vanes



PERIPHERAL TUBE CLEARANCE



51 Series S/G



APWR — S/G

Conclusion

The Advanced PWR Steam Generator incorporates features which have been extensively tested and most have already been implemented in operating steam generators.

The three dominant design enhancements over earlier SG Models are...

1. Alloy 690TT Tube Material
2. Tube Bundle Sludge Control
3. Enhanced Maintenance Features

The Advanced PWR Steam Generator meets or exceeds all of the EPRI/SGOG Design Recommendations (SG Reference Handbook, Section 4).

SP/90

REACTOR COOLANT PUMP

MODEL DESIGNATION	100A
DESIGN FLOW (GPM)	100,100
DEVELOPED HEAD (FT)	333.8
SEAL INJECTION (GPM)	8
SEAL RETURN (GPM)	3
MOTOR POWER (HP)	8000

*IDENTICAL TO SOUTH TEXAS.

SP/90

PRESSURIZER

TOTAL VOLUME (CUFT)	2500
STEAM VOLUME (CUFT)	1000
HEATER CAPACITY (KW)	2500
LIQUID VOLUME (CUFT)	1500
NO. OF SAFETY VALVES	3
NO. OF RELIEF VALVES	3

SP/90

RESIDUAL HEAT REMOVAL SYSTEM

CS/RHR PUMPS

. QUALITY	4
. DESIGN FLOW (GPM)	1940
. DESIGN HEAD (PSI)	180
. MOTOR RATING (HP)	420

RHR HEAT EXCHANGERS

. QUANTITY	4
. RHR FLOW (GPM)	1600
. CCW FLOW (GPM)	1880
. APPROXIMATE UA (BTU/HR-°F)	800,000

SP/90

LOW TEMPERATURE OVERPRESSURE PROTECTION*

- LTOP FUNCTION IS PROVIDED BY RHR RELIEF VALVES

- RHR ISOLATION VALVE AUTOCLOSURE INTERLOCK HAS BEEN ELIMINATED.

- TWO OUT OF FOUR RHR SUBSYSTEMS ARE SUFFICIENT TO PROVIDE LTOP.

- POWER IS REMOVED FROM RHR ISOLATION VALVES IN SUBSYSTEMS PERFORMING LTOP FUNCTION.

- ALARM IS PROVIDED IF LESS THAN TWO RHR SUBSYSTEMS ARE ALIGNED DURING CONDITIONS REQUIRING LTOP.

- OPERATING PROCEDURES WILL ALLOW ONLY ONE RHR SUBSYSTEM TO BE IN MAINTENANCE.

MID-LOOP OPERATION*

- WATER LEVEL DURING MID-LOOP OPERATION IS AT LEAST 9 INCHES ABOVE ACTUAL MID-PLANE ELEVATION.

- WITH VORTEX BREAKER, AIR ENTRAINMENT STARTS TO OCCUR AT APPROXIMATELY 3 INCHES BELOW MID-PLANE ELEVATION, BUT IS LIMITED TO LESS THAN 10%.

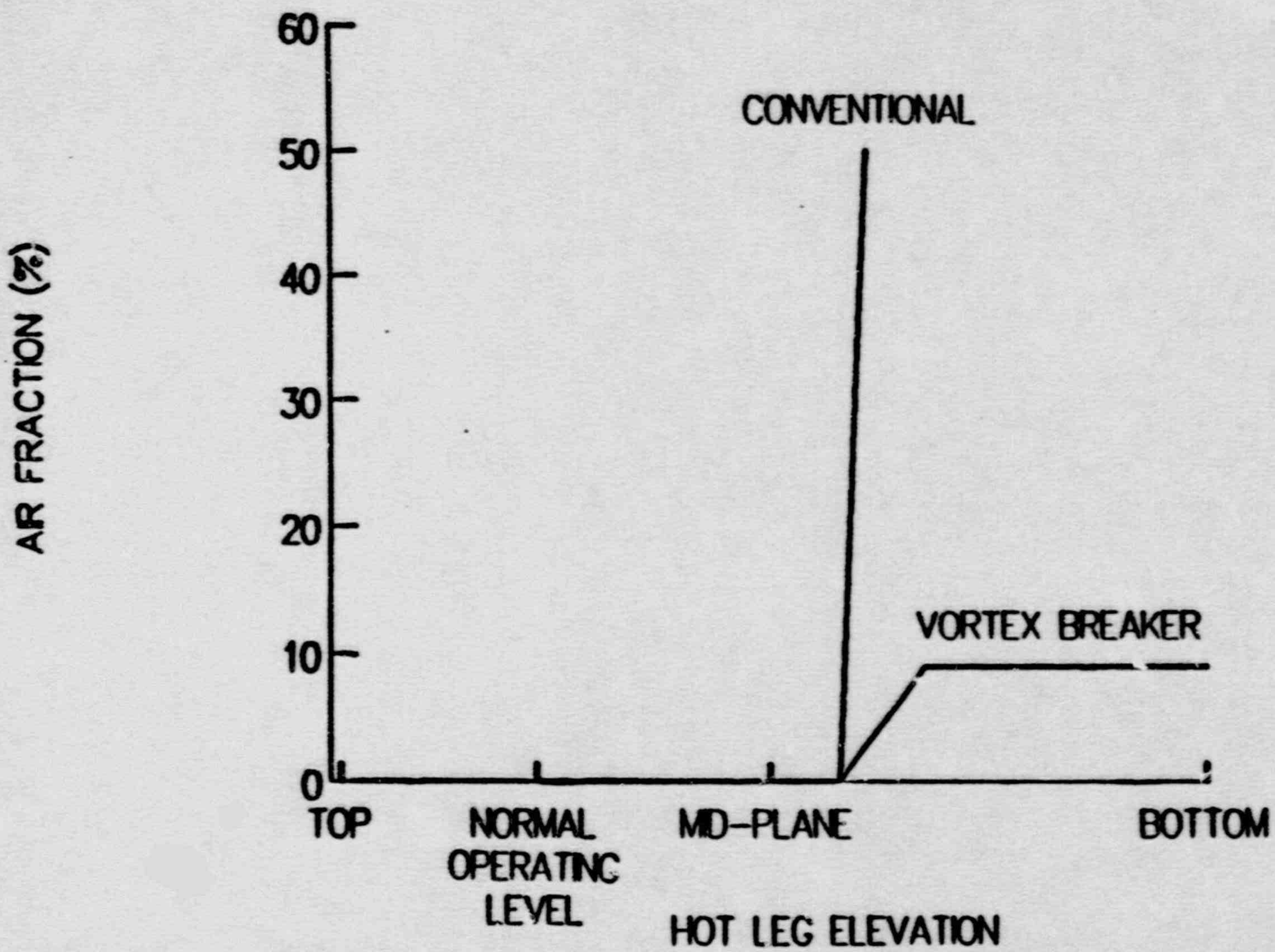
- RHR SUCTION LINES ARE SLOPED CONTINUOUSLY DOWNWARDS TOWARDS RHR PUMPS AND ARE, THEREFORE, SELF-VENTING.

- RHR PUMP SUCTION LINES PROVIDE ADEQUATE PUMP NPSH AT FULL FLOW ASSUMING SATURATION IN THE HOT LEG.

- HHSI PUMP WILL BE AVAILABLE DURING MID-LOOP OPERATION FOR EMERGENCY MAKEUP IF REQUIRED.

* DSER OPEN ISSUE 54

RHR SUCTION NOZZLE PERFORMANCE



1

IMAGE EVALUATION TEST TARGET (MT-3)

150mm

6"

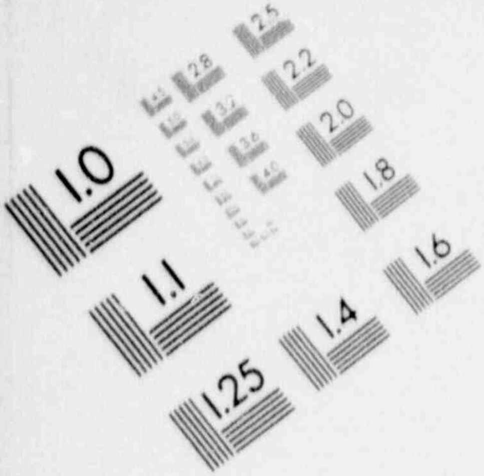
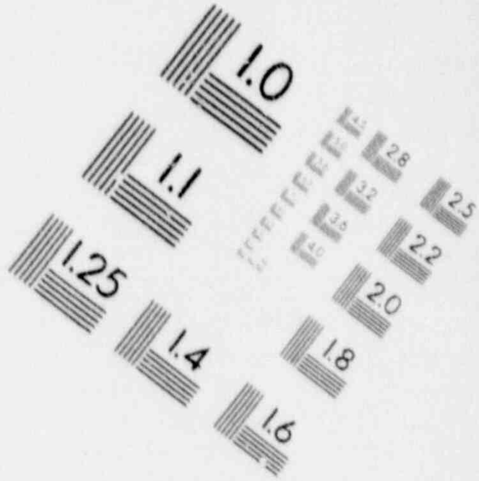



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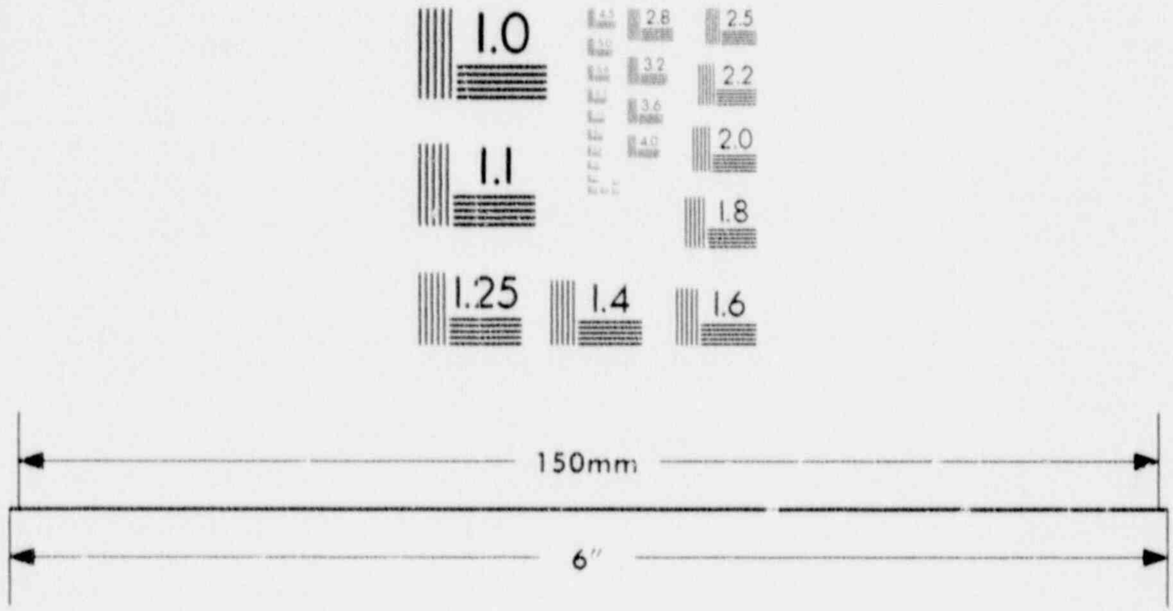
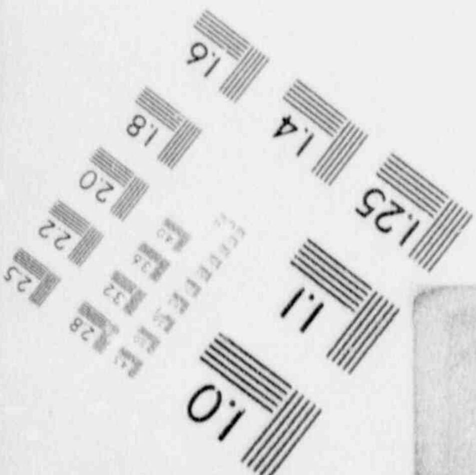
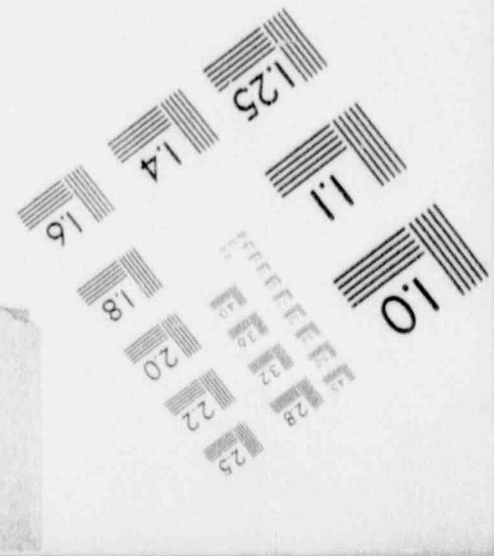
IMAGE EVALUATION TEST TARGET (MT-3)



1

IMAGE EVALUATION TEST TARGET (MT-3)

150mm

6″

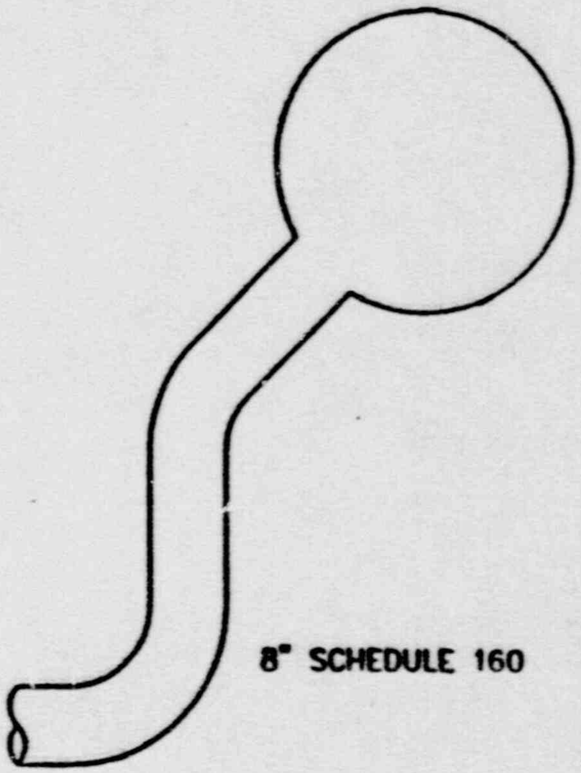
1

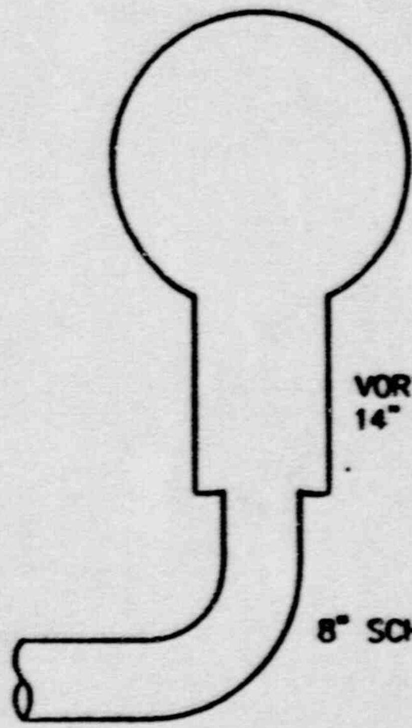
IMAGE EVALUATION TEST TARGET (MT-3)

150mm

6″

HOT LEG RHR CONNECTION





MID-LOOP OPERATION
(CONTINUED)

- DEDICATED, REDUNDANT NARROW RANGE LEVEL INSTRUMENTS WITH MCR INDICATION AND ALARM ARE PROVIDED.

- RANGE OF 'COLD' PRESSURIZER LEVEL INSTRUMENTATION HAS BEEN EXPANDED TO THE BOTTOM OF THE HOT LEG.

- EACH OF THE FOUR REDUNDANT ISS SUBSYSTEMS INCLUDES RHR FLOW MEASUREMENT AND MAIN CONTROL ROOM INDICATION.

- REDUNDANT IN-CORE THERMOCOUPLES WILL BE AVAILABLE TO MEASURE CORE EXIT TEMPERATURE DURING MID-LOOP OPERATION.

- ALL MID-LOOP OPERATIONS CAN BE PERFORMED FROM THE MCR USING THE NORMAL RHR AND CVCS FUNCTIONS.

Chapter 5 - Reactor Coolant System

Category 1 Open Issues - Clarification Provided by W

DSER Open Issue 47: Low-temperature overpressure protection (LTOP) during plant startup (5.2.2.2).

DSER Open Issue 48: LTOP during single failure of residual heat removal (RHR) valve (5.2.2.2).

DSER Open Issue 51: Decay heat generation rates (5.4.3.1).

DSER Open Issue 52: Power supply restoration of motor-operated valves (Movs) in RHR system return line from control room (5.4.3.2).

DSER Open Issue 53: Thermal relief protection for RHR (5.4.3.3).

DSER Open Issue 54: Lowered reactor coolant ystem (RCS) inventory operation of RHR (Generic Letter 88-17) (5.4.3.4).

Category 2 Open Issues - RESAR Revised to Reflect NRC Staff Position

DSER Open Issue 45: ASME code case commitments for all ASME Class 1, 2 and 3 components (5.2.1.2).

DSER Open Issue 46: Pressurizer safety valve sizing (5.2.2.1).

DSER Open Issue 49: Positive indication/alarm to signal need for initiation of LTOP system (5.2.2.2).

DSER Open Issue 50: Emergency feedwater storage tank compliance with Position G of BTP RSB 5-1 (5.4.3.1).

DSER Open Issue 55: Boron mixing/natural circulation test (5.4.3.5).

OPEN ISSUE NUMBER 42 CATEGORY 4

Integrated N16 and excore power density surveillance and protection system (4.3.1, 4.3.3, 15.3.2).

DSER (March 1989) Section 4.3.1, page 4-8

BACKGROUND

The RESAR-SP/90 uses the N16 power level and the four-segment ex-core neutron detector systems, which replace the delta coolant temperature power level system and the two-segment excore detectors used in many current Westinghouse reactors. The staff partially reviewed these systems as part of the PDA review of the RESAR 414, and reviewed and approved a form of the N16 system as part of the overpower and DNBR protection system at Comanche Peak. The four-segment excore neutron detector, which is included in the Shearon Harris design, was reviewed and partially accepted in RESAR 414 only as a monitoring system for axial power distribution because there was not sufficient information for an uncertainty analysis review of the accuracy of axial distribution monitoring.

WESTINGHOUSE POSITION

The N16 system is an improved substitute for the core delta temperature power level system and involves no significant change in operation. The four-segment excore system provides a distinct improvement over the two-segment system with its ability to monitor the axial power distribution and to remove many of the operating restrictions entailed when using the constant axial offset control (CAOC) mode to maintain power distribution within peaking factor limits. RESAR-SP/90 uses a form of CAOC with relaxed axial offset limits and no penalties for exceeding limits.

NRC STAFF POSITION

The staff is currently reviewing the integrated (N16 and excore) power density surveillance and protection system and will address this issue in the final SER.

RESAR-SP/90 RESOLUTION APPROACH

To be determined

RESAR SP/90

CHAPTER 6

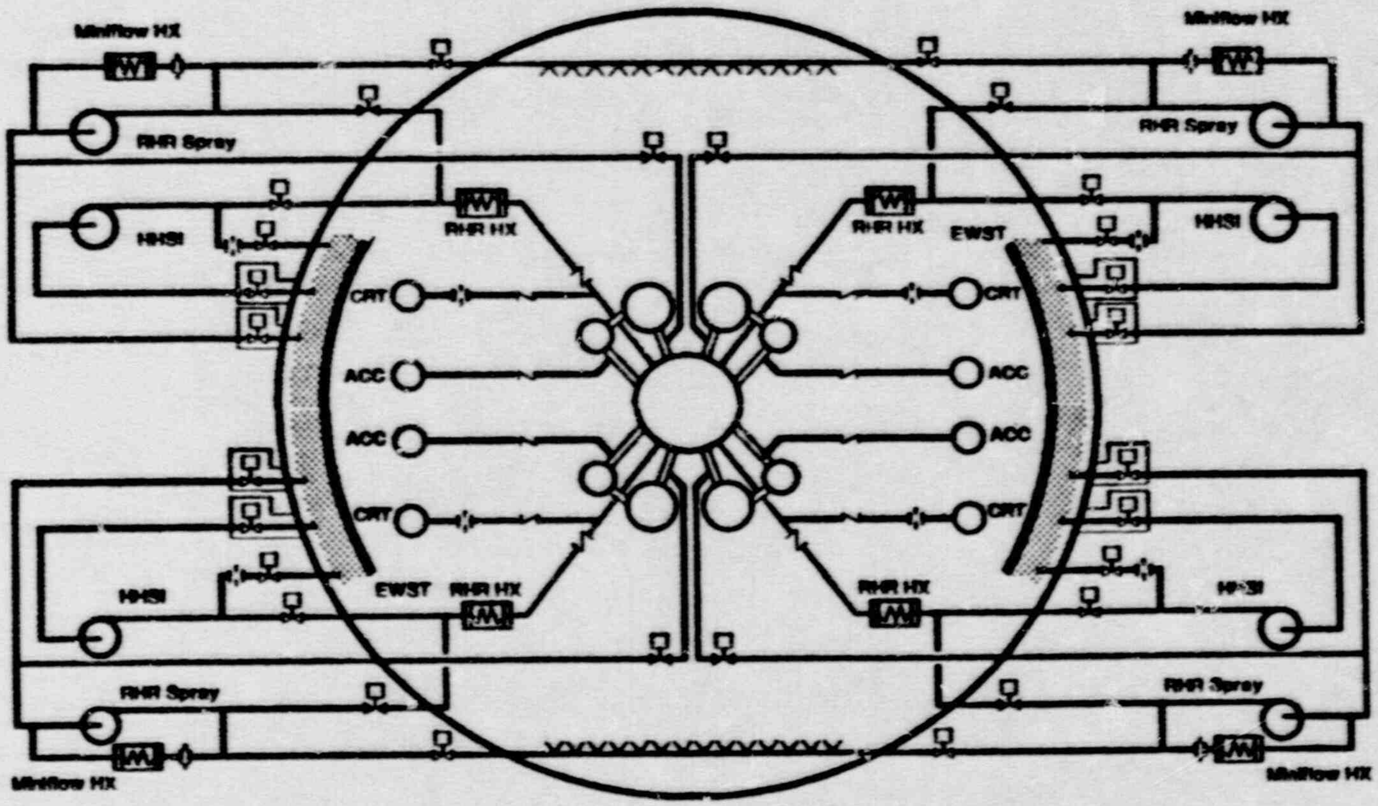
ENGINEERED SAFETY FEATURES

SP/90

CONTAINMENT

CONTAINMENT TYPE	SPHERICAL STEEL
INTERNAL DIAMETER (FT)	197
WALL THICKNESS (IN)	1.65
MATERIAL	SA 537 CL 2
DESIGN PRESSURE (PSIG)	46.9
FREE VOLUME (CUFT)	3.1E+06

APWR INTEGRATED SAFEGUARDS SYSTEM



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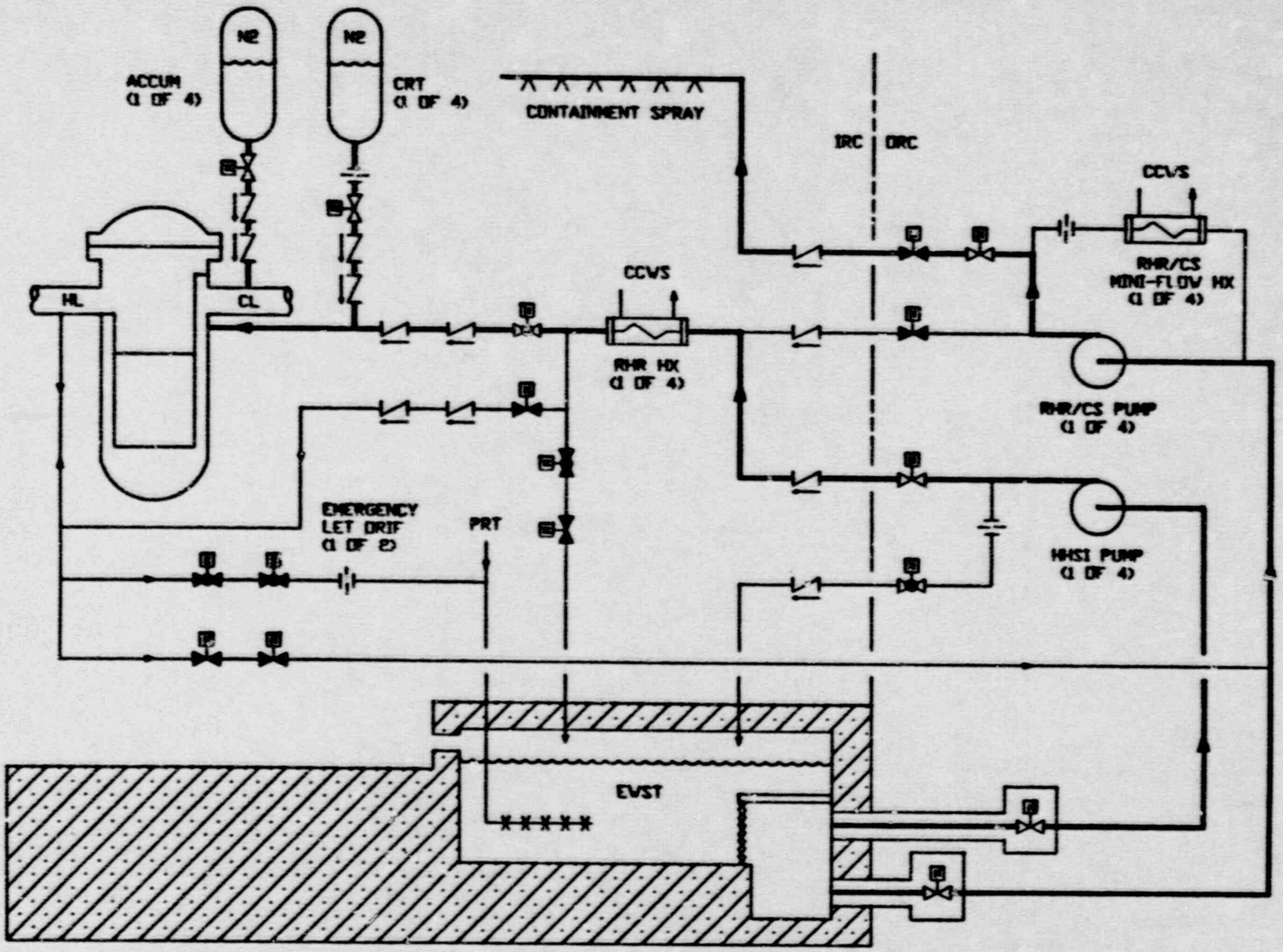
APWR - INTEGRATED SAFEGUARDS SYSTEM



SP/90

EMERGENCY CORE COOLING SYSTEM

HHSI PUMPS	
. QUANTITY	4
. RUNOUT FLOW (GPM)	1000
. DESIGN FLOW (GPM)	500
. DESIGN HEAD (PSI)	1425
. SHUTOFF HEAD (PSI)	1790
. MOTOR RATING (HP)	800
ACCUMULATORS	
. QUANTITY	4
. TANK VOLUME (CUFT)	2500
. OPERATING PRESSURE (PSIG)	600
CORE REFLOOD TANKS	
. QUANTITY	4
. TANK VOLUME (CUFT)	2000
. OPERATING PRESSURE (PSIG)	200
IN-CONTAINMENT RWST	
. QUANTITY	1
. TANK VOLUME (GAL)	580,000
. OPERATING PRESSURE	COTNAINMENT

SP/90

CONTAINMENT HEAT REMOVAL

CS/RHR PUMPS

.	QUANTITY	4
.	DESIGN FLOW (GPM)	3325
.	DESIGN HEAD (PSIA)	155
.	MOTOR RATING (HP)	420

CONTAINMENT FAN COOLERS

.	QUANTITY	4*
.	HEAT REMOVAL (BTU/HR)	80E+06

*ONLY ONE UNIT IS ASSUMED TO OPERATE POST-ACCIDENT.

SP/90

COMBUSTIBLE GAS CONTROL

- REDUNDANT ELECTRIC HYDROGEN RECOMBINERS
- HYDROGEN IGNITERS WITH CLASS 1E POWER SUPPLY
- NO RG 1.7 HYDROGEN PURGE SYSTEM, BUT OPERATING PURGE SYSTEM CAN PERFORM FUNCTION
- CONTAINMENT HYDROGEN MONITORING SYSTEM

SP/90

FISSION PRODUCT CONTROL

- NO SPRAY ADDITIVE SUBSYSTEM
- ANNULUS EXHAUST FILTRATION

Chapter 6 - Engineered Safety Features

Category 1 Open Issues - Clarification Provided by W

DSER Open Issue 59: Low-head pump deadheading (6.3.1).

DSER Open Issue 60: Loss-of-coolant accident (LOCA) analysis assumptions for ECCS (6.3.5).

DSER Open Issue 61: ECCS flow to reactor vessel during LOCA/compliance with Title 10 to the Code of Federal Regulations, Part 50, Section 50.46 (10CFR50.46) and General Design Criterion (GDC) 35 (6.3.5).

OPEN ISSUE NUMBER 39 CATEGORY 5

Testing difficulties for inservice pump and valve testing (3.9.6).

DSER (March 1989) Section 3.9.6, page 3-49

BACKGROUND

ISI testing of pumps and valves needs to be performed in accordance with the requirements of the ASME Code, Section XI. In many of the current generation designs, this testing is difficult or impossible to perform in accordance with these requirements.

WESTINGHOUSE POSITION

The SP/90 Integrated Safeguards (emergency core cooling, containment spray, and residual heat removal functions) and Emergency Feedwater systems contain features aimed at resolving problems encountered in current plants.

- o Pump miniflows are sized to allow continuous operation without damage.
- o Each pump can be tested over its full operational range with the plant at power by means of specially installed test lines.
- o ECCS injection lines including redundant check valves cannot be tested with the plant at power because the shutoff head of the HHSI pumps is below RCS pressure; however, these lines are at full flow conditions as part of normal RHR operation.
- o EFWS injection lines including redundant check valves could in principle be tested at power; however, such testing is indesirable because of the thermal transients it induces.
- o Motor operated valves (MOVs) can be stroked with the plant at power.
- o A permanently installed system is provided to allow leak testing of valves isolating the RCS from low pressure systems during each plant startup.
- o EFW pumps are provided with individual suction lines in order to eliminate the possibility of steam binding in more than one pump as a result of backleakage through the series of check valves in one pump discharge line; temperature instrumentation is also provided to detect instances of such backleakage.

In addition, the FDA Application will include the following:

- o Frequency of pump and valve testing as well as disassembly and inspection.
- o Description of pump and valve diagnostic systems.
- o Information on pump and valve prototype or in-situ testing.

OPEN ISSUE NUMBER 39 CATEGORY 5

Testing difficulties for inservice pump and valve testing (3.9.6).

DSER (March 1989) Section 3.9.6, page 3-49

(continued)

NRC STAFF POSITION

The staff has requested detailed descriptions of how various pump and valve tests will be performed.

RESAR-SP/90 RESOLUTION APPROACH

Defer detailed test descriptions to FDA Application.

OPEN ISSUE NUMBER 56 CATEGORY 4

Minimum containment pressure analysis for performance capability studies on the emergency core cooling system (ECCS) (6.2.1.5).

DSER (March 1989) Section 6.2.1, page 6-18

BACKGROUND

Appendix K, "ECCS Evaluation Model," to 10 CFR 50 states, in part, that the containment pressure used for evaluating cooling effectiveness during reflood and spray cooling shall not exceed a pressure calculated consertively for this purpose. It further requires that the calculation includes the effects of operation of all installed pressure reducing systems and processes.

WESTINGHOUSE POSITION

In response to staff question 430.12, Westinghouse provided the results of the analysis to conseratively calculate the containment pressure response. The analysis predicted a peak containment pressure of approximately 38.5 psia and decayed down to approximately 25.5 at 284 seconds. Based upon this analysis a conservatively low, constant containment pressure of 24.7 psia was used throughout the entire SP/90 ECCS transient. The inputs for the containment pressure transient modeled in the analysis are bounded by the response predicted by the minimum pressure analysis. The use of this conservatively low value for containment pressure compliance with Appendix K and Branch Technical Position CSB 6.1.

NRC STAFF POSITION

At the time of issuance of the DSER, the staff was reviewing the Westinghouse response to staff question 430.12 with regard to this matter. The results of that review will be provided in the final SER.

RESAR-SP/90 RESOLUTION APPROACH

To be determined

OPEN ISSUE NUMBER 57 CATEGORY 4

Containment pressure 24 hours after accident (6.2.2).

DSER (March 1989) Section 6.2.2, page 6-11

BACKGROUND

GDC-38 requires that containment pressure be reduced rapidly following a postulated design basis accident. The staff's position is that the containment pressure be reduced to 50 percent of peak calculated pressure for the design basis LOCA.

WESTINGHOUSE POSITION

Westinghouse is of the opinion that the reduction should be to 50 percent of containment design pressure. The rationale for this is that the basis for requiring a reduction in containment pressure is to obtain a reduction in containment leakage rate. In dose calculations it is generally assumed that the leakage rate drops to 50 percent of the design leak rate at 24 hours; this is compatible with a calculated containment pressure equal to 50 percent of design pressure.

SP/90 results are as follows:

o Containment design pressure	46.9 psig
o Calculated peak pressure (max.)	36.4 psig
o Calculated pressure @ 24 hrs. (max.)	23.5 psig

NRC STAFF POSITION

The staff has requested Westinghouse to justify the SP/90 deviation from the staff position, i.e., pressure at 24 hours should be less than 50 percent of peak pressure. The staff had not completed their review of the Westinghouse response at the issuance of the DSER.

RESAR-SP/90 RESOLUTION APPROACH

There are several approaches that could be used to meet the staff position. For example, the capacity of the heat removal systems could be increased such that the pressure at 24 hours would be about 18 psig; at the same time, containment design pressure could be decreased to 41 psig (1.1 X calculated peak) since it would no longer be constrained by pressure at 24 hours. Another approach could focus on increasing calculated peak pressure by reducing containment volume or by increasing the conservatism in short term mass and energy releases

None of these approaches appears to provide a net improvement in safety (in fact there may be a net loss); however, if the staff position remains unchanged, Westinghouse will commit to perform analyses and/or to incorporate design modifications in the FDA submittal to demonstrate that pressure at 24 hours is 50 percent of peak pressure.

OPEN ISSUE NUMBER 58 CATEGORY 5

Hydrogen purge and vent system (6.2.5).

DSER (March 1989) Section 6.2.5, page 6-18

BACKGROUND

In order to meet the intent of Regulatory Guide 1.7, most current plants include a containment hydrogen purge system as a backup to the containment hydrogen recombiners for long term hydrogen control post-LOCA. In some cases, the mini-purge (or operating purge) system is designed to perform this function.

WESTINGHOUSE POSITION

In the SP/90 plant design, backup to the in-containment electric hydrogen recombiners is provided by igniters, which are designed to mitigate a 100 percent Zr-water reaction. No separate containment hydrogen purge system is provided, nor is this function specifically assigned to the operating purge system which is, therefore, not necessarily designed in accordance with R.G. 1.7. However, in the extremely unlikely event of coincident failure of the redundant in-containment electric hydrogen recombiners and the hydrogen igniters, the operating purge system could also be used to control long term hydrogen buildup.

NRC STAFF POSITION

The staff has indicated that the operating purge system should be designed to meet the requirements of R.G. 1.7. In addition, the staff has indicated that they will provide additional guidance regarding the need for a "hardened" venting capability. The letter is not related to hydrogen control, but concerns containment performance following a severe accident, in particular in case of long term overpressurization.

RESAR-SP/90 RESOLUTION APPROACH

Westinghouse considers the hydrogen igniters to be an acceptable backup to the hydrogen recombiners in accordance with the intent of R.G. 1.7. However, if this approach is not acceptable to the staff, Westinghouse will commit to design the operating purge system in accordance with the requirements of R.G. 1.7 in order to aid in cleanup following a LOCA.

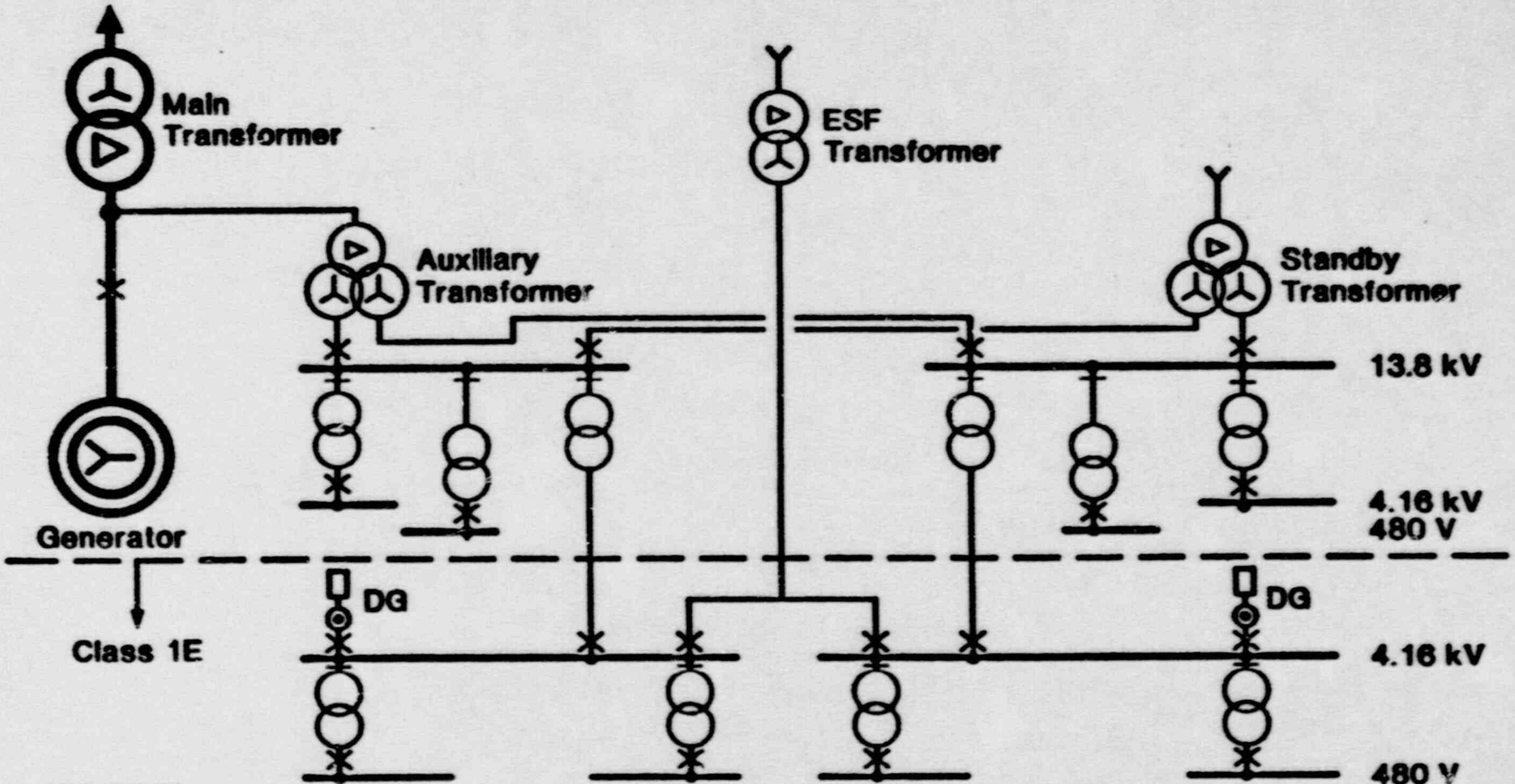
The "hardened" venting capability is related to the "Severe Accident Issue" on containment performance. This issue is presently considered by the staff as part of their review of the EPRI ALWR Requirements Document, which incorporates the Nuclear Industry (including Westinghouse) position that such a vent is not required. Westinghouse commits to meet any new requirements that may be forthcoming from this review in the FDA submittal.

RESAR SP/90

CHAPTER 8

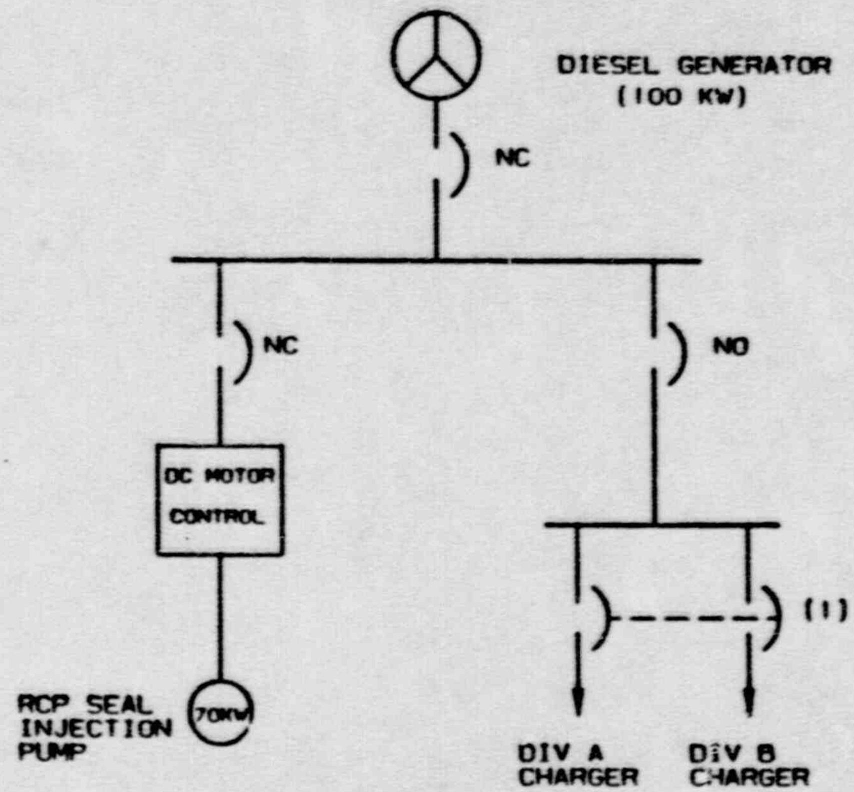
ELECTRIC POWER

APWR
Main One-Line Diagram



863 E14820.030

ALTERNATE AC POWER SOURCE



(1) INTERLOCKED SUCH THAT ONLY ONE DIVISION CAN BE CONNECTED AT ANY ONE TIME

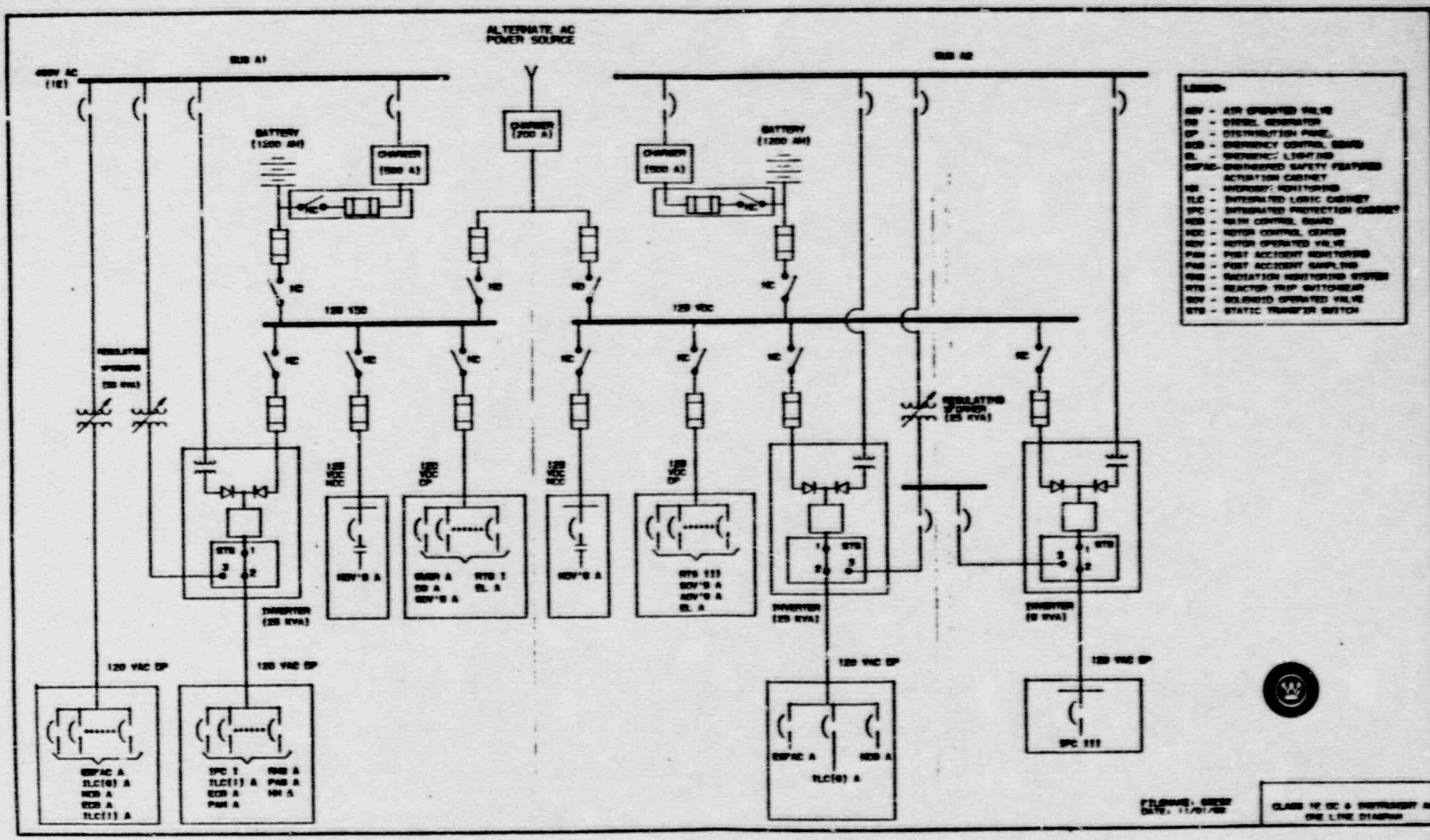
FILENAME: [illegible]
DATE: 10/17/[illegible]

ALTERNATE AC POWER SOURCE

SP/90

AC POWER SYSTEM

- MAIN GENERATOR BREAKER
- AUXILIARY AND STANDBY TRANSFORMER
- ESF TRANSFORMER WITH CAPABILITY TO SUPPLY ONE DIVISION OF ESF LOADS
- TWO CLASS 1E BUSES EACH WITH ONE CLASS 1E DIESEL GENERATOR
- ONE SMALL NON-1E DIESEL GENERATOR TO POWER SEAL INJECTION PUMP AND CHARGE BATTERIES DURING STATION BLACKOUT



ALTERNATE AC
POWER SOURCE
BATTERY
(1200 AH)
CHARGER
(500 A)
CHARGER
(200 A)
120 VAC DP
INVERTER
(25 KVA)

SP/90

DC/INSTRUMENT AC POWER SYSTEMS

- FOUR CLASS 1E BATTERIES WITH ASSOCIATED CLASS 1E CHARGERS, INVERTERS AND PANELS

- TWO NON-CLASS 1 BATTERIES WITH ASSOCIATED NON-CLASS 1E EQUIPMENT

- FOUR CLASS 1E INSTRUMENT BUSES

- TWO NON-CLASS 1E INSTRUMENT BUSES

OPEN ISSUE NUMBER 66 CATEGORY 5

Station blackout (Unresolved Safety Issue [USI] A-44) (8.4.8). Initially identified as Open Issue 5 of the staff's June 1988 Draft Safety Evaluation Report (DSER).

DSER (June 1988) Section 8.4.8, page 8-19

BACKGROUND

The final evaluation of station blackout accidents at nuclear power plants was performed by the staff and published in NUREG-1032. In resolving this issue, the staff performed a regulatory analysis which was documented in NUREG-1109. In June 1988, this USI was resolved with the publication of a new rule (53 FR 23203) and Regulatory Guide 1.155. Thus, this issue was RESOLVED and new requirements were established.

WESTINGHOUSE POSITION

The proposed resolution for the SP/90 plant includes a small diesel generator independent of off-site and on-site AC power supplies, whose primary function is to power a positive displacement pump providing backup seal injection to the reactor coolant pumps. This power source can also be used to recharge the Class 1E batteries, which will be depleted in about 4 hours. Thus, continuing operation of key instrumentation and control systems is assured.

NRC STAFF POSITION

The staff is concerned that over time the environment in rooms containing electrical, instrumentation, and control equipment (e.g. emergency control room, protection system rooms, battery rooms, inverter rooms, etc...) will deteriorate due to lack of ventilation to the point where equipment would fail. For this reason, the staff would like to see the size of the third diesel generator increased in order to allow continuing operation of selected HVAC systems.

RESAR-SP/90 RESOLUTION APPROACH

Westinghouse will commit to include environmental control of selected rooms containing electrical, instrumentation, and control equipment which is required to operate during station blackout. The equipment required to perform this environmental control function will be manually actuated and, the size of the third diesel generator will be increased as needed to power this equipment.

Chapter 8 - Electric Power

Category 1 Open Issues - Clarification Provided by W

DSER Open Issue 64: Power lockout to MOVs (8.4.3).

DSER Open Issue 65: Reliability to load sequencer with offsite power (8.4.7).

Category 2 Open Issues - RESAR Revised to Reflect NRC Staff Position

DSER Open Issue 62: Testing of fast transfer scheme (8.2.2).

DSER Open Issue 63: Containment electrical penetrations (8.4.1).

RESAR SP/90 PDA
REVIEW STATUS

A PRESENTATION TO THE ACRS SUBCOMMITTEE ON ADVANCED PRESSURIZED REACTORS

LOREN DONATELL, PROJECT MANAGER

NOVEMBER 3, 1989

CURRENT REVIEW STATUS

Accomplishments to November 1989

DSER PRA "FRONTEND"	MARCH 1988
ACRS SUBCOMMITTEE	APRIL 1988
DSER - SRP	JUNE 1988
DSER - SRP	MARCH 1989
WESTINGHOUSE RESPONDED TO OPEN ITEMS	JUNE-SEPTEMBER 1989
ACRS SUBCOMMITTEE	SEPTEMBER 1989
WESTINGHOUSE SUBMITTED AMENDED USIs/GSIs	OCTOBER 1989
ACRS SUBCOMMITTEE	NOVEMBER 1989

DSER OPEN ITEMS

CHAPTER 3.0 "DESIGN OF STRUCTURES, COMPONENTS, EQUIPMENT AND SYSTEMS"
open items # 1 - 41

CHAPTER 4.0 "REACTOR"
open items # 42 - 44

CHAPTER 5.0 "REACTOR COOLANT SYSTEM AND CONNECTED SYSTEMS"
open items # 45 - 55

CHAPTER 6.0 "ENGINEERED SAFETY FEATURES"
open items # 56 - 61

CHAPTER 8.0 "ELECTRIC POWER SYSTEMS"
open items # 62 - 66

SCHEDULE TO COMPLETE PDA REVIEW

items to be accomplished

NRC ISSUE DSER PRA "BACKEND"	NOVEMBER 1989
NRC REVIEW USIs/GSIs AND PROVIDES INPUT TO WESTINGHOUSE	NOVEMBER - DECEMBER 1989
ACRS SUBCOMMITTEE Re: DSER CHAPTERS	JANUARY 1990
WESTINGHOUSE RESPONDS TO USI/GSI INPUT	JANUARY 1990
ACRS SUBCOMMITTEE Re: USIs/GSIs	FEBRUARY 1990
NRC ISSUES DSER ON USIs/GSIs AND SEVERE ACCIDENTS	FEBRUARY 1990
ACRS SUBCOMMITTEE Re: DRAFT FINAL SER AND REQUEST LETTER	MARCH 1990
ACRS FULL COMMITTEE Re: DRAFT FINAL SER AND REQUEST LETTER	APRIL 1990
NRC ISSUES FINAL SER	MAY 1990
PDA DECISION AND SSER	JUNE 1990

SUMMARY

- o ESTABLISH COMMISSION - APPROVED PRIORITY FOR SP/90 PDA
- o 3 DSERS ISSUED
- o OPEN ITEMS
  - o 107 BEFORE PDA IS ISSUED
  - o 53 BEFORE FDA IS ISSUED
  - o 99 BEFORE FDA IS ISSUED AND/OR PLANT SPECIFIC APPLICATION
- o RESOLVE USI/GSI AND SEVERE ACCIDENT ISSUES
- o 2 ADDITIONAL DSERs NEEDED BEFORE PDA DECISION
- o ROUND OF ACRS MEETINGS
- o ISSUE FINAL SER
- o ISSUE PDA AND SSER