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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

In the matter of:

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

Docket No.

Subcommittee on Emergency Core Cooling Systems

OPEN MEETING

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TAYLOE ASSOCIATES
Court Reporters
1625 I Street, N.W. Suite 1004
Washington, D.C. 20006
(202) 293-3950

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NUCLEAR REGULATORY COMMISSION

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

Subcommittee on Emergency Core Cooling Systems

Room 1046
1717 H Street, NW
Washington, D.C.

Tuesday, November 8, 1983

The Subcommittee on Emergency Core Cooling Systems convened at 8:30 a.m., pursuant to notice, David Ward, Chairman of the Subcommittee, presiding.

PRESENT FOR THE ACRS:

D. WARD, Member

J. EBERSOLE, Member

C. MICHELSON, Member

I. CATTON, Consultant

M. SHROCK, Consultant

M. TIEN, Consultant

P. BOEHNERT, Designated Federal Employee

AUDIENCE PARTICIPANTS:

L. SHOTKIN

B. SHERON

V. BECHNER

M. YOUNG

R. CARTER

C. MORGAN

N. ZUBER

R. JONES

N. LOWBIN

P R O C E E D I N G S

MR. WARD: The meeting will come to order.

This is a meeting of the Advisory Committee on Reactor Safeguards' Subcommittee on the Emergency Core Cooling Systems.

I am David Ward, the subcommittee chairman.

Other ACRS members here are Mr. Ebersole and Mr. Michelson, who will be in in a moment.

We also have ACRS consultants Mr. Catton and Mr. Shrock and Mr. Tien.

The purpose of the meeting today is: First, to continue our review of Joint NRC-B&W EPRI interval test program.

Second, review selected NRC research programs to support the ACRS report to Congress for fiscal years 1985 and '86.

The meeting is being conducted in accordance with provisions of the Federal Advisory Committee Act and the Government in the Sunshine Act.

Mr. Paul Boehnert, on my right, is the Designated Federal Employee.

Rules for participation in today's meeting have been announced as part of the notice previously published in the Federal Register on Monday, October 24th, 1983.

A transcript is being kept and will be made

available, as stated in the Federal Register notice.

We request that each speaker first identify herself or himself and speak with sufficient clarity and volume so that he or she can be readily heard.

We have received no written comment from members of the public and no request for time to make oral statements from members of the public.

If there is anyone here who would like to make a statement, if he or she would make himself or herself known to Mr.Boehnert during a break, we can arrange that later in the meeting.

We have a variety of topics to cover. Most of the morning, however, will be spent with a single topic, the continuation of our review of IST program investigating the thermal hydraulic behavior of Babcock & Wilcox reactors. At our last meeting on this topic in Alliance in July, the subcommittee concluded it was not prepared to support the MIST design and, by implication, the test program.

Whether this was because we didn't like what was being proposed or the program managers hadn't successfully communicated to us the reason for design choices wasn't clear.

Perhaps it was some combination of those two things.

Since then, two of our consultants, Mr. Schrock

and Mr. Catton attended an IST review group meeting in Bethesda in October. Although some points were clarified, in reading the reports, I concluded that the situation is approximately where it was after the Alliance meeting.

As far as the subcommittee's understanding or position on the facility design, I hope that by the end of the morning session we can go further toward improving our understanding and perhaps see our way clear to make some more positive suggestions or an endorsement of the proposal the IST group has developed. I think we certainly believe in the program. The experimental investigation to provide a better understanding of the thermal hydraulic behavior in B&W plants is of great interest and of very great importance. And the organization that has been brought to bear on the program is an excellent one, combining talents from several different institutions.

What we have asked to hear -- what we want to hear about the program is an explanation of the logical development of the design and test specifications for MIST, in particular, which seems to be the centerpiece and certainly the most expensive part of the program.

I have some concern, in looking at the agenda and some advanced word, whether we are going to hear that laid out today as well as we would like to have it.

My concern there is perhaps not so much -- or not

only that.

This logical development of the specifications hasn't been presented to us in an understandable way, but because it has not been -- at least I have some concern over how logical the development really has been.

If the development of specifications has been highly subjective, if the reasons are buried in a thick document and are not readily explainable, I think the subcommittee will probably retain its uncertainty about the program.

We presume that the goal of the MIST program is to end up with a good code which describes the thermal hydraulic behavior of the B&W plants and permits it to be understood and predicted over a wide range of normal and off-normal conditions. And we presume you have identified some particular facets of the overall behavior which you believe are not well enough understood at the present time, and therefore the experimental program is needed.

So, all we are asking for is for you to tell us what those are, what, in relationship to those facets or uncertainties in behavior, you expect to learn from MIST. Tell us what you do not expect to learn from MIST, and then what sort of support you expect to get from the other test facilities, other experimental programs.

Then, finally, I think we would like to hear

something about the benefit from any experimental program and its potential to discover things, phenomena that may be important but have not been recognized for.

So, we would like to hear something from you about how you are structuring the experimental programs to look for surprises that might be important.

Do any of our -- I have talked mainly about the IST program. And, of course, the subject of our two-day program is broader than that.

I think Mr. Shotkin's introduction is going to be somewhat broader. But does anyone else on the subcommittee or any of the consultants have any comments they would like to make at the present time -- in particular, about the IST program?

MR. EBERSOLE: I haven't.

MR. MICHELSON: (Nods negatively.)

MR. WARD: Let's go ahead then.

And I will call on Mr. Lou Shotkin.

Let's see, Lou, are you going to give us some cautionary words?

Does your handout include some dollar numbers?

MR. SHOTKIN: Yes, it does.

MR. WARD: When you get to that, maybe you would provide the necessary cautionary words to us.

MR. SHOTKIN: Okay. I have given you two handouts.

One with this cover page on it. (Indicating.)

It contains four separate parts. I will be giving, during the next two days, four separate talks, and they are all on that handout.

I will start right now with the Reactor Systems Research Branch's programs.

In addition to the main handout, there's a supplementary handout which contains the budget numbers. And I understand I am not allowed to mention the numbers, but we will go over them the best way we can.

MR. WARD: I think that means the subcommittee members and consultants aren't allowed to mention the numbers either.

MR. SHOTKIN: This is a matrix that shows the totality of our research programs.

Across the top -- and I presented a similar slide at the June meeting -- across the top are major analysis codes: TRAC-PWR, RELAP-5, TRAC-BWR, COBRA, and component codes, and then over there, other codes.

And here (indicating) are the main safety issue topics we work on.

And in the matrix are either facilities that address these issues or labs that are working on them.

In the next two days, we will be talking primarily in this box here. (Indicating.)

We will be talking of the three codes, the TRAC-PWR, RELAP-5, and TRAC-BWR. And we will be going down only through the PWR safety issues. We will not be discussing any GE safety issues or any component codes.

This afternoon we will be talking about the nuclear plant analyzer and data bank. You asked for a three-hour presentation on that. And there LASL is developing the TRAC-PWR, Idaho, the RELAP-5 part. And then, way over here, Brookhaven is working with another code to develop the BWR. But we will go over more on that in detail this afternoon.

Tomorrow, we will go over the 2D/3D program, which includes these three facilities, one in Germany. We will be telling you what we are doing there, what the status of the program is and what options we are working on after the agreement expires in April of '85.

We will bring you up to date on the ROSA IV program that addresses Westinghouse and Combustion safety issues.

Also, you asked for ROSA III, and we have something prepared on that.

We will tell you of our options that we are looking at on SEMISCALE, which are new since the June meeting.

We are looking at a funding reduction for SEMISCALE in the outyears.

And, of course, today we will concentrate on the B&W facilities with the MIST facility, OTIS, GERDA, the University of Maryland, and so on.

Another major development that has happened since the June meeting is indicated by this box with the star, which says all tne U.S. and overseas facilities. And under the Code Assessment Program, you will hear of our developments where we have code technology exchange agreements that we are working on with other countries to have them take our safety codes, which they are interested in getting, analyze the data from their facilities and share the results with us, and also data from their plants.

With that, I think I will just go into the budget unless there are any questions.

Now, I understand I don't put up any viewgraphs on this. So, if you will just take your handout -- and am I allowed to show something?

The next to the last page has a graph. (Indicating.)

It shows fiscal years '83 through '86, and then budget in the ordinate. And this branch funding is broken up into two decision units: One, the LOCA decision unit, which you see going down precipitously in '83. That is primarily due to the LOFT program. And then the total funding -- this is thermal hydraulic plus LOCA. And you

see that going down by something like 10 percent a year or more.

I had a discussion with my management yesterday. And what I was told to tell you is that this is good news. The budget may go down even more than this in '85 and '86, depending upon OMB. It is up in the air right now.

Now, if you will turn to the first page --

MR. WARD: Lou, can I ask you a question about that?

With a budget turning down and LOCA becoming less important, what is the incentive for maintaining two decision units for this work? There is a lot of overlap.

MR. SHOTKIN: I think it is just historical.

I see your point, and we can recommend it be combined. There is no real sense in keeping them separate anymore.

Essentially, the next slides -- all of the rest of the slides at the beginning explain these budget reductions and in some cases budget increases in more detail.

So, if you turn to the first page of that handout, this gives the total funding for the thermal hydraulic transient decision unit and the LOCA decision unit by fiscal year. They are the same numbers as on the graph.

And between '83 and '84, you see the budget of thermal hydraulic transients increasing.

And if you go down, at delta plus, it explains roughly the programs where that increase took place.

The one mistake on this slide is "ROSA IV" should be crossed out. That should not be there as a budget increase. It is just about the same, but there was an increase in the MIST facility and in the plant analyzer.

MR. CATTON: What fraction of the '84 is MIST?

MR. SHOTKIN: 11 percent of the '84 -- I am sorry, the fraction of what, of the increase or of the funding?

MR. CATTON: Total.

MR. SHOTKIN: That will come up on another slide.

MR. CATTON: Okay.

MR. SHOTKIN: Between '84 and '85, you see a budget decrease of thermal hydraulic transients -- the decrease between '84 and '85, you will look at the delta minus. And that decrease occurred in SEMISCALE, FIST and codes.

Most of that decrease occurred in the code in improvement maintenance assessment application and also some of the plant analyzers.

Between '85 and '86, there is a further decrease.

That's broken up.

There's some increase between '85 and '86.

There was some increase on model development work and analysis, mostly in applications. But there was an

SEMISCALE?

even bigger decrease in SEMISCALE -- a decrease in funding in MIST, but that is just our projected funding. We have a committed amount that we give, so much per fiscal year.

And then, as you know, we have some fuel behavior work in our decision unit that is under another branch, and that was cut some between '85 and '86.

On the loss-of-cooling accident, there was a big decrease in '84 and '85. It was mainly in LOFT, some in 2D and 3D. We zeroed it out after '84.

Most of the decreases are plant decreases in the 2D/3D program and in the LOCA codes program.

The next slide goes into more details -- a breakout for each decision unit, the sub-elements. So, the next page has the integral facilities sub-element.

And if you, in answer to Catton's -- Professor Catton's question, you see the third line down, MIST Otis facility, this gives the total funding for each of these facilities in each fiscal year.

So, in '84, the percentage of the total funding

end 1

for MIST is roughly 20 percent -- well, about 18 percent.

I don't know how much detail to go into in these, but I have some time so I can go in a little bit. You see, in SEMISCALE between '84 and '85, there is a moderate decrease and the reason is we complete the planned feedline, steamline break test. But there is an even bigger precipitous drop, something new for SEMISCALE programs between 85 and 86. We will tell you about that tomorrow, what our plans are for the facility, and why we are looking for a big funding reduction.

MR. CATTON: Are we going to hear why NRR wants to keep it as well?

MR. SHOTKIN: Yes. That will be one of the major parts of the presentation.

The PIST program, you see there is some degrees between '84 and '85. That is, mainly we complete the Phase 2 testing and the Phase 3 testing right now is being discussed. We have some interesting ideas from EPRI on what should be done, but we won't talk about that on these two days.

And then MIST is just -- you have seen these numbers before, I think. These are just planned funding for MIST.

MR. CATTON: You have a fixed budget, over the next few years. What are you going to do when one of the programs cost more than planned?

MR. SHOTKIN: I think, as we look ahead in the out years, with these budget decreases in bureaucratic terms, there is no more fat left and we are down to the bone. And

some programs will just have to be hurt or cut out.

MR. CATTON: It would be interesting -- at least to me -- if, as you went along, we would get some kind of a measure as to which programs fall first during a period of reducing budget.

MR. SHOTKIN: You don't mean today?

MR. CATTON: Well, when the two days are over you would like to be able -- in my own mind -- to decide what would happen under a decreasing budget.

MR. SHOTKIN: I will tell you what we have planned to absorb these projected cuts. We are certainly decreasing the SEMISCALE funding and we will tell you about that. We are trying to do most of our code assessment work as part of code technology exchange and save money there. And you will hear that we have a re-evaluation of the TRAC-PWR and RELAP 5 codes that I will go over with you tomorrow where we will continue funding for one code and just continue user support in the other code, but I will bring that up.

MR. CATTON: What I am thinking more of is -- in a large experimental program -- being able to project three or four years into the future is nearly impossible and I have never seen one yet that did not grow. And I would like to know how you will accomodate this. I'm not sure this should be discussed here, but it is certainly something we should all think about, something will have to be squeezed.

MR. SHOTKIN: The next phase is the separate effects. There is model development. There is a big increase between '83 and '84. We started the Small Business Innovative Research Program, and most of that increase went into these small business contracts and in between '85 and '86 there is a big increase in model development and we plan to look over all of our constituent models and our codes at that time and we will expect we will have to do a lot of model work in general heat transfer and condensation processes.

Under experiments, the increase between '83 --

MR. WARD: Lou, the small business programs, are we going to hear a little more about that?

MR. SHOTKIN: I hadn't planned to, but I can tell you right now.

MR. WARD: Yes. Just quickly, what sort of work is being done by small businesses?

MR. SHOTKIN: There's a NUREG that comes out every year. Actually, there has been one coming out and we are working on the next version where we list -- we meaning the Office of Research -- list all of the programs, by branch, that we might be interested in having a small business compete. It is a competitive program. In fact, last year I think there was something like 50 to 70 proposals and seven were accepted. The idea is to seek innovative research, where NRC doesn't stand over your head and tell you exactly what you do, but

where small business is encouraged to try to meet the needs we define in this NUREG and submit a proposal, which we then fund.

There is a seed part of it, Phase 1, in the first year which is something like 50 K and then it can go up to something like 250 K for the next year, in Phase 2. It's not a long term program. It's like a two and three year program to see what we can get out of it.

MR. WARD: So the NUREG you are talking about is for a class of board programs in the research office, or broader?

MR. SHOTKIN: Yes.

MR. CATTON: DOE has a similar program. Is this the same kind of thing? It is not for universities. It is for small business, as defined by the Small Business Administration?

MR. SHOTKIN: Yes. Under 50 people, or something like that. But a lot of our proposals come from university people who form little companies.

(Laughter.)

MR. WARD: What percentage, would you say, come from those?

MR. SHOTKIN: I don't know.

MR. CATTON: High.

MR. TIEN: I think this is a program for all federal agencies. All agencies have that program. It is mandated

by Congress, in fact.

MR. SHOTKIN: I can only address the one our office administers. Is that enough on that?

MR. WARD: That's good, thanks.

MR. SHOTKIN: The experimental work between '83 and '84, the increase mainly goes or partially goes into the thermal hydraulic experimental facility in Idaho. And after several years of effort, we are finally going to get our small break critical flow testing done in '84. We also have a small little program on steam generated tube rupture research that Oak Ridge is doing and there are a lot of little programs there.

Then the decrease between '84 and '85 and THEF is an EPRI cooperative program, between '84 and '85 the decrease is mainly between THEF -- where we have only defined right now a one year program. ROSA IV is fairly constant and the next big drop between '85 and '86 is in the fuel behavior sub-element and that is a sub-element that is mainly supporting the fuel codes.

The next page looks at the sub-element called Transient Models Codes. The first decrease in code improvement maintenance, the big one is between 1984 and '85 and that is spread out fairly equally between the three major codes, RELAP 5, TRAC, and COBRA. And that is not only in improvement and maintenance -- well, it is in improvement and maintenance.

Then under Code Assessment and Application, a big decrease between '84 and '85 is mainly in assessment. We figure that we'll be finishing up most of our domestic assessment work. And by that time, we will be counting on our code technology exchange, mainly with foreign countries but also with some U.S. countries, to supply most of our assessment results. And then the big increase between 1985 and '86 is in code application work. The plant analyzer and data bank increase between '83 and '84 was mainly just a putting the funding. It was a budgetary shift of identifying the funding at I&L Lanel separately for the plant analyzer and data bank.

And finally, the last page before the graph, has the 2D Loss of Coolant Accidents. The first line is the 2D/3D program, which is the major actor in this area. And you see there is an almost continual decrease through the years. This is mainly a planned decrease. Between '83 and '84 a lot of our instruments have been delivered to the Japanese facilities. The DAS for the German UPTF was mostly finished. There was some work in '84. Between '84 and '85 we are, again, delivering some instruments from Oak Ridge and Idaho and phasing out that work. The Germans are picking up some in instrument calibration and saving some money there.

And finally, between '85 and '86, almost all of our instruments will be delivered and we go down to mainly an

analysis program and some instrument maintenance work. And finally the codes. It decreases, as you see. This is under the LOCA decision. There is pretty much a planned decrease in code development and assessment work under this decision unit, through the fiscal years. There is a big decrease between '83 and '84 and another between '84 and '85.

MR. CATTON: Lou, under the 2D/3D, between '85 and '86, how much of that will go to the German program and how much to the Japanese, fractionally?

MR. SHOTKIN: The decrease?

MR. CATTON: No. I see the decrease. But Fiscal '86 has a number associated with it. How much is going to Japan and how much to the German program?

MR. SHOTKIN: At that point, it is about equal because most of it is in analysis. We will be doing analyses for both UPTF and SEF in '86.

MR. CATTON: So most of that will be in this country? The number under '86?

MR. SHOTKIN: All of that money is spent in this country.

MR. CATTON: Okay.

MR. SHOTKIN: There was one other slide in your package, and that was to show the change since the last slide in the package. These are all delta numbers. They are all minus delta numbers. In June of 1983 we presented some OND

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budget numbers to you. And since then there has been a decrease. And this slide explains how much that decrease was in each fiscal year and for each of the two decision units and roughly the major programs where that decrease was absorbed. So thermal hydraulic transients, there was a decrease in '84. That small decrease was just absorbed under miscellaneous programs. The big decrease in '85 was mainly SEMISCALE, some codes, some in model developments and experiments.

The big decrease in '86 was primarily all in SEMI-SCALE and under Loss of Coolant Accidents. The decreases, in '84 were some in -- about equally between 2D/3D and codes. And that was absorbed by tightening belts. But in '85 and '86 the decrease that came in the code part, we have this idea for this computer simulation scaling. We used to call this a decision unit where we were going to take data from experimental facilities or test operation of experimental facilities and run plant calculations with the same initial and boundary conditions and compare the behavior with the test. We pretty much had to drop that program. We did get some interesting results, if you will remember, not from this past information meeting but the previous one. Vic Ransom presented a calculation with RELAP of the two LOFT pumps on, pumps off test, L3-5 and L3-6, where LOFT was telling us that pumps on was worse, pumps off was better. But because of the geometry in LOFT, they had a different height of the loop seal and a different

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bypass flow, when he did it, than that at same test conditions on a Westinghouse plant. So he got the opposite conditions on pumps on, pumps off. We thought that would be interesting to investigate, but we have had to put that in the back burner, or drop it.

And the decrease in 1985, in Loss of Coolants, we had some analysis reserved and some tech support reserved that was undesignated and we absorbed most of it there. So we lost most of our reserve and the same thing in '86. We had some undesignated tech support, in case some of our instruments weren't working or in case we needed another Resident Engineer, that we won't be able to do now.

And under Analysis, we had planned to do some coupling studies that we will just have to drop.

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MR. SHOTKIN: That's all I have.

MR. WARD: Any questions?

(No response.)

MR. WARD: Thank you. I think that has been an effective way to give us an overview.

Let's go on to our next speaker, then.

Mr. Sheron?

MR. SHERON: I am Brian Sheron, with the Reactors Systems Branch. I am going to try to give you a quick overview of what the agenda says, NRR comments on this.

I think after hearing Dr. Ward's opening remarks, there is a bit of a disconnect here and I will hopefully try to clean it up a little.

My understanding is the ACRS Subcommittee has already expressed concerns regarding the adequacy of this proposed integral system test program which is comprised of GERDA, OTIS, MIST and the University of Maryland.

The concerns I gleaned from a memo from Dr. Ward, who heard that we had -- Staff I should say -- has not clearly identified what the concerns of thermal hydraulic behavior associated with the concerns are, that the current understanding of the particular phenomena which we were worried about had not defined that the capability or lack of capability of the codes to model these phenomena we were interested in had not been identified and that the ability of GERDA, OTIS, MIST

and the University of Maryland, or what have you, to address or not address these issues has not been identified.

Speaking quite honestly, I was a little concerned because I thought we had on numerous occasions rather painfully gone through the process of identifying the concerns.

I say "painful" because in the early stages of negotiation, the B & W owners asked us the same question. They said, what is your problem? Can you tell us what your problem is? We will be able to answer it.

So, we put down in rather excruciating detail as best as we could what the concerns were in this area and they were identified in a letter from Mr. Denton to Mr. Parker as far back as April 1, 1981.

There was a meeting summary issued when we met with the executive representatives of the owners' group concerning the experimental verification of accident models. This was also in 1981.

There was a general request of what our concerns were when we had asked research to perform a conceptual design study of the facility to discover the B & W and CE integral system characteristics. That went out in 1981.

The most recent letter I remember which kind of spelled out in gory detail what the problems were was a letter from Mr. Denton to John Mattimoe of SMUD, basically saying, look, here is the problem and here is what it will take to

resolve it.

As a result of this user need letter to research, EG&G was commissioned to produce what we call a 2x4 study and that went through a lot of tradeoffs looking at various options of one-loop, two-loop, 2x4 facilities, what should be a modification to the existing SEMISCALE, whether it should be a completely new facility or something else.

As a result of the Denton to Mattimoe letter, and I believe there was a subsequent meeting with the senior executives of the B & W utilities in that time frame , it was established what was referred to as the TAG Committee, Test Advisory Group.

This was composed of representatives from various offices within NRC, the NRR, AEOD research and well as the B & W owners, EPRI, and I believe some of the ACRS consultants also attended some of these meetings and met on some three or four different occasions and debated and the like in rather gory detail on what is the best test facility that would best answer the concerns previously expressed by the Staff.

They looked at a number of options from existing facilities like GERDA to brand new facilities that looked like B & W plants as well as modifications to existing facilities.

MR. SCHROCK: Could you reiterate the forays of concern referenced at the bottom of that last slide.

MR. SHERON: They were the ones that were on the first slide. Those four bullets that I am referring to.

MR. CATTON: Would you push that up?

I think I could help, Brian. I think in part I am probably the one who has raised a lot of these questions. I can just take the first one. The Staff has not clearly identified concerns for thermal hydraulic behavior associated with the concerns -- you say loss of natural circulation, for example.

What is the information that you need and how are you going to get it?

I understand the statement when you say we are concerned with understanding loss of natural circulation but, what is it about the loss of natural circulation you are looking for, and why do we not understand it?

What phenomena associated with it is it that we are missing and how are we going to get it? That is what the question is.

MR. SHERON: This is where we are getting into a philosophical difference of opinion on what constitutes a problem, okay?

I see a code that was used to predict small break loss of coolant accidents by a vendor prior to TMI. Prior to TMI that code never identified this interaction of natural circulation phenomena because it wasn't utilized correctly.

After TMI, and I guess at the insistence and prodding of Mr. Michelson for that matter, B & W did reanalyze the small break in this range and lo! and behold! they said, yes, if we nodalize it differently we get this whole different phenomena. It is a whole different bag. You can't carry that any further, I don't think. It is something new that we learned.

You say, what is the concern? Is the core going to melt? I don't know. I don't think it is. We tried to trace it through and follow it through.

We said, as a matter of fact, there was a question why should we let these plants keep operating back in 1979?

MR. CATTON: Brian, if I write a code and I do it, I was going to use the the word "stupidly" but I will use "oversimplistically" and I leave something out of the code, that doesn't mean I run a multimillion dollar experiment.

That means I look at my code and try to do it right. It is not that I don't understand. It is that for some reason I left it out.

MR. SHERON: Let's carry it one step further, all right?

Then realizing that we had an unknown phenomena, which we had not previously thought about or considered, then we took a little harder look and we said, gee, these plants have to drop the level all of the way down into a condensing surface and the steam generator, in order to reestablish what

we call the boiler condenser mode of natural circulation, which again we had never looked at, the codes had never been verified.

MR. CATTON: That again is another example.

MR. SHERON: That's right --

MR. CATTON: -- of not putting the codes together right and I recollect many loud discussions about you can't work the code that way; you must do something more with the code.

Now do you run a multimillion dollar experiment to demonstrate that?

MR. SHERON: Where do you draw the line, Ivan, between running small scale facilities or an integral system facilities?

MR. CATTON: I may believe in an integral system facilities providing they are doing the right thing.

MR. SHERON: I am saying we looked at the overall picture, okay, of what areas we were uncomfortable with. We started to think about steam generator tube ruptures. We realized these beasts behave a little differently than tube ruptures.

When you start looking at all of the question marks we were piling up on behavior there were enough of them that I think in our engineering judgment collectively we felt that warranted the integral system facility approach as opposed to

a separate effect-type of resolution.

There is no clear-cut criteria that says when you stay with separate effects, small scale, bench scale, do-it-cheap, do-it-quick, versus I go to a multimillion dollar facility, okay?

It was just our judgment and we tried to get an opinion from a number of different sources including the ACRS and the consultants that this was the appropriate way to go based upon our collective opinion of what the problems were.

And I thought in going forward with this TAG group and which ultimately culminated in a contract that all of the parties that have been consulted were on board.

We had a favorable letter from the ACRS saying we think this is the right way to go. Our management at NRR was telling us, yes, you are on the right track; this is the right way to go. The research management was saying, yes, this is the right way to go.

MR. CATTON: Maybe you don't read the ACRS consultants' letters.

MR. SHERON: I recall a letter you wrote; as a matter of fact, I pulled it. You said a SEMISCALE type facility was appropriate, you thought, provided it had the right support facilities such as the University of Maryland or an SRI and I think that is a legitimate concern and I think we can address that, that we have the right

support facilities to fill in the blanks, but I felt the appropriate consensus had been reached in terms of the integral assistance approach is the right way to go to solve the problems.

MR. WARD: I am not sure we are discussing the point of difference here.

Perhaps, Ivan, it is your point of difference, but I don't think the Committee took the position questioning the need for an integral facility of this sort.

As you say, you have a letter from the Committee endorsing that approach. What we are talking about here is the next level down, the design.

MR. SHERON: Is this the right facility?

MR. CATTON: That is right.

MR. WARD: Yes.

MR. SHERON: Let me get to that, if I may.

End 3.

MR. WARD: All right.

MR. SHERON: Okay.

I am going to expand on this. So, don't take it too literally.

Basically, in looking at it, we have sort of come to the conclusion that we felt all of the issues had been clearly identified, discussed in an open forum, and documented.

I recall being down here a number of times going through the gory details of concerns.

The thermal hydraulic issues have, indeed, been identified. The capabilities of the various facilities to produce the desired data, including scaling considerations, have been evaluated -- in fact, in more detail than any other integral facility this Commission has embarked on, like SEMISCALE, FIST or LOFT.

I think we have run this one out.

I believe we could probably -- I really believe that residual concerns can best be addressed by us, by the PMG as a group, if one can characterize them as specifically omissions, deletions, or faults with the TAG report.

MR. EBERSOLE: May I ask a question?

MR. SHERON: Sure.

MR. EBERSOLE: Just to clarify for me, would you say we get out of this experiment, this facility and the codes that go with it, a fair representation of what I will call the changes in vertical profile characteristics of the

facilities that we are trying to study in terms of the parting surface areas, the different elevations, the effects on steam quality at the point of emission or the leaks that we postulate as a function of variable levels and these parting-surface geometries as we go down and thus get an accurate representation of the in-flow to loss versus the the coolant loss, which changes drastically according to these surfaces?

MR. SHERON: Probably not.

MR. EBERSOLE: Then, how will we ever get an adequate representation of heat loss versus inventory loss?

MR. SHERON: You have to ask yourself, when you are verifying a code, what it is that you are looking at.

MR. EBERSOLE: I'm looking at where the heat is going versus where the fluid is going.

MR. SHERON: Let me back off a second.

I got into this one. I read through the issue, reports and the C-scaling criteria, which said make it short and fast.

One has to ask oneself -- okay, number one, I never take a code or an experimental facility and I never take those results and apply them directly to a plant by saying, "Gee, the experiment acted this way, therefore all plants act this way. Therefore, I will take some licensing action based upon the experiment." I don't do that.

I take the experiment and I convince myself that the code can take that experiment. I take a hard look at all the phenomena that occurred in the experiment, and I try, through some rational engineering means, to convince myself that the same phenomena is expected to occur in the large plant.

Sometimes I am not sure to such a degree that I have to run a full-scale separate-effects facility to confirm that. And we are doing that in stuff like 2D/3D to confirm that.

In the same sense, I don't need to assure that I match everything perfectly to verify my code.

For example, I remember Dr. Catton talked about what about time-scaling -- "Gee, why don't you want time-scale?" Why is okay not to time-scale?

MR. CATTON: Just a minute, Brian. I have not been an advocate of time-scaling. So, you are taking my name in vain.

MR. SHERON: You raised the question of the rationale.

MR. CATTON: The question I have always raised is: Why do you want time-scaling? Why do you pay such a price for time-scaling?

MR. SHERON: And I think what my answer would be is we don't necessarily have to have time-scaling.

And, in fact, if one can show -- take the interruption of natural circulation in a B&W plant, it is calculated to occur at what? Is it five minutes, extending through 20 minutes? Something like that?

Now, suppose that in the experiment it occurred at two minutes and extended through seven minutes, do I care?

The fact that it occurred on an entirely different time scale, between what we think the big plant would versus the experiment, the answer is probably not, because I really accomplished the goal I was after, which was I have interrupted natural circulation. I have produced the phenomena of interest.

If the code could correctly predict that phenomena of interest, then the time-scaling may be secondary.

I have convinced myself, yes, the code knows how to predict that phenomena and when it is expected to occur, which is really what I want.

There is some phenonmena which I could convince myself, yes, I don't know if it is going to scale perfectly, but it is the right phenomena -- boiler-condenser. Maybe it won't occur for as long as to the extent that it is predicted to in a big plant. But if it does occur in the model and you can demonstrate that the code can properly predict it and all the right models are being exercised --

maybe not in the same parameter range that a large plant is -- I think you pick up a lot of confidence that that code can properly predict boiler-condenser.

MR. CATTON: As soon as you start shifting all of your time scales like that, you have called up two things. One is the loss of natural circulation.

We heard, at the three-day meeting, that with MIST you lose natural circulation almost immediately. And if you do some simple scaling, you see that that is, indeed, the case.

The question that comes to mind, then, is: Well, what kind of impact does that have on the rest of transient, because it is out of phase with everything else that is occurring?

Now, if it has none, then it might as well be run as a separate effects test maybe.

Your boiler-condenser mode -- I mean in piecemeal.

I agree with the statements you are making, but I wonder, then, is why do I need this particular facility if I can separate out these various phenomena so nicely?

MR. SHERON: You can only separate them out because your code tells you you can separate them out.

You sit there and you say, "Well, gee, if it doesn't have any effect on other parts of the transient, then I can separate it out." Well, what tells you it doesn't

have an effect -- the code? Okay, how good is the code? I don't know.

If you want to take that leap of faith, as my minister used to call it --

MR. CATTON: But you are taking a leap of faith by saying, a priori, it doesn't matter.

You've just said it doesn't matter. How do you know it doesn't matter?

MR. SHERON: I don't. That's why we're advocating the integral system test.

MR. CATTON: That's why you have to be careful with scaling. I don't think there's anyone here who would not advocate an integral test of some kind. But you've got to be damned careful to make sure that whatever it is you are looking for you are going to get.

My own view is that I am not sure that has been done.

MR. SHERON: I think it has. I think you will hear that.

MR. CATTON: I sat through the TAG meeting at Florida, and I saw those things put up and at the time questioned them.

When you named those various things, the five that I have quoted you a number of times -- maybe not quite correctly: Loss of natural circulation -- you don't scale

it; right. The boiler-condenser mode -- there were certain questions about void fractions in the vertical sections.

As you march through these things -- recovery by pressure -- as you march through it, the skewed scaling you missed kind of tells me you're not hitting those things.

Does it matter? It may matter that you don't want to go to a major expense. Maybe you want to do something else.

Now, you brought up the Ishii scaling. There's one thing about the Ishii scaling -- he went after the phenomena. He said, "I want to reprodcue the phenomena." And from that, out comes the scaling picture.

Now, that was not the approach that was taken with MIST. MIST was driven by the steam generators that were available, given -- I think we all understand those kinds of economic constraints, but where does it lead you? I am not sure that it has led you in the right direction.

MR. SHERON: Well, why don't we look at some examples of what the TAG Committee did.

One of them is the identification of phenomena and the ranking. These were taken out of the TAG Report, by the way.

A is obviously of high priority.

D is of low priority.

These (indicating) were the major headings of the

phenomena we were concerned about. Okay, it is just a summary of it. There is more detail buried somewhere in various reports, letters, and the like.

This (indicating) is the ranking as evaluated by the Test Advisory Group, not just NRR.

This is for natural circulation as a separate entity. And in there are small break loss-of-coolant accidents.

Again, you can see.

I would like to point out that the vent valve here, which I know has been a matter of considerable discussion, was ranked as C.

There may be a misunderstanding. When we identified loop-to-loop interaction as the driving force for needing two loops, as opposed to one, that concern was not premised entirely upon hydraulic instability, back-and-forth oscillations.

If you go back and read some of the documents -- which I did to convince myself that we had not misled anyone -- what we were concerned with was asymmetric transients, like steam generator tube ruptures, where you are cooling one loop and removing heat with the other -- steam line breaks, which can remove heat from one loop but not the other. It is that type of asymmetry which we were worried about.

And the hydraulic instabilities, where vent valves may play a very big role, are not the total driving force, for saying, "Gee, I have to worry about the vent valve design." The vent valve design may not be that significant.

For these other transients, we are worried about the steam-generated tube rupture, the steam line break, any asymmetric behavior, excess feedwater to one steam generator.

So, I think that is one reason you can see the vent valves ranked C here in terms of the areas we were concerned with.

MR. EBERSOLE: Under "Natural Circulation," why is it that I do not see something like progression of water level conditions and quality of steam at emission points? -- which define, at least for me, in an orderly fashion, the ratio of heat emission to inventory emission.

MR. SHERON: I don't think that was ever identified as being one of our major uncertainties.

MR. EBERSOLE: Isn't it a fundamental fact of life you look at point of emission from the hypothetical break?

MR. SHERON: Yes.

MR. EBERSOLE: That the ratio of thermal and heat emission is a function of quality. And I need to know that to know where I'm going.

MR. SHERON: The breaks which we are concerned about here, which fool around with interrupting natural

circulation and produce all of these, are in the cold leg.

MR. EBERSOLE: Well, how do I know that always?

MR. SHERON: That break quality -- as a matter of fact, I think the question you are coming at is right here.

We did calculations for TRAC way back on the B&W plants. And what we saw was this alternate stagnation and reestablishment of natural circulation in that cold leg. And we saw these very large temperature oscillations in the vicinity of the break.

And what was happening is we were getting cold slugs of water, as I recall, travelling along the cold leg. They would go out the break and you would get some depressurization.

MR. EBERSOLE: It depends upon where the break is. If it's in a seal, it's one thing. If it's in the PORV, it's something else.

So, it's location, as well as the vertical profile and the particular design --

MR. SHERON: This is one area where I think your concern is, to some extent, covered. But from the standpoint of a break flow out of a pipe, especially a small hole, say, on the side of a pipe or something, is a whole area called branch flow. And I believe Research has a program -- doesn't it, Dr. Schrock? -- on this very subject.

MR. SCHROCK: (Nods affirmatively.)

MR. SHERON: So, I kind of look at that as that was looked at. And it is something that can be treated in a separate effects approach.

The break flow, in which you might get four Voorhees sucking vapor into a break, which is still the below a liquid level, and the like -- that, I think, was evaluated and considered to be a good separate effects test, which Dr. Schrock is working on right now.

MR. CATTON: Are you referring now to the cold leg oscillation?

MR. SCHROCK: I don't see correlation.

MR. SHERON: It's similar.

I think Mr. Ebersole's question was: How do you know what is coming out of the hole as a function of time? Because what is coming out of the hole determines your energy balance in the whole system. It is your mass and energy balance.

MR. EBERSOLE: Right.

MR. SHERON: And I think what we are saying is that we are looking at it. And it was identified indirectly here (indicating).

MR. EBERSOLE: Well, there may be no oscillation if it's high.

MR. SHERON: That's right. We asked the question are those oscillations real; we didn't know.

MR. EBERSOLE: For instance, if you had real events instead of these little, tiny things at the top of the U-bend, you would have clear steam vents at a certain point. In effect, you would have a boiler, and you would have a parting surface and substantial separation.

MR. SHERON: Except those vents can't remove --

MR. EBERSOLE: They can do whatever they're designed to except get out of noncondensables.

If they were designed as inventory heat releases, it would be a different machine.

MR. SHERON: Yes.

So, this encompasses some. I think Dr. Schrock's program encompasses the other part. And through that combination, one would hopefully arrive at a conclusion on the adequacy or inadequacy of the current models.

MR. TIEN: Brian, I would like to make a general point for my own benefit.

I did not attend many meetings of this, but I have seen this table several times already. I think we all agree, as mentioned, integrated tests is a valuable one. But we would like to make sure it's a proper one.

I think, in terms of the table and the issues, I think we probably agree we should study that. But that is not the point. I think perhaps this morning we should concentrate on to show exactly the MIST facility can show

those phenomena and can benefit -- you know, the test can benefit understanding and also, as Dave mentioned, perhaps to tell us something we don't know yet, anything expected or unpredicted by code. That is the point.

The question is not what phenomena we should study, but whether we can really get to that with scaling and simulation now proposed by MIST.

I would like to listen more about that than -- to the details of that, than again talking to the philosophy level.

end 4

MR. SHERON: Okay, I just want to point out there was a very comprehensive rating of the various options.

MR. EBERSOLE: Brian, you threw away that other slide too fast for me. If you could go back for just a second on the second grouping at the bottom, there is one called, "location of break."

It has a D ranking. That says to me these participants don't really care whether the break is at the very bottom of the physical complex where the cold water is or at the very top, where you have a clear steam leak.

How can that be unimportant?

MR. SHERON: I will ask if there is someone here who was at those TAG meetings, because I did not attend it.

MR. EBERSOLE: Do you follow me?

MR. SHERON: I understand what you are saying and I can't answer your question right now why that is a D rating.

MR. EBERSOLE: On the one hand it appears almost 100 percent inventory loss and virtually no heat lost.

MR. SHERON: I think Ralph Landry may be able to answer this for you.

MR. LANDRY: I am Ralph Landry from research, Jesse.

The rating given there, A through D is a rating that we have to select, a prioritization we have to select, for all of the required phenomena.

There is no phenomenon listed in that list which

we felt could be dropped.

Every one, we felt, must be studied, however we felt we had to in some ways rank those phenomena.

MR. EBERSOLE: I would put that at A.

MR. LANDRY: We argued back and forth about that one quite a bit and felt that there were still other phenomena on that list that we would rank of greater importance.

That was, this list that is shown is a collection of the ratings given by the NRC representatives and by the owners and B & W and EPRI representatives.

MR. CATTON: It is a negotiated list, Jesse.

MR. LANDRY: That's right. Some of those we could not resolve.

MR. EBERSOLE: However, it was put together. When I see that ranking, I begin to get dismally concerned about the whole process.

MR. CATTON: That is what happens when you vote.

MR. LANDRY: If you look at high point events that we have ranked A/D, NRC thought it was an A, the owners thought it was a D. We could not resolve that point and come to a collective opinion on it so we thought that one had to be noted in a special manner.

The location, I can't remember exactly the ratings we have on every one of these but I believe that was one of those in which we had one of us rated it one step higher

than the other and in talking back and forth we said okay, we will just agree to rate this as such and such a letter. That doesn't mean we will drop it out of the test matrix.

We do have tests in there to examine the effects of location, but we felt that there were other tests that were more important will probably receive a higher emphasis in the test matrix.

MR. EBERSOLE: All right.

MR. WARD: Go ahead, please.

MR. MICHELSON: I have a couple of questions.

MR. WARD: I'm sorry.

MR. MICHELSON: On previous occasions, Brian, I have asked you about the desirability of examining the effects of sprays in the candy cane, or was that even a worthwhile thing to talk about in terms of this facility?

Could you give me what your current view is on that?

MR. SHERON: My current view is, that is something I would like to examine as what I would call MIST, Phase 2. In other words, I don't need it to answer the licensing concerns and I don't think I need to force owners to pay for it but I do think it is a worthwhile thing to look at in terms of its advisability for future designs or even a retrofit if there is such a benefit.

We have already told research as a part of their longrange planning that they might want to think about funding

MIST for an additional year beyond the current PMG program to identify or test areas that are of interest to NRC, but we could not clearly be requesting licensees to foot the bill.

MR. MICHELSON: Did you find if any foreign countries have done such tests?

MR. SHERON: I am not aware of any. I remember the the North Anna 3 was supposedly thinking about high point vent sprays -- I'm sorry, high point sprays but I think since the plant was cancelled, that is kind of dead.

MR. MICHELSON: I was thinking more in terms of foreign participation.

MR. SHERON: Jim Towell is here. Maybe he is aware of any.

MR. TOWELL: (Nods negatively.)

MR. MICHELSON: But you are thinking about it then yet in terms of phase two?

MR. SHERON: Yes.

MR. WARD: Virgil, did you have a question?

MR. SCHROCK: I just wanted to comment that for me a lot of the difficulty here has to do with the feeling that in many of these questions the cart seems to be before the horse in the sense that as the vent valves, we have differences of opinions as to whether vent valve performance is really an important thing as an initiator of something that we don't understand very well yet, whatever that may be, so maybe you

learn that from a separate effects test, but I haven't heard any really good engineering evidence that would support the argument that there is not an area for concern here.

It is given a C -- that reflects the fact that a number of knowledgeable people think that maybe compared to other things, it doesn't rank very highly.

That is the kind of thing where a surprise could arise. That is the way it appears to me.

MR. SHERON: That's right.

MR. SCHROCK: Given that, we need to understand the physics of that more clearly than we do now. We need to have a calculational ability which does not presently exist in any of the codes to do that or we need to see some experimental evidence that shows us that in fact the conclusion that that could rank as C instead of B or A is really valid and that impacts on the MIST design.

Then we take the next giant step and start arguing about scaling issues having to do with how to configure the, for part of the downcomer, what to do about the valves. Should we represent eight of them with one, with two, with four? With something else? Shall we try to simulate the annular geometry of the upper part of the downcomer in some kind of a fudged-up way? Is that or is that not important to do, and if we do, what are the scaling principles we have used to get at the thing we have put on the drawing from which

it will be manufactured.

To me there is a lot of missing engineering in this sequence of events.

MR. SHERON: I may not be the best person to address it, okay, although I hate to point the finger to research and say, gee, it's their worry because it is their facility.

MR. CATTON: Brian, I don't think we are asking you to. We are just trying to get a clear picture of what the licensee needs are from you and another comment along the same lines as Virgil's.

You are building a 2x4 loop and there must be a reason for a 2x4 loop. I think there is; namely, loop to loop interactions and that is one of the biggest criticisms of MIST, how you are bringing those loops together so they can interact, that brings a new vent valve that touches on cold leg operations, that touches on steam generator instabilities.Unless a piece can be properly explained, I think it is a weak program.

MR. MICHELSON: Brian, maybe you could help me a little bit and perhaps some of my colleagues in maybe telling us a little bit of your view about well, you have told us a great deal about where the program came from and how we got to where we are today.

It would appear at least to me, and I want to get your views on it, that we are getting into a tenuous situation

if we continue to try to refine and debate and so forth this facility. There is a balance here between trying to do it as correctly as we can versus maybe not being able to do it at all and if we are not able to do it at all, is there even a reasonable substitute?

So give us your views a little bit or your feeling on how long we can procrastinate here before we could get the program in trouble and perhaps not get any facility?

MR. SHERON: In terms of detailed schedule and drop-dead dates, I would defer to Research, but I will give you my views. To some extent, I operate on experience back when I was in graduate school trying to build a heat transfer loop. I had condensers, a heated section and everything. I ran freon. I only had one problem: I had to build it by myself using junk parts from the Navy because I didn't have a lot of money and it was a Navy contract, by the way. We were trying to measure void fraction and we were late on the contract and there was always that question of, are we building this thing right -- gee, maybe we could configure it differently; gee, maybe I shouldn't have the separator that tall, maybe it should be this tall and the like.

And I had a fellow classmate who also worked for NRC, Hans Scherling, some of you may know him, and he had been there a couple of years and I guess I hadn't been there awhile and he came and he put his arm around me and he told me, he

said, build it, build it and run it, find out what is wrong with it, and fix it, he said, but if you sit there and design it forever you will never get it done and to some extent -- and that worked okay.

I built it, I ran it, I worked it and I worked the bugs out and I had to make a couple of changes, sure, it wasn't perfect the first time, but I got the thing built and running and I got my degree out of it, which was the prime objective.

(Laughter.)

So, I was on my way and there were still people fooling around with their experiments, trying to design them.

MR. EBERSOLE: That was the only real basis for building the breeder, Brian.

MR. SHERON: Yes, so to some extent, my feeling is we could engineer this to get every one of these engineering studies, that we do these tradeoffs to see if, gee, maybe there is some other configuration that will work better, cost a lot of money and someone has to pay for it, for someone to sit down and do the calculations and write the report and the like.

The owners I know are not anxious to study this to death. They entered into this agreement under an understanding that theirs was a limited commitment.

We certainly told them that is what we intended it

to be, a limited commitment on their part.

This was not an open-ended, shovel money into a project. In the same sense as you just heard from Lew, research is faced with budget cuts and reductions. They cannot, every time they have to do additional studies on this which go beyond their projected budget, something else suffers, so I don't know where you draw the line as to when you stop the study and when you don't.

I think the PMG addressed one key problem, which was the downcomer and as those of you who were there know, there are a lot of ways you can configure that downcomer to try to make it look something like a large plant downcomer.

You can put baffles in there to represent the flow path between the pipes. You can make it simple with no flow restrictions. You can put in one vent valve; you can put in eight.

I think they agreed at that meeting they were going to go with the more complicated design and back it up with separate effects tests. That was a collective decision based upon the people there.

MR. CATTON: Brian, we all know the history of SEMISCALE, how many things were done there and how long it took to explain a great deal of it and I think we are really trying to avoid that.

MR. SHERON: I agree. We've learned a lot from

SEMISCALE. We learned a lot of mistakes and hopefully they will be reflected in this.

MR. CATTON: And here we are going to multiple loop. If we are going to multiple loop, there must be a reason. If we go to multiple loop, we must be sure that what we want to find out about multiple loops we can find out because if we could not, it might as well have been a single loop.

MR. SHERON: As I said, multiple loop, the original reason NRR wanted it was --

MR. CATTON: I agree with the reasons, by the way, for multiple loop steam generator tube rupture, steam line break, excess heat removal in one loop.

Those types of transients which can throw asymetries on the system. It was not to see if the thing in some natural circulation mode was going to simply chug back and forth.

MR. CATTON: I agree with the need for the multiple loop. It is where the loops all hook together that some of us are having difficulty with.

MR. SHERON: I understand and I can't answer you today, that coupling, how significant it is in design, how it reflects on performance.

I think it's a good question, okay? I think it should be looked at somehow, whether the resources are there

and the time, I don't know.

The other way to do it is, like I said, build it and run it and if the thing screws up, you tear it out and put in something that may work.

MR. CATTON: Graduate students are expendible, you know. Maybe you learned the wrong lesson.

MR. TIEN: I hate to talk about philosophy myself, now, but I just want to take issue with your example .

When we were graduate students that was different, we tried to learn. It is an education process. We learned by mistakes and so on, but when we are designing a multi-million dollar facility, I think we had better be sure, at least convinced to a certain degree that it will give us some correct information or something to work on.

I don't think we should just go ahead, build it and try to change it. Maybe we will not be able to change it. It is not like a graduate student's project.

MR. SHERON: If you look on your agenda, you will see, you will hear some of that later on from B & W on the facility design. I think those questions might be appropriate to them in terms of what work they did.

MR. CATTON: I am also hoping we have made requests for code calculations, at least as good as the codes may be, to try to address some of these questions. I hope some time today we will hear about those calculations.

If those calculations have not been done, I am not sure that you can conclude anything.

End 5.

MR. SHERON: I am going to defer that to the PMG people.

MR. CATTON: I meant for it to be heard by research.

MR. MICHELSON: Are you going to give us a little feeling on the schedule, though? How much time do we have to think about this problem, before real action has to be taken or the budgets are going to screw us up?

VOICE: We will deal with that.

MR. SHERON: I will let research handle that one.

Quickly, also, this is on the TAG report. It shows how the facilities were ranked, in order of their ability to address all of the various phenomena that were identified in the previous slide.

MR. WARD: Let's see. You have option 1' drawn in the box there.

MR. SHERON: If you're going to pick my brain on what these options are, I think Bob Jones can answer what that is.

MR. WARD: No. I mean, is option 1' the one being proposed?

MR. JONES: This is Bob Jones of NRR. Option 1' is the agreed upon facility -- essentially, the MIST facility.

MR. WARD: Okay.

MR. SHERON: This is also what they call the TAG effective facility rating. I'll let Bob describe it, if you

want to know what that is, in detail.

MR. WARD: All right.

MR. SHERON: That was basically all I have. I think the bottom line I want to leave with you -- the message I want to leave with you is that I share your concern. There still may be unanswered questions on this facility design and its abilities to meet its stated objectives. I think a lot of it has been done as part of the TAG group, as part of the 2x4 study. These are extensive documents that were prepared specifically for this purpose. I feel they address a majority of the questions that I understand are on the books. They are not perfect documents. They will not answer everything. There will always be residual questions. I think there are residual questions on LOFT, on SEMISCALE, on FIST, on whatever.

Now you get into the question that Mr. Michelson just brought up. What is the trade-off between doing these engineering studies and the associated cost versus getting on with the design and saying it is just not worth it for me to spend all of this money studying this. It's a tough question and I don't have a clear answer for you on that right now. To some extent, the need to do these additional studies is beyond my control at this point because, as I said, the facility is now a cooperative venture with the industry. It is being run by research. Our input into the facility is one of many customers -- well, we are one of many customers of the data and

we would pass our needs on to research and they would try to implement as part of their membership in the Program Management Group. So it's not all that clear that just because the study needs to be done someone will be able to find the money to do it, or the people. And this is where we get into horse trading back and forth of what should we do and what should we not do with the available resources and bucks.

And I think your questions are appropriate and they can be addressed to TAG. Not TAG, but PMG and evaluated as they see necessary to work on it.

MR. WARD: Thanks, Brian. I think, to some extent, we have looked to you for what the reseach people really ought to be telling us, partly because you have come closest in past meetings to giving us answers to questions.

MR. SHERON: I realize I was -- to some extent -- helpful in trying to get this thing off the ground, but --

MR. WARD: I guess, basically from your position what we would like to hear, and what you have told us, is that the TAG evaluation of issues, the A and B, C and D ranking and so forth, that NRR is an essential agreement with that.

MR. SHERON: Yes.

MR. WARD: And now we really need to look to the research people to tell us how the facility they are proposing is matching up against those issues. So I think it is really the research people who should be telling us that, rather than

expecting it of Mr. Sheron.

MR. EBERSOLE: Brian, before you get out of sight, let me ask you: in the spec for this facility, I noticed that what you are looking at is small break LOCAs.

MR. SHERON: Yes.

MR. EBEPSOLE: And in every case, leak flow is the initiating event. What that doesn't account for is the fact that other system conditions, such as Loss of Secondary Cooling, et cetera, will always precipitate loss of cooling and will cost the system in some adverse circumstances. Just spontaneous leakage, as a point of beginning, is not appropriate in all cases.

MR. SHERON: I understand. The facility, if you will recall though, is not a full power facility. So you cannot initiate transients at time zero.

MR. EBERSOLE: I can lose secondary can't I?

MR. SHERON: I don't think so.

MR. EBERSOLE: Then that becomes another question.

MR. SHERON: The power level of the facilities, the transformers, the power supplies, are only capable of providing decayed heat level energy.

MR. EBERSOLE: I guess I'm trying to say it isn't the initiation of a small break that is always our problem. There's also some service secondary.

MR. SHERON: Which results in a small breach.

MR. EBERSOLE: It will produce it at some point, but it will do it under adverse conditions to begin with.

MR. SHERON: But there was a conscious decision made that we would be starting these events simulating them at some point.

MR. EBERSOLE: I'm reminded of the large breaks. We came to our view, directly to large LOCAs and that's all we ever did. I think if we just look at small breaks, as a point of beginning, we will again miss --

MR. SHERON: As I point out, there is Phase 2, which we have been keeping on the back burner for this additional year of testing while we can look at other transients that are not LOCAs and I think we would value very much your input, or anyone else's on the committee or subcommittee, in terms of what events might be useful to look at, non-LOCA type of events we can look at in this Phase 2 testing which might be secondary sight initiated events.

Questions we will have to ask are, the facility has the full power capability. It's being designed with it. The heater elements will have it. We won't have power supply. There is a price that would have to be paid to get that capability. Is it worth it? I don't know, yet.

MR. WARD: Thank you. Let's take a ten minute break.

(Recess.)

MR. WARD: Let's reconvene. Mr. Beckner?

MR. BECKNER: Good morning. I'm Bill Beckner. I was supposed to be an effective warmup man for the IST presentation, but I think Brian has already done a fairly good job by way of introduction. So I think my presentation, and some of the later ones, may be a little shortened and we may be able to recover some of the schedule.

I planned a little bit of background. Again, Brian has gotten into some of this. There was a TAG group formed in September of '82 and their mission is outlined here, to basically outline the data, any data, that might exist, to evaluate how well the state might address the needs that have been identified and to provide recommendations for future programs.

When TAG provided their recommendations, I think they completed their works in about March. And in June of 1983 they issued a formal report which resulted in the IST program we are discussing today. Again, by way of some very quick background, most of you are familiar with this information. The IST program is now a contract. It was signed in July. It is a joint effort between NRC, the B&W Owners, B&W, and EPRI.

There are three phases. The first phase is the OTIS, or Once-Through Integral System Project. This is a single loop facility which will give us data on a relatively short time frame. The other two phases have to do with MIST, which is

what we are primarily discussing here, a TASK to determine the MIST facility and then the project itself.

The IST was a contract signed in July of '83. It is a $31 million program funded 42 percent by NRC, 27 percent each by B&W and B&W Owner's, and EPRI is a 4 percent participant. This $31 million figure includes cash and contributions in kind, which includes facilities, waivings of fees, data analysis, and so forth. I think one thing Brian pointed out at the end, this is a joint project now, jointly managed by a Program Management Group with a representative from each of the four parties.

The next slide is a schedule of both past milestones and the future. We will get to one question asked by Mr. Michelson, but briefly going over: TAG was established in September of '82. The ACRS endorsed the project in February, I believe, in one of their reports on the research program. The TAG report came out as I indicated and I believe also this ACRS subcommittee was alluded to by Mr. Ward, in which we presented the current plans for the program and also there were a number of questions asked.

There was also, I believe, an ACRS meeting in Denver, at which we made a presentation. Since that time, there have been a number of meetings. There have been smaller review group meetings and meetings with NRC and NRC contract is looking at such things as scaling. There have been two

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formal PMG meetings to settle up some long lead items, such as the pump design and the building. There was also the most recent meeting, held just last month, to specifically look at some of the more important things, such as facility scaling, the test matrix, and the instrumentation. That was held last month. It was really a two part meeting. There was really a review group meeting, in which we had a number of consultants in to review these three important items. And it was followed by a PMG meeting to make some decisions.

As a result of that meeting, the facility specification document was issued in the end of October and we come down to this point in time, right now, in November and one of the purposes today is to tell you basically what we have decided to this point and some of the things that occurred in this October meeting.

As far as where we are, in terms of milestones and having to complete things, our next major milestone is a formal design review to be held in about one week, making use of the information contained in the facility specification which has been issued. We have a target date for final concurrence on the facility, at the end of November. And our key drop dead date is this December 1 date. This is the date on which we have to start initiating the major procurement activities to meet the schedules we have put in the contract. With the target currently, for the MIST construction, to be August of

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'85.

So basically, the question was asked where are we as far as scheduling? And we are at the point, right now, that we have to make some decisions very soon to initiate procurement if we don't want to impact the program.

This next slide is an attempt to try to clarify some questions and issues that have been raised around the program. Brian has dealt with a lot of these already so I won't get into too much detail. But basically there were some questions as to what the phenomena were that were interested in studying and whether the facility would be able to provide data to understand this phenomena. Again, I would point out, we have had a number of meetings. The most recent was the October meeting and we will be reporting today some of the results of that meeting.

What I want to highlight, however, is the last point I have. This is an attempt to look at some of the issues in a little different manner. Up until now, as Brian did, we put matrices of concerns we had and then phenomena associated with those concerns and so forth. I believe we we will continue to do that. Mike Young, later, has a similar presentation, going through the same type of thing. But what I tried to focus on is really the facility design and scaling issues that have been questioned here by various consultants to the committee.

I've lumped these into three different areas in which the facility design had been questioned. That is, first of all, the design of the downcomer and the Reactor Vessel Vent Walls. The second is the design of the hot leg and the U-bend. The third -- possibly I should have put it first, because it sort of results in the other two, but the full height scaling. Why do we go to full height scaling, as opposed to starting with some other type of scaling?

So at least in my mind, listening to all of the questions and concerns that have been addressed, it really boils down to these three facility design questions. And given these designs, what will be the facility limitation? One of the major things we plan to do is address these three topics today. We will be addressing a number of other things, such as instrumentation, test plans, and so forth. But as far as the facility and the facility scaling itself, it's capabilities and limitations, these are the three things we plan to hit hardest today.

That really concludes my warmup and my introduction. Are there any questions -- or I guess any disagreements before we move on to the main presentation?

MR. SCHROCK: Concerning your overall issues and full height scaling, so-called, do you lump together with that real time evolution?

MR. BECHNER: I think that falls out of a scaling choice and from that standpoint it would be put in there.

I think the thing Mr. Morgan will be presenting is some rationales for going to full height.

There are certainly some rationales with components available.

Also, as far as phenomenon, I think there are reasons to go to full height and we will be discussing some of that today but certainly the time scale comes into effect in your overall scaling choices.

We can deal with that specifically if you would like to. I don't think we have plans right now to do it but we can.

MR. SCHROCK: It seemed to me the preservation of real time evolution is something that has been taken as a sacred thing that had to be sought and the way I heard the argument or the comments concerning so-called time scaling this morning, it sounds a little bit different than that to me.

MR. BECHNER: I don't know about time scaling, but one thing we have been interesting in making sure the phenomena occur together as they should be, that you do not distort times, for example, natural circulations are broken when you are on a drastically different proportion of power, something to this effect.

MR. SCHROCK: Well, perhaps it will come up.

MR. BECKNER: Okay, briefly the way we have it organized is, I would like to introduce Mike Young, first of all. Mike is the NRC project manager for the IST program and he is also the PMG representative to the four-party PMG management group.

He will be giving you some background as far as what went on in the PMG meeting. He will also give you a little more about the rationale as far as how we came to this particular facility and this test program and after Mike, Chuck Morgan from B & W will be getting up and talking in more details as far as the scaling and facility design and so forth.

If there are no questions, I would like to let Mike Young address you.

MR. WARD: For the Subcommittee members, the agenda you have has changed a little.

The University of Maryland SRI discussion will come down a few steps in a more logical place.

MR. YOUNG: Okay, what I would like to do is go through this black diagram quickly, first of all to give an idea of what we would like to accomplish this morning in the upcoming presentations on MIST.

Basically, Brian has touched on the data needs and issues. I was going to speak on this a little more but I

will probably move through that fairly fast to save a little bit of time.

MR. WARD: Mike, I wouldn't do that. Even though you think we may have heard it, I don't think we have heard it as clearly as we need and I think your interpretation and perspective would be helpful to us.

Mr. Young: Fine.

What I want to get across here is certainly the program is based upon a definition of data needs or this list of issues we have seen.

TAG was responsible for putting together this list of issues and from this block, this list of issues, the program, in order for it to be successful, certainly we want these issues to be adequately resolved.

This morning what we would like to do is follow through each one of these blocks to show you how each ones connects with each other and we hope to get to a resolution of these issues certainly. In order to address the issues, we will need a presentation by Randy Carter, when he will go into some depth on data needs of test matrix.

In this direction (indicating) this implies certain phenomena or events that are going to occur. That is a requirement certainly is the experimental facility, that is design and the instrumentation are adequate to see these types of phenomena or events.

If we can ensure that the facility instrumentation is adequate, then certainly we should be in good shape to resolve these issues.

This is what we would like to do today, show how each block leads on to another, down to this last one, resolution of issues.

This is somewhat repetitious of what I said, but I will go over the purpose of the IST program; in addition, I have a few slides on the IST program formulation and foundation. I will express what those data needs are again and the issues and how TAG arrived at the experimental facility they felt was justified.

The facility design and evaluation section, I will report to you on what were some of the key decisions that came out of the last PMG meeting we had in October and then the scaling summary and component design requirements will be presented by Chuck Morgan and Randy Carter will describe the instrumentation requirements and the test matrix.

I will speak on support programs and an overall schedule of the program.

Basically, the purpose of the IST program as envisioned by the TAG participants was to satisfy the requirements of the TMI 2 Task Action Plan, Item II.K.3.30, which required the small breaks models be compared to applicable data, also to gain technical insight and to allow assessment

of B & W abnormal transient operation guidelines,to investigate scenarios and also steam generator tube ruptures in addition.

Also there was the purpose to benchmark and assess the NRC computer codes to allow independent audits to be performed.

Again, this was mentioned earlier -- TAG was established in September of last year, 1982, to accomplish these four tasks: identify the experimental data needs, also in the available data that presently existed, and to evaluate how well this data addressed the identified needs and to recommend any future programs.

The major elements which came out of the TAG effort were an agreement on the prioritized list of issues, use of the GERDA facility for constructing OTIS and MIST, test matrix for OTIS and MIST and agreement on central design features of MIST.

The contract was signed July 8, 1983. What I would like to do now is go through for you some of the TAG thinking in the development of these prioritized list of issues and then I will go on and touch on the MIST design as proposed or agreed upon by TAG.

TAG did develop a list of testing needs. They also reviewed existing test data. They felt that there were data needed to gain additional confidence in the understanding

of transient thermal hydraulic phenomena of B & W plants, particularly to understand slow, cyclic pressure changes postulated by B & W to occur during during certain small break LOCAs, also to assess the revised small break models and to characterize natural circulation, particularly occurring in the region of hot leg U- bend.

TAG categorized a list of issues into four basic phenomena: natural circulation, small break LOCA, feed and bleed cooling and steam generator tube rupture.

As I said, some of the TAG thinking in developing the list of issues is what I would like to present now.

In the previous large IST program, they felt, did not model the unique hot leg configuration of the B & W facility. As a result, they felt it did not simulate appropriate natural circulation conditions. They also believe there was uncertainty about the effects of two phase flow noncondensible gases and the validity of the boiler condenser mode of heat removal.

MR. CATTON: So, Mike, you don't call out loop to loop interaction as a separate phenomena?

MR. YOUNG: No.

MR. CATTON: Your only interest is as those four items would cause it?

MR. YOUNG: As I said, what we will be leading to is the development of this table you see on the this of issues.

This was some of the thinking that they felt that they went through in putting together this table.

Under small break LOCA, they felt that natural circulation mode of heat removal is a major phenomena in small break LOCA, therefore it should be investigated.

Break size, location and isolation sensitivity to ECCS operation should also be addressed.

The effect of reactor coolant pump operation during a small break LOCA should be evaluated and finally the effect of RVVV should be verified on an integral basis.

Feed and bleed cooling, although it was not a high priority issue, code capability of predicting this type of heat removal mode, should also be addressed.

MR. WARD: Why is that not a high priority issue?

MR. YOUNG: I am not sure. Probably a member of TAG would be able to answer that. I am not familiar with exactly the rationale behind this particular issue as to why it was categorized.

MR. EBERSOLE: Did they think it is well understood and therefore you don't need to investigate it?

MR. WARD: You are just reiterating the D evaluation of the TAG team?

MR. YOUNG: Ralph might be able to shed some light on this.

MR. LANDRY: We put that on the list, the feed and

bleed, because at the time we were going through the iterations and designing the facility or coming up with the facilities, feed and bleed was just coming in as a concern.

The main impetus to perform this work and to go ahead with this facility was small break LOCA. However, the Semiscale test we ran in support of the feed and bleed concerns about a year after showed that the feed and bleed cooling method was highly dependent upon the design of the facility.

We felt on that basis we had to add feed and bleed cooling even though it was not a specific licensing issue to the list of tasks to be performed by what would ultimately be the MIST facility.

MR. CATTON: When it is in the feed and bleed mode, will it act any differently than another PWR?

MR. LANDRY: We felt that based upon the tests at Semiscale, the exact hardware and location of the pressurizer top will influence the details of the feed and bleed operation.

MR. CATTON: In an unknown way?

MR. LANDRY: We felt it was an analyzable way but we wanted reassurance we were analyzing it properly. We want to test the code for more than one particular configuration.

You must recall the pressurizer's surge line is on a vertical pipe in a B & W plant. The B & W plants have vent valves. This is a much different animal than the U-tube

type plant we were analyzing with SEMISCALE.

MR. WARD: The three reasons that have been given, I mean the purpose of them, is the, you said, a small break LOCA but support of the ATOG development and understanding of the steam generator tube breakage in a once-through steam generator are the other two reasons.

Now is feed and bleed in the B & W ATOG?

MR. YOUNG: Yes, I believe it is.

MR. WARD: It is? All right.

I am just trying to understand, then, it seems it got a D rating just because it is felt it is pretty well understood, is that it, not because the phenomena is not important but it is fairly understood?

MR. LANDRY: We felt we had to do some testing to reassure ourselves.

MR. WARD: We are not questioning why it is on the list at all, we are questioning why it is given a ranking of D.

MR. LANDRY: We did not feel it was as significant a safety concern as are the concerns around the small break LOCA.

MR. WARD: Because it was better understood?

MR. LANDRY: We felt it was better understood, but there are unique features of this plant's designs that warranted doing tests on the feed and bleed operation.

MR. WARD: Thank you.

MR. LANDRY: Mr. Chairman, I would like to point out that because it has a D does not mean it should be dropped. Those phenomenon that are listed as ares that need to be studied, we felt must all be studied, A through D, it is just a ranking within those we felt have to be studied.

That is just a relative importance compared to other serious concerns that have to be studied.

MR. WARD: All right, thanks.

MR. YOUNG: Finally, the last category identified by TAG was the once-through steam generator tube rupture.

The feeling was the OTSG is certainly a different configuration than the new tube and integral testing of tube ruptures is certainly warranted. Particularly we are interested in the effects of single and multiple tubes. Reactor coolant pump operation during a tube rupture, asymmetric loop effects. Also, I combined tube rupture and steam line break. You have seen this many times.

MR. EBERSOLE: May I ask a question? Could you point out to me why reactor pump cooling operation is considered to be important for the operator or not whereas the location of the break is not important?

MR. YOUNG: The location of the break is identified as a concern.

MR. EBERSOLE: But it has a very low priority.

MR. YOUNG:--not under the steam generator tube rupture series.

This is the same composite list of issues you have seen previously this morning. I have highlighted several issues which were identified in our last ACRS meeting in July as important issues. They are certainly contained in this list of issues. I don't feel I should spend a lot of time on this. The priority is given here.

MR. EBERSOLE: In the bottom grouping, do you see you have reactor cooling pump operation and it has a ranking of D and location of break has a ranking of D. I would think these are inter-related such that for a low break configuration it wouldn't matter whether the pump is operating or not.

End 7.

I can see the relationship in the context of the ranking you have.

As a matter of fact, I will be inclined to ignore the ranking.

MR. YOUNG: I think that's an appropriate thing to do.

MR. WARD: I think they are telling us these are A to D, on a scale of A to Z.

MR. EBERSOLE: Maybe you are right.

MR. WARD: That's what Ralph just told us.

MR. CATTON: With the reactor pump coolant operation, it's my understanding you can't scale the pump too well.

Have you done anything to try to assess what the impact of a different kind of pump will be on your final results?

MR. YOUNG: I think we have done a fairly reasonable job on scaling that pump. And we will speak specifically on that later this morning.

The specific speed was not scaled, but there is certainly some uncertainty as to whether that is an important scaling parameter.

MR. CATTON: One way you could find out would be to do some TRAC calculations.

Have you done any?

MR. YOUNG: No. No TRAC calculations -- on the difference on scaled pumps and its effects on transients.

MR. CATTON: In general, have you done any TRAC calculations for the MIST facility?

I would think you would want to do those before December 1st.

MR. YOUNG: I will get into that later in support programs.

MR. CATTON: Good.

I will eagerly await your getting into it.

MR. YOUNG: I will wait until then, also.

Okay. From this list of issues, B&W generated this table of small break LOCA events and phenomena.

If you recall, the first slide I showed, there was a category there identified as "Events and Phenomena." This is pretty much what we want to be sure to address in the facility, also what we want to be able to be capable of measuring with the instrumentation that is utilized.

Now, to get into what TAG agreed to regarding facility design, separate from the issue, they agreed to a formulation of a 2 x 4 integral system test and also that the facility should be based on GERDA.

And one of the reasons they felt this was a rational approach to take was that full elevation, power and volume scaling has been used in other integral system test

programs.

There is certainly a cost-benefit by using the existing OSTG hot leg and instrumentation on GERDA.

Also, B&W certainly observed some of the important phenomena that we feel must be present in this, particularly in hot leg U-bend voiding and interruption and boiler-condenser cooling.

MR. WARD: Mike, when you give the first reason that full elevation has been used in other test facilities, I guess what you are saying it has been used successfully and used without regrets.

Is that a fair assessment? I don't know.

MR. YOUNG: As a general overview, yes, certainly there were problems, and there were concerns that have been shown over the years.

But the facilities that have been scaled with this rationale have achieved reasonable results and were reasonably successful programs.

MR. WARD: And what facilities do you refer to there?

MR. YOUNG: Semiscale, LOFT.

MR. WARD: Okay. I guess for the boiling water reactors, FIST is the first facility that meets that description; is that correct?

MR. YOUNG: For boiling water reactors?

MR. WARD: Yes.

MR. YOUNG: Yes, that is correct.

Before getting into the discussion with B&W, I would like to go over some of the key decisions that came out of the last PMG meeting in October.

First, I would like to indicate what the basic objectives of this meeting were.

They were to review and concur on the scaling approach supporting the mist facility, with respect to the objectives of the program -- also, to review the OTIS and MIST test matrix -- basically, to receive comments and recommendations from the consultants and any participants -- and finally, to recommend and concur on the MIST instrumentation layout needs based on test objectives.

Also, we looked at the data acquisition requirements and fielded comments on that. Basically, there were three main decisions or agreements which were reached during this meeting by the PMG. They were on the subject of the downcomer design, the instrumentation and data acquisition channel capacity and also advanced instrumentation utilization of the MIST facility.

I will have a slide on each one of these individually.

First, on the downcomer. During the meeting, there was presented by B&W several design conceptions of this

or options of this downcomer. There was certainly a wide variety of opinions and suggestions or recommendations on which would be an appropriate downcomer to utilize in this.

The PMG considered a lot of these concerns and did make a decision to utilize what B&W referred to as a battle quadrant design. It uses for reactor vessel vent valves.

I won't get into a lot of details on this, because Chuck Morgan will speak specifically to this. But some of the main reasons on the PMG decision behind this was the design should ensure symmetric flow in the downcomer.

Secondly, it would prevent any atypical flow communication between the four cold legs. And it makes an attempt to maintain some of the B&W design features.

We felt that this was a desire. And the baffle quadrant design did reflect these design features over the others that were presented.

MR. SCHROCK: Do you really mean that it ensures symmetric flow?

MR. YOUNG: Yes.

MR. SCHROCK: Can I understand why you do?

MR. YOUNG: A symmetric flow into each quadrant of the downcomer -- one of the designs we considered at the last ACRS meeting was a -- one line coming from the upper plenum, feeding into an upper plenum region of the downcomer.

And I think one of the major objections to this, as it was later investigated and looked at more, was that you have a preferential flow into perhaps one side of the downcomer versus another.

The four vent lines coming off of the upper plenum should serve to equalize the amount of flow which is directed into that downcomer.

MR. WARD: But isn't that begging the question a little bit?

When you say "ensure symmetric flow," that is only if you are completely confident that the real system will always have symmetric flow.

How have you reached that confidence?

MR. YOUNG: Okay. One of the concerns everyone seemed to express was that they are not sure how these vent valves are going to operate. You don't know whether one will open or two and, furthermore, whether you even have a design that will properly model that.

MR. WARD: Right.

MR. YOUNG: So, there was certainly the opinion that perhaps you should go simple, make sure that you can model the thing, which basically says that you have flow going -- you've got symmetric flow going into the downcomer. You don't have an asymmetry imposed upon it.

So, we feel we are at least ensuring this type of

condition, where we can also operate those valves by themselves and they will respond to delta Ps accordingly. And we can either impose a transient or we can run them full gain and they should operate together.

MR. CATTON: Maybe I could comment a little bit.

My perception was a little bit different than yours. I had the feeling at that meeting that the conclusion was if you really can't scale it right you should probably keep it simple so that you know what is going on.

I had hoped that maybe you were going to tell us why, even though that is begging the issue, it is still all right -- your first one up there, to ensure symmetric flow in the downcomer.

The reason I keep harping about these TRAC calculations is because, for PTS, they show communication around the downcomer from one side to the other, and that is just the result of temperature differences in single-phase flow. I don't know what two-phase flow will do, but I would certainly like to have in my hand someone's attempt to tell me before I am going to try to build this cluge.

And you are stopping all of those kinds of interractions at this point to keep it simple.

VOICES: No, no.

MR. CATTON: Am I misinterpreting what he is going to say?

Then, someone should say it differently.

VOICE: Chuck Morgan will discuss this in more detail.

MR. LANDRY: Also, a part of this decision was separate effects experiments would also be run to characterize this design.

Okay.

We feel, with an appropriate test matrix in the separate effects effort, the code's ability to model this design could be made.

MR. SCHROCK: Before you leave that, your comment concerning the vent valve being able to drive the thing suggested to me that it still is a servo design; is tht correct?

MR. YOUNG: That is correct.

MR. SCHROCK: So, Chuck Morgan will give us more detail on the justification for that?

MR. YOUNG: Yes.

MR. SCHROCK: All right.

MR. YOUNG: On instrumentation, we felt like we were in a position where we could solicit comments or recommendations for these needs from our code analyist.

This slide here is a list of instrumentation needs as the code analyst sees them.

What Research commissioned LASL to do prior

to this meeting was to develop a model on TRAC of the GERDA facility. And given the initial conditions of one of their tests, the small break test, run through this analysis and try to get an indication or a feeling of what kinds of instruments they certainly feel are required on the facility.

And after they did this -- and this is what they felt were instrumentation needs on their part -- first of all, initial boundary conditions was very important.

Systems inventories, inflow and outflow, boundary conditions at places such as breakflows, ECC injection, vent flows, noncondensible injection, feedwater into and steam flow out of the OTSG.

The believe the extermal heat losses from the system was required.

Power to the guard heaters -- they were interested in reporting.

The flow in each piping leg, at least the velocity, the requested, in addition, reactor vessel vent-valve flow, density in each piping hot leg and density in the hot leg U-bend.

This slide is continued.

We were interested in a temperature in the cold leg to get a thermal stratification -- also, T/C rake in the hot leg.

Their last recommendation is that they do not support any reduction in the proposed instrumentation list, which numbered about 700.

MR. WARD: Mike, let me ask you -- it looks like an excellent approach to get the code -- in a sense the user's input to this.

How did you go about that? Who was this?

MR. YOUNG: This was Los Alamos National Laboratory, utilizing TRAC, PF-1, Model 1.

MR. WARD: B&W plans to use a version of RELAP-5.

MR. YOUNG That is correct.

MR. WARD: I have a little disconnect there.

If RELAP 5 is the code that is going to be used but you had LANL-TRAC people advising you on instrumentation, why is that all right?

MR. YOUNG: First of all, I guess what you are getting to is you are thinking of TRAC in the frame of mind that it is a three-dimensional code, versus a 1-D, as is RELAP.

Is this the separation you see?

MR. WARD: I am not sure.

MR. YOUNG: The calculation was 1-D throughout. It did not model anything in 2-D or 3-D -- a 2-D or a 3-D component.

MR. WARD: I mean if you had had RELAP developers

advising you on instrumentation, do you think you would have gotten the same advice?

MR. YOUNG: Yes, I believe we would. We certainly could have done that.

But considering the cost and that sort of thing associated with getting this work done, we felt that TRAC was a good code to use, because we plan to use this in our analysis efforts later on in the program.

MR. WARD: The Staff was going to use TRAC, and B&W is going to use RELAP.

MR. CATTON: It's going to be their own code, Dave. I think that is the point.

MR. WARD: But it's a version of RELAP.

MR. CATTON: It's RELAP-5.

You pick it up at the Argonne Code Center and develop it for your own needs. It's a proprietary code. I don't think Mike can ask them to run it. That is the difference. It is not -- the RELAP-5 that B&W is going to use is not a part of this program.

MR. SCHROCK: But the question is still a good question -- that is, are there any differences in the code developer's views coming out of RELAP-5 development versus TRAC development? Would we have heard different requirements?

MR. YOUNG: B&W may be able to respond to this. It may be a part of their proposed instrumentation list --

that is, getting input from their analyst at B&W.

MR. CATTON: I would be more interested in you running the 3-D TRAC to find out if there are things that we should be concerned about.

Are you going to do that before you make your "drop dead" decision?

MR. YOUNG: Again, that is part of a separate support program.

MR. CATTON: I'm just looking for a yes or a no.

MR. YOUNG: We are going to have a special analysis effort look at the design of this downcomer, yes.

MR. CATTON: Before?

MR. YOUNG: Not only analysis, but also the separate effects effort.

end 8

MR. CATTON: Before you make your final decisions?

MR. YOUNG: It will be done before it would have an impact on any schedule or cost, as the program is presently defined.

MR. CATTON: So a little later you will show us the schedule associated with these calculations?

MR. YOUNG: Yes.

MR. WARD: While that question of B&W people is in the air, maybe we can get it if there is a yes or no answer. Since you intend to use RELAP 5 as the list of instrumentation that B&W wanted in the facility, related specifically to what you see as requirements for developing a RELAP 5 version?

MR. MORGAN: Yes.

MR. WARD: It is?

MR. LANDRY: If I may, Mr. Chairman, I would like to talk to the codes for a minute. The question came up about the B&W RELAP 5. In the original agreement we signed in this work, B&W will provide the NRC with their version of RELAP 5 Mod 1 in April of this coming year. When the program is complete, we will be permitted to release that version of RELAP 5, Mod 1. The B&W version, which has the steam generator models which they have developed -- which is why it is proprietary -- we will have that version of Mod 1 available for our use.

We have tech assistance work in place at not only

Los Alamos but Idaho also. And the Idaho effort will be using RELAP 5, Mod 2 to analyze this facility. So we will be using both TRAC work and Los Alamos. The RELAP 5, Mod 2 work at Idaho and in addition to having the B&W version of RELAP 5 at our disposal for our use.

MR. WARD: Okay. Thank you.

MR. YOUNG: There was a PMG decision or agreement on the instrumentation requirements and that was that we did agree to the proposed list of instruments by B&W. No reduction in those instrumentation needs were made. Therefore, the LANL major requirements, as they listed them, were met.

Regarding the Gamma Densitometers, the PMG agreed to install five Densitometer washers and to the use of -- excuse me, installing about somewhere on the order of 13 or 14 Densitometer washers and the use of five Gamma Densitometers which are to be put at selected locations throughout the loop.

There were some follow up requirements that had to be made, first of all, and that was that a design feasibility in welding these washers into the piping should have been made, primarily to investigate what kind of fluid leakage may occur from doing this. Also to evaluate the calibration procedure and its impact on the testing schedule and cost. And this is being done now and we should get the information soon. We will have a meeting on this very quickly, within the next week.

Regarding the Data Acquisition System, PMG agreed for a 700 channel capacity on the system resulting from many of the comments out of that meeting, the PMG decided that a DAS review meeting should be held. And that was held last Friday where the experts -- we had an individual from INEL and also from Weile Laboratories attend this meeting, particularly to evaluate the criterion and basis for the proposed DAS layout and needs, both hardware and software.

Finally, I think we certainly received some good comments from the review group meeting we had. These list some of the areas in which there was certainly an impact on some of the decisions that were made in the design of this facility. Regarding instrumentation needs, it was felt that stratification of the cold leg was an important thing that should be measured and the instrumentation placement accomodated to receive stratification in the cold legs. Gamma Densitometers will be used pending the decision that I mentioned before.

Also, placement of metal and fluid T/Cs in the core were revived. There was strong support for steady state types of tests in this test matrix. The existing test matrix -- as will be discussed later -- certainly has many steady state tests in it. It is pretty much the framework on which this matrix was developed.

MR. CATTON: There were also some recommendations

to run it at skewed power. Did that get built into the test matrix?

MR. YOUNG: No. We haven't revised the test matrix as a result of this meeting. I think --

MR. CATTON: That was to accomodate part of the skewed scaling in the hot leg?

MR. YOUNG: Right.

MR. CATTON: You were either going to make the same runs over again, at lower pressure, or possible make the same run over again with a high power?

MR. YOUNG: Right.

MR. CATTON: We will hear about that?

MR. YOUNG: Yes.

MR. WARD: What does skewed power mean?

MR. CATTON: Well, they can't scale the thing properly, so they think they're close. So now you go in and preturb this base case when you think you are close. You run it at a little higher power or lower pressure so you get a little more voiding because you can't simulate it exactly. You run extra tests.

MR. WARD: (Nods affirmatively.)

MR. YOUNG: Regarding the downcomer reactor vessel vent valve design, certainly asymmetries were argued for. Also a simple design which would provide no asymmetries were argued for. And the separate effects testing was argued for. As

I mentioned earlier and B&W will talk about it in more detail later, we feel we have covered these issues with the design we selected. Also, there was quite a bit of comments and recommendations regarding the Data Acquisition System, that it should be further reveiwed. And out of this meeting we did decide to have this review meeting on the Data Acquisition, which was held last Friday. As I said, this is bascially some of the items which impact the program which came out of the review group.

MR. SCHROCK: Could I ask a question?

MR. YOUNG: Yes.

MR. SCHROCK: One of the things that we raised at the meeting in Bethesda was the identification of a bench-mark experiment that would relate different test facilities somehow. And that sort of bogged down, there. Was it later reviewed and some conclusion reached?

MR. YOUNG: Yes. We had a PMG action item on that in which NRC and the University of Maryland would formulate a test and present that to the PMG and that is basically where we ended up at that time.

MR. SCHROCK: What about SRI 2?

MR. YOUNG: The SRI 2 facility -- do you mean as far as designing this test?

MR. SCHROCK: The common test.

MR. YOUNG: The common test is something SRI 2 could

be involved in, yes.

MR. SCHROCK: Could or would?

MR. CATTON: Well, or might?

MR. YOUNG: Well --

(Pause.)

And this is the last slide I have. At this time I would like to ask Chuck Morgan to come up and give a discussion.

MR. TIEN: Could I ask one question about instrumentation needs?

MR. YOUNG: Sure.

MR. TIEN: The instrumentation requirement is basically derived from the 1D code analysis. Is that right?

MR. YOUNG: Yes, that is correct.

MR. TIEN: And would this instrumentation review any 2D or 3D facts because MIST is basically a 1D facility? Still, the testing would show 2D or 3D, which can be checked by TRAC. Say 2D or 3D. Was the instrumentation or data would reveal anything about 2D or 3D?

MR. YOUNG: They didn't make any runs using a 2D or 3D component. All of their recommendations were based upon the 1D version, or test run. It was something that was done quite quickly. They did this in about a month and a half and I don't think they could have done this -- given their time anyway.

MR. TIEN: So the test will not tell you anything

about 2D or 3D affects. Is that correct?

MR. CARTER: Randy Carter from Babcock and Wilcox. One of the things that Mike indicated is that the instrumentation is partly defined by the TRAC calculation.

MR. TIEN: For 1D?

MR. CARTER: For 1D. There are some other things we have done. I will talk about them in detail later. But it is influenced from the Byrd experiment. We had upgrades from that. Also the TAG representation. The instrumentation itself certainly show there are some multi-dimensional effects, particularly in the steam generator we saw. It showed us particularly you can have multi-dimensional effects.

Also the core region will be instrumented. If there are multi-dimensional effects, you will see it in the core region, the downcomer also. Like in the cold leg we are looking for stratification effects in cold legs.

MR. TIEN: Then my next question really is have you or can you perform a 2D or 3D TRAC calculation, as compared to the 1D TRAC calculation, to reveal under the design system and so on? Can you tell some difference and which might really lead you to perhaps estimate or preduct what will happen in your actual test facility?

MR. MORGAN: Mike?

MR. YOUNG: I think that is a very good suggestion. It has not been done, but we have talked about doing this kind

of analysis and it probably will be done. But it is not something that will likely be done prior to the final decision on this facility.

MR. CATTON: Well, Mike, you know you have a set up deck for a B&W reactor and calculations are being made for the PTS issue. And those are harder kinds of calculations, in many respects, than what is needed here. It seems to me, if there is communication department to department, within Los Alamos, you could easily do that. Just tell them run this case. I think it is important to get it done straight away. All we do is operate on speculation, with respect to the impact of the symmetric downcomer you are building. You could make a run and I know they are finding, in their PTS calculations, when they use a 6 node azimuthal node on the downcomer, that there are azimuthal effects. And what is coming from one cold leg is affecting what's happening in another. And that is just water with temperature gradients. I think you need to run that test.

MR. YOUNG: Yes.

MR. CATTON: If I could remember the name of the person, I would give it to you. I just don't recollect. But he did give a presentation that Nick Criari held, on PTS.

MR. YOUNG: We do have plans to do this sort of analysis. And as I said earlier, I will get into this in the support program section. I will also give you an indication

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of how much time we will have available to us to do this.

MR. SHOTKIN: This is Shotkin. I would like to just make one statement on the Los Alamos use of TRAC to define the instrumentation. Several calculations have already been performed for RES, NOR, and PTS on B&W plants. And in fact, Ted Knight was in the group that had access to these calculations and he used these in defining this instrumentation.

MR. CATTON: I was thinking not only instrumentation but how important are these multi-dimensional effects in the annular. You've got the codes. You've even got it with six azimuthal nodes, just run it.

MR. SHOTKIN: There was one calculation where he ran the multi-dimensional and then put in a piped downcomer and he did see different results, which was one reason we are happier with this baffled quadrant design. At least it gives us some chance at picking up some of the multi-dimensional things.

MR. CATTON: I think if we are supposed to aid the ACRS in coming to a decison, we should have seen those.

MR. SHOTKIN: That's no problem.

MR. WARD: Are those results something that are in a form that you could present and give us a summary of tomorrow, for example? Is that a practical thing to ask.

MR. SHOTKIN: We can try.

MR. WARD: Mike, before Chet gets started, if I

go back, it was about your tenth chart. You don't have to dig it out but there you give your three, I guess, powerful reasons for agreeing to the 2x4 system, based on GERDA. One was that that sort of system has proven to be successful in experience with Semiscale and LOFT. The second was the cost benefit because there are some existing facilities there. Both of these seem to be good reasons.

The third -- I am going over this because it is sort of central to what we have been crabbing about here for several months -- but the third is that the B&W observed phenomena in GERDA, the hot leg U-bend voiding interruption and the boiler condenser cooling mode. I wanted to ask you, a little bit more, what you meant by the last. Were those phenomena discovered as being important in the GERDA tests, or did the GERDA test results indicate that this sort of facility was able to give you a good handle on understanding those phenomena? Or what did you mean by that?

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MR. YOUNG: What I meant was given the list of issues TAG defined, certainly some of those issues could be addressed. There was some confidence given to us by the GERDA experience and being able to see and observe those types of phenomena or particularly those I mentioned as examples.

The GERDA facility in its layout allowed those phenomena to be seen and it was, as I said, an additional confidence that this type of utilization of the steam generator, which implied full elevation scaling, was an appropriate design concept to go with.

MR. WARD: Okay, thank you.

Chuck, you can go ahead, please.

MR. MORGAN: Okay.

I had planned to talk not a whole lot about dimensionalist groups but to try to get clear --

MR. CATTON: Could you lift that up so we could see it?

(Laughter.)

MR. MICHELSON: It's not that late in the day yet.

MR. YOUNG: To try to get clear why we made some of the scaling choices we made, specifically the full-length scaling because that does drive some of the other compromises that must be made in designing a facility which is less than full scale.

If you design any facility less than full scale,

you have to make some kind of compromises. There are, I guess, now two philosophies of a way to do some of the integral system testing.

There is the full elevation scaling and the so-called Ishii scaling. Actually the Ishii scaling, if you had the length ratio equal to one, would be the same as full length scaling but if you have a length ratio equal to one, you run into problems with matching pressure drops. You can't do it.

MR. CATTON: Ishii disagreed with that statement and I am not sure why.

MR. MORGAN: I am not sure. Well, there are several components to the Ishii scale.

MR. CATTON: I am responding to what you just said. When I asked him if that was correct, he said no.

MR. MORGAN: Because he also wants to preserve the individual pressure drops of the components and you can't do that.

MR. CATTON: And he wants to preserve a void and maybe you don't?

MR. MORGAN: Yes, I do but you have to make compromises.

MR. CATTON; Okay, you make compromises so the statement isn't exactly right.

MR. MORGAN: Well, okay. He has a length ratio.

What I am saying is --

MR. CATTON: I haven't done this. All I know is your statement is different than the one made by Ishii. He said when you make the length scale issue to one --

MR. MORGAN: Then you can -- right -- well, I think most of the people who have done full length scaling have said I want to preserve the length, I want to preserve the pressure drop. I guess it is a matter of priority.

If I say I am going to preserve the length first and make some other accommodations, so I scale these other quantities as best as possible, I am saying in Ishii's scale if you had L_R = one, that would be full length scaling. He said I am going L_R somewhat less than one, on the order of one-half, so I can get the pressure drop characteristics of the different components as close to the same in the model as in the system.

So, it is a difference, a little bit in philosophy there and that is what I want to get into -- the reasons for this philosophy.

I start off with why MIST? There are three, I will back up here.

MR. SCHROCK: Chuck, I agree with Ivan on that. We heard the statement in Bethesda and I think it is incorrect so it should not be left loosely defined.

As I hear the argument, you say if you choose L_R

equals one, Ishii's scaling leads to the MIST facility. That is the question. I don't think that the answer is yes. I don't think it does lead to the MIST facility.

MR. MORGAN: Okay, one --

MR. SCHROCK: You know, it is a simple question, really, and maybe it is not all that relevant but we should not make the claim that it does.

MR. MORGAN: Well, if L_R = one, you have to make some compromises.

MR. SCHROCK: Sure, you have to do a lot of other things but Ishii's scale does not lead logically to MIST.

MR. MORGAN: It may not be exactly to MIST, but it would obviously lead to something tall and skinny, you can't get away from that.

MR. SCHROCK: By definition, if you use L_R equals one is tall and skinny --

MR. CATTON: It is tall, not necessarily skinny.

MR. MORGAN: All right, it is necessarily tall.

MR. CATTON: It may lead to something fatter that requires more power that you probably can't do it. That is where the compromise comes.

MR. MORGAN: All right, I start off with why MIST and I think philosophically the reason for MIST is there are three major differences between a B & W and any others: that is the steam generator design which is once-through the

hot leg piping and the reactor vessel vent valves and the NRC felt the need to have data to check out the codes.

Now, of course, B & W and the Licensee in Germany, BBR, made these same judgments and built a single loop facility which was full length scale to address some of these concerns.

The NRC wanted more information concerning the interaction between loops. What happens has been pointed out before when one steam generator is operating differently than another. The reasons for full elevation of scaling are two-fold: one is the major post small break LOCA phenomena are elevation dependent. The thermal centers in the once-through steam generator, and I will get into this is a little more detail in a few minutes, are dependent very strongly on what happens on the secondary side.

One of the -- I don't want to denigrate Ishii's scaling as opposed to full length scaling. I think both type scalings have a place.

We had a scaling meeting over one year ago with a lot of experts there and the conclusion from that meeting was that there was something to be said for both different systems and a good program would be one that had maybe a mixture of the two, which is with the University of Maryland type program, which is the NRC is proposing.

But one of the assumptions made in Ishii's scaling is that the heat transfer coefficient is a function of the

flow rates and the fluid thermodynamic properties. A length dependence is not assumed.

Now in a once-through steam generator and I will get into a little more detail in a few minutes, that is not a valid assumption.

The length, you have several different regimes of heat transfer with heat transfer coefficients on the secondary side which are orders of magnitude different from one another and it has been B & W's experience that a full length model is required to obtain meaningful data on the once-through steam generator design.

MR. CATTON: But don't you lose when you make it so tall and skinning with respect to aux feed and how it interacts with the tubes?

MR. MORGAN: No.

MR. CATTON: I mean life is full of compromises. You are buying one and losing on another.

MR. MORGAN: We have seen radial differences in something as small. We have done effects testing on the spray, the aux sprays. We have designed the nozzles for the GERDA test to look at complete wetting and partial wetting, as we have seen, and we can see two-dimensional effects in the GERDA steam generator, which is a 19 tube steam generator.

I think more important than radial effects are the axial effects and in just a minute I plan to get to that.

Besides the steam generator, the length of the interrupted portion of natural circulation I think is a strong function of the elevations of the hot leg and the hot leg U-bend relative to the steam generator.

The second reason is the more practical one, it is the money one, although I really think the analytical reasons or the engineering reasons embodied in the first one is really the more important one.

The second is, B & W has a lot of experience characterizing once-through steam generators.

MR. CATTON: Isn't the loss of natural circulation, Item B, wouldn't the time be more related to the volume you have to displace at the top of the U-bend than anything else?

MR. MORGAN: No, it is the volume between the length of time it takes when you break the communication between one side of the hot leg and the other and the time you drain down to establish a condensing surface in the steam generator.

MR. CATTON: I understand that but if you are interested in and when you lose the communication from upflow to downflow because you have filled up the U-bend with steam then you have that volume scaled right.

If you don't have that volume scaled right, you miss it half the time.

MR. MORGAN: That would be the time at which this

process is initiated but the length of time it lasts is going to be until that level drops and I have a slide on that again in just a moment, but the 15 years here I allude to is the 15 years perhaps of doing -- it is probably even more than that. It is 15 years I have working with the research center and doing once-through steam generator testing.

If you go back, the once-through steam generator concept comes from the universal pressure boiler. B & W started out there with single tubes. They have done 7-tube steam generators, 19-tube steam generators, 37-tube steam generators. We have done an awful lot of characterization and study of these.

MR. TIEN: Could I come back to that slide also?

You mentioned the first major reason is the most important really.

MR. MORGAN: Yes.

MR. TIEN: My question is, does that elevation dependence automatically lead you to the full elevation scaling?

MR. MORGAN: Yes, yes.

MR. TIEN: It must be full-scale, there is no other way, you think? A modified Ishii model to incorporate some --

MR. MORGAN: I don't see it and I will show you in just a second.

One of the the things I have there is, we have also compared the model steam generator testing we have done with full size plant operation and we have gotten very good agreement.

Here (indicating) is a plot that shows the distance above the lower tube sheet at which I complete the boiling of the water and develop saturated steam. You can see there is very good agreement between data we took on Oconee 1's start up data and the laboratory results we got on a laboratory once-through steam generator.

We have quite a few other comparisons that have been in reports on the steam generators. I think there is confidence that a 19-tube steam generator behaves very similarly to the fullsize plant.

If you look at a once-through steam generator, it behaves significantly differently from the U-tube, which is always covered by water and over the entire length has roughly the same -- the heat transfer coefficient will vary with lenth but probably very, very moderately.

If we look at the primary temperature fluid distribution in the once-through steam generator, we see characteristics of very good heat transfer while the secondary side is boiling. If we have a critical heat flux at this point, the heat transfer rate goes way down as we go from this point here (indicating) to the dryout point would be

dispersed flow film boiling and then into the superheat region.

The location of this critical heat flux point determines really for a given temperature difference between the primary inlet and the feedwater, how much heat I can get out of the steam generator because if I go into, say I go into critical heat flux early, then I will not have as much nuclear boilout. I will have a lot of poor heat transfer service here and I won't get as much steam out.

If you go into the Ishii scaling, you will want to run at higher power. If you run at higher power, the consequences of that are operating the steam generator tubes at -- one of the cases we have looked at, say where we have an L_r .5, you roughly end up with twice the heat flux. Twice the heat flux means I will have a critical heat flux occurring earlier.Then the location at which things change and the steam generator is going to be different.

In order to get the right power, I have to juggle what do I do, lower the temperature of the inlet feedwater or do I raise the temperature of the prim --

I have to juggle the temperatures that go into the steam generator if I am going to remove energy.

We have looked at it and our experience going way back to the fossil and was that if you want to find out how a once-through steam generator operates, you build your test facility full length, and that is why all of our test

facilities from the early days of the fossil once-through generators have been full-length generators and I guess that is why we had a steam generator around that was full-length that we want to use in this program.

I think it is very difficult to come up with a meaningful once-through steam generator that is scaled to less than full length.

MR. WARD: Chuck, on the previous slide, where you showed the laboratory unit faithfully reproduced the Oconee, that was at full power?

MR. MORGAN: That was a series of percentages of full power.

MR. WARD: In the mode you are interested in here for decay power levels, can you still come to that? Do you have any data to support the point you make?

MR. MORGAN: We don't have any Oconee data or any fullsize plant data for decay power levels that I am aware of.

MR. WARD: But do you think the phenomena are similar enough? Is the variation of heat transfer coefficient or something with elevation, is that as important at decay power levels as it is at --

MR. MORGAN: Yes. Well, it is going to -- at decay power levels what will happen is you will have a smaller zone of boiling. You need less boiling.

MR. WARD: Yes.

MR. MORGAN: But you will still have very drastic changes in heat transfer coefficients as a function of length.

What we have seen is at the very low power levels from GERDA, that the models we have developed to look at once-through steam generators do a reasonable job.

End 10.

I don't have anything. Back when Oconee 1 was run, low power was not an issue and we don't have any data at less than probably 20 percent power.

MR. CATTON: There are also circumstances where your steam generator may be heating the primary system. That is a horse of a different color, isn't it?

MR. MORGAN: That is possible, yes.

MR. CATTON: And I don't think there are many models that could handle that, are there? I don't know.

MR. MORGAN: I don't know. If I have hotter water on the secondary side then I have on the primary side, I would hope the models would.

MR. CATTON: Because it is natural convection, stratified flows and all kinds of nonsense going on inside the tube bundle.

MR. WARD: But his arguments may be even more important there.

MR. CATTON: I am not sure it is so much the argument for full length there. It is just an argument for trying to understand the basic processes that occurred. And if I understand them, I don't care so much about length again.

MR. CATTON: I don't know if this is going to tell us what kind of processes are going on inside the steam generator, under those circumstances. You may get an integrated effect but then you include your codes too much.

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I'm not sure you understand the process.

MR. MORGAN: The steam generators have been fairly --

MR. CATTON: Ishii scaling didn't address that, either.

MR. MORGAN: As we will get into later, the steam generators are fairly extensively instrumented and it's not just an overall heat balance. So I would think there would be sufficient --

MR. TIEN: Chuck, I'm still not clear about your argument or explanation about why you must have full elevation scaling. I grant, for the primary site, you have a different locational CHF and a different dry-out point and so on. But still, I think what Ivan just pointed out is one of the basic phenomena you find, that you must use the full elevation scaling. I don't say you must use full elevation scaling in order to see some of the basic phenomena you don't otherwise see. I agree, Ishii scaling did not address this question either, but I still don't see why you must have full elevation scaling. It is a basic phenomena. Any new basic phenomena cannot be achieved from --

MR. MORGAN: You can achieve the basic phenomena with Ishii scaling. What I am saying --

MR. TIEN: I don't want to address Ishii scaling, now, just your full elevation scaling.

MR. MORGAN: What I am saying is if you do that, the

only way to obtain the required power output from the steam generator, in the Ishii scaling, you have to have more power out then the same type of test on a full lengh scale, to simulate the same point in time for decay heat removal. If you do that you have to juggle around either primary temperatures or secondary temperatures. You are giving up an awful lot, granted, by going full length. We are giving up something on having the correct void fraction in the hot leg. But we see that running several tests at different power levels, which will get us different void fractions in the hot leg, as a means of addressing that shortcoming of the full length design. And it seems more meaningful. In B&W's judgment, it is more meaningful to do that than it is to clunge up the secondary flow rates and temperatures or change the primary temperatures because the main difference, the main reason for doing these things -- at least as I can gather -- is the steam generator is the big difference between the B&W PWR and anybody else's.

And if that is the big thing that is causing the differences, boy I want that thing to behave as close as it does in the plant. And I would rather make my adjustments through the codes than in some other area, if I think I can come up with a reasonable design.

MR. CATTON: But you are operating there under the assumption that the phenomena that is not understood is in a

steam generator. And I'm not sure you'll get full agreement on that. I think some of us feel that what goes on in the hot leg is where you have weaknesses in your ability to model the phenomena. You know how to handle CHF. You know how to handle nuclear boiling. So as long as you are boiling the steam generator, the basic phenomena is understood. You may change the scale. You may stretch out the nuclear boiling regime. You may have a little more film boiling, or something else, but you're not dealing with anything brand new. Or maybe I am missing something.

On the other hand, you are dealing with things that are brand new, with that U-bend in the hot leg. That is where the important phenomena to be studied is located, I think. At least, if I have understood the basis for this program. Am I wrong?

MR. MORGAN: I don't believe what goes on in the hot leg U-bend is the controlling phenomena that governs the transient.

MR. CATTON: You may be right but that was not what I said. I am not talking about controlling phenomena at any given instant. The question really is what is it we are looking for? What do we not understand? What are we trying to get out of this test, that we will then understand so that we can do proper calculations? Now if it's because you have that big hot leg U-bend, then we damned well had better

be studying it as best we can. If it is the steam generator, after your 15 years of experience, I would like to know why.

That is a separate question. I think that is all I want to say about this.

MR. MORGAN: The TAG concerns, when we had the TAG meetings, and the concern I gathered from the people in Regulatory -- and they can correct me if I am wrong -- that they were concerned about how the Once-Through Steam Generator operated during some of these transients. In the initial stages I didn't hear very much about the details of the hot leg U-bend. It was more the overall system, the overall changes in elevation and how does this different steam generator operate.

Now I think, in B&W's judgment, we think we understand that steam generator fairly well. There are people who want to see that proved and verified through a test program, who think there may be some surprises. I think if there is going to be a surprise, you want to make sure it is a surprise due to the steam generator, or it could be modeled correctly. We don't agree on that point and someone will have to resolve it, but in my opinion the correct modeling of the steam generator is extremely important and that can only be done full length.

MR. CATTON: Have you incorporated the work done at EPRI on the Once-Through Steam Generator that took place

right after TMI, into your thinking?

MR. MORGAN: Yes.

MR. CATTON: Particularly when it comes to --

MR. MORGAN: I think the work they did was on a very small reduced elevation scale, reduced pressure system. And they never saw the separation because of changes in elevation and possible differences in flow regime. I think the results were something that would tell you you really want to go to full elevation scaling and as high pressure as possible.

MR. CATTON: Is that why they went? But they didn't, when they built their SRI-2 model.

MR. MORGAN: I didn't have any part in designing that. I would have made it higher pressure.

MR. SCHROCK: Could I come back to your previous diagram, on which you based a good deal of your argument, as to why full length was absolutely essential, that secondary fluid temperature curve doesn't seem -- to me -- realistic, in terms of my understanding of the transition and film boiling regimes. It appears to me you have calculated that as an equilibrium temperature, so how does that aspect of the --

MR. MORGAN: This is a draftsman drawing it, but it does look very close. If I had the data, it wouldn't be nice and sharp down here. It bends up and goes in. There is a period of non-equilibrium, but basically the data looked

very close to this.

MR. SCHROCK: Why is it, you think, these general shapes of temperature profile could not be achieved in other lengths?

MR. MORGAN: You can achieve them in other lengths. What I am saying is the amount of power you remove will be different.

MR. SCHROCK: The amount of power you remove is a function of diameter as well.

MR. MORGAN: No -- well, yes.

MR. SCHROCK: Yes.

MR. MORGAN: The Once-Through Steam Generator -- the point I was trying to make -- it is very dependent on this heat flux point. We did some benchmarking against the original version of RELAP 5. The first time through we got very poor results. We traced it to the critical heat flux correlation that was being used was inappropriately applied. We used a more realistic low flow chf correlation and got good agreement between RELAP 5 and 19-tube data.

The reason is the other correlation predicted the critical heat flux too early. This was a case of prediction. That would remove this trait of good heat transfer down. Well, you would come up like this.

(Indicating.)

The secondary side -- what actually happened is we

never even got it to dry out. But say I move the critical heat flux down two or three feet. What I have done is lost two or three feet of nuclear boiling on the secondary side, with a very high heat transfer coefficient, and replaced it with a very low. And that means the rest of the generator is really ineffective heat transfer service.

When you look at the Once-Through Steam Generator, this is either ineffective heat transfer service or cheap dryers. If you look at it from a heat transfer point of view, it's not very effective because it is in film boiling. If the chf occurs early, you can't get as much heat out. If you operate at a higher heat flux, it will go into CHF at an earlier length than if you operate at design heat flux.

MR. SCHROCK: Presumably, you designed the thing so that it does produce your 100 percent operating capability, however you define 100 percent.

MR. MORGAN: You could only do it by adjusting temperatures. You can't do it by adjusting surface.

MR. SCHROCK: Why not? You could make it larger, a greater number of tubes.

MR. MORGAN: Then you lose the Ishii scales.

MR. SCHROCK: We're not arguing on the Ishii scale. We are talking about is there no scaled steam generator that will replicate the behavior of the B&W steam generator in a length less than a full length.

MR. MORGAN: I wouldn't say that there is none, but I can't think how you would do it right offhand.

If you keep the heat fluxes the same, then you will go into the critical heat flux at the same location. And if it's shorter, you won't have as much heat transfer out.

If you change the heat flux that goes through the tubes, you change the point at which CHF occurs.

And I haven't done an infinite number of design studies, so I can't say there isn't one out there someplace. But I think it would take a long time to find it if it is there.

MR. MICHELSON: You are beginning to lose me a little bit. Let me go back for a moment.

You are looking at the temperature distribution of a typical once-through generator at full power. In the real world which we are worried about, which is small break LOCAs, we are not dealing with anything like real power. We are dealing with a few percent of power. And we are wanting to simulate now what is happening in a real-world generator under a 2 percent, 1 percent, 1/2 percent power case.

How does critical heat flux relate to that?

MR. MORGAN: 3 to 5 percent.

MR. MICHELSON: Okay. But how does critical heat

flux relate to that?

MR. MORGAN: We still go through the same -- on the secondary side, you can still go through the same series of events.

MR. MICHELSON: Well, it's not too likely with the heat fluxes you are talking about under post-LOCA conditions.

We are talking about extremely small heat fluxes through the tubes. So, how does that relate to this concern, the scaling, that we worry about the critical heat flux point?

MR. MORGAN: The overall design, we were told, was to be capable of full-power operation.

MR. MICHELSON: That is a different rule -- but I wasn't aware that was the rule you were following, in terms of this.

MR. MORGAN: I think, to answer your question, the critical heat flux point may not be as important. But the length of fall and the way the auxiliary sprays come on and so forth --

MR. MICHELSON: Those might be legitimate arguments.

MR. MORGAN: I was using this as an illustration that there are different flow regimes in a once-through steam generator. There are different heat transfer characteristics which are strong functions of length.

MR. MICHELSON: And they are quite different.

MR. MORGAN: So, some of the other scaling philosophies that were developed did not consider the changes of these characteristics with length.

And what I am saying is, in our judgment, the changes in heat transfer that go on as a function of length in the once-through steam generator make it very desirable to go to full-length scaling to preserve where these changes occur, because they affect --

MR. MICHELSON: I am not convinced that is at all the case, except where you do, indeed, want to scale power as well, up to 100 percent. But there has been no inference we are drawing to scale the steam generator to 100 percent power.

MR. WARD: No. There was, in the background, a desire to have a facility that could go to full-power instrumentation.

MR. MORGAN: The core is designed for 100 percent power, and that was a design criteria.

MR. MICHELSON: That may be the tail wagging the dog, but it would be a desirable thing if you could.

MR. WARD: Yes, maybe you cannot accommodate that.

MR. MICHELSON: I appreciate now why this may be a germane discussion.

MR. WARD: I think you say more than that. I

think you say even at decay power levels the system behavior is dominated by elevation-sensitive heat transfer coefficients in the once-through steam generator.

MR. MORGAN: Right.

MR. WARD: That leads you into having an extremely difficult problem in a model that is anything but full-length.

MR. MICHELSON: Well --

MR. WARD: Well, wait a minute. You are saying, of the three things, this is the dominant uniqueness of the B&W design.

I think what you are going to maybe go on and tell us, if we let you, is that the other two uniquenesses can be accommodated satisfactorily with the full-length scaling somehow. We haven't heard that yet, but that is what we are looking for.

MR. MORGAN: I haven't gotten that far. I hope we do do that, yes.

MR. WARD: You have conceived of ways you can accommodate the other two uniquenesses in the full-length scaling. Neither you nor anyone else has conceived of any way to accommodate this uniqueness without full-length scaling. Is that kind of the bottom line?

MR. MORGAN: That is the gist of what I am trying to get. Yes, I think you have said it.

MR. MICHELSON: Let's talk for a moment about the real world of a small break LOCA in this case, where you slowly drain the water out the tube side and you are beginning to get an interface that can start to condense and so forth. That is a whole different world than the normal operation of a once-through steam generator.

MR. MORGAN: That is right.

MR. MICHELSON: That is what you will see through your tests. You may eventually get the water all the way down the tubes in 15 or 20 minutes or whatever, and you begin to look a little more like a once-through generator. But it is inconceivable to me that this discussion pertains to what is really happening during a small break LOCA.

MR. MORGAN: Most of the heat transfer, again, is going to come out -- even in 3 percent power, it is dominated by what goes on in the secondary side.

MR. MICHELSON: It's dominated by what goes on in the primary side.

MR. MORGAN: Not by condensation.

MR. WARD: In a small break LOCA, by definition, the heat transfer is through the steam generator.

MR. MICHELSON: But only on the interface formed by the difference in elevation between the water in the tube and the water on the secondary side.

MR. WARD: But what he is saying is that is

tremendously elevation-sensitive.

MR. MICHELSON: But it all happens to the top of the generator for a long time because the water slowly comes down from the top.

MR. WARD: Yes.

MR. MICHELSON: And the other water comes up from the bottom.

And until they meet, you don't even get significant condensation. It's just a different world.

MR. WARD: It sounds like elevation-sensitive to me.

MR. CATTON: It's relative levels.

MR. MICHELSON: It's only a few feet of elevation difference to do all the condensing you are talking about.

MR. MORGAN: That's right.

MR. CATTON: It's more a matter of relative levels than overall length.

MR. MICHELSON: That's why I couldn't relate this to what is really of interest.

MR. CATTON: You mentioned natural convection as being one of the things that the full-length steam generator preserves.

If you are referring to natural convection in your fuel bundle on the secondary side, which is down in the bottom regions, you have to preserve aspect ratio, because it

is going to act like a forced medium, and it is a tall, skinny one. And these scaling parameters are fairly easy to com by. And the first thing you will find is unless you have that whole system, you pretty much can't scale it right.

I don't know how important that skewed scaling is, but you certainly can't use full-length, partial-length, or anything else to argue that you are doing it right.

MR. CARTER: Randy Carter, Babcock & Wilcox.

I would like to go back to Mr. Michelson's point for a second.

One thing we observed during the GERDA testing -- and this has to do more before you really reach the boiler condenser mode -- you have, in GERDA, both auxiliary feedwater, either at the top, above 50 feet, above the lower tube sheet -- we also run tests with auxiliary feedwater injected about five feet above the tube sheet.

We saw that the heat transfer associated with that feedwater injection was extremely important on establishing thermal centers.

We also saw the distance above the water pool that the water had to fall had a significant effect on the thermal center and also a significant effect on multi-dimensionality.

And if you constrain this overall elevation significantly, you will change the overall thermal centers,

the overall natural circulation, and also the time you reach boiler-condenser mode.

MR. MICHELSON: I think those are all correct, to quite a degree. I am not sure though how well you are even simulating the sprays in the tubes, as opposed to the real world generator when the spray doesn't even get to the center part of the bundle.

Again, you are almost hopeless to begin to see those kinds of effects.

MR. CARTER: But you can --

MR. MICHELSON: I was only trying to relate it to the discussion of critical heat flux points and so forth. I don't think those are even germane to what is happening in the actual test case.

MR. CARTER: Continuing just a second with the spray effect, you can at least bound the overall effects.

We did that in GERDA. We intend to do that in MIST, in the sense that some of the tests we ran with minimal voiding, where roughly the ratio of wetted to unwetted tubes was correct. And we also ran tests where all tubes were wetted and we could see the effect on thermal centers and on heat transfer, and they are very, very definite.

MR. MICHELSON: Are they quite elevation-sensitive though?

MR. MORGAN: Particularly in minimum wetting, they are.

MR. MICHELSON: I would think it would be most sensitive to where the spray was positioned relative to the tubes, whether it was the top, the mid-point or no spray at all, just flooding.

MR. MORGAN: Particularly where you have minimum wetting, where there is a large amount of water on a few tubes, the distance the water falls before it reaches a saturated water pool seems to be very important.

And again, I think that is the point, that you need sufficient elevation.

MR. MICHELSON: Remember, in the real world, for quite a while the water in the primary side is way near the top of the tube. So, water falling down below would have a miminal effect on cooling, as opposed to the condensing area near the top of the tube.

MR. MORGAN: This is still even during the natural circulation, before you ever reached it.

MR. MICHELSON: That would have a more important effect?

MR. MORGAN: That part of the transient has a big impact on what happens later on in the boiler condenser.

MR. MICHELSON: It could be important there.

MR. TIEN: I'm still not clear -- I think

elevation-sensitive does not necessarily mean we have to go to full elevation scale.

The other thing is if we say we don't go to full-elevation scaling, that means we go to Ishii scaling. I think we should not talk about Ishii scaling now and just talk about elevation-sensitive type of scaling.

I still have not heard the real argument saying why we have to go to full-elevation scaling. There are other ways to do the scaling, even for full power.

Why must we go to full-elevation in order to get some elevation-sensitive scaling phenomena?

You mentioned the other things.

CHF -- I am not convinced. The CHF location will vary a little bit. I don't see any real fundamental phenomena changing. Maybe there are spray and other things. But I would like to hear that -- make that very clear.

First, we are not trying to compare Ishii scaling with full-elevation scaling.

The second is elevation-sensitive doesn't necessarily mean we have to go to full-elevation.

Why? I would like to hear that -- specific examples as well.

(Pause.)

MR. MORGAN: The point I am trying to make is out of a lot of experience in testing various concepts, from

fossil on up, I have found that if you want to reproduce the behavior of the once-through steam generator, it makes sense to test it a full-length. We have compared full-length behavior at least down to 20 percent power. We have not carried this comparison on down to the 3 or 4 percent power we are looking at. But we know that the model agrees.

The full-size plant and the model agree very well over the range at which they have been tested. So, I have confidence a full-length model is going to behave like the plant.

I think the people who are checking out the codes would like to have some confidence and some input into how they model the codes to have as few places where there are large uncertainties as possible.

I think if you go and redesign a less than full-length scale steam generator, it is not clear, initially, that you can do it. Certainly, I don't believe you can over the entire power range, to have it replicate what is going on in a once-through steam generator. You lose the value of previous testing that allows a code modeler to check out at least the steam generator component of his code and say, "Well, you know, I have checked that component out against some separate-effects data, and it works. And if I find something wrong in my predictions, I am going to look -- at least first off, I will look somewhere other than the steam

generator. I think if you go to another scale steam generator, you are throwing away a lot of good information, and I think you are getting different -- maybe not entirely different phenomena, but you are getting them in different scales. And you have a more difficult question in trying to design the overall -- at least in our judgment, in designing the overall test.

We made the judgment it is best to go to full-length steam generator, based upon our previous experience. We realize that leads us to some problems with void fractions in the hot leg.

Various consultants have suggested to us -- Peter Griffin said: Run it at several different power levels. You will get different void fractions in the hot leg. And that way you will develop a map anyway of what phenomena occurs in the hot let that may affect the overall steam generator. While I am doing those other tests at different power levels, I know how my steam generator is behaving. That part I would have confidence in because I have previous experimental data and a lot of experience in analyzing. That is basically, I think, the reason.

I think you could design a less-than-full-length steam generator, but it would be a substantial test.

MR. CATTON: Fortunately, you will have them on SRI-2 and University of Maryland, because part of that

argument you are giving leads us away from approving the code. Because if you have a good code and good sound models in it, then whether it is full-length or three-quarter-length should not bother you in the slightest. As a matter of fact, having those two scales to test your codes against gives me a lot of confidence. If you always test it against the same kind of steam generator, I'm a little concerned about how flexible your code is with respect to handling things you have not seen before.

MR. TIEN: Following the same sense of the thing, what I see still -- I am listening to your argument, it is a very strong argument -- you have a lot of experience for the full-scale type of testing before, and you would like to utilize it.

What still bothers me a little bit is I didn't see you mention certain basic phenomena -- say what pheonomena we can do very well and what we cannot and perhaps we would not be able to do, what phenomena might be expected.

That ends up, again, if you have a good model, good scaling, perhaps you can see all of those types of things. I think perhaps those things have not been looked at more closely, but based on primarily the experience you had before and so on.

MR. ZUBER: I'm Novack Zuber from Research.

Can I make a comment?

Let me tell you, I share the concern of Sheron and the consultants.

Let me say this, there is no perfect scaling. If you want to scale perfectly on one thing, you miss on the other one.

In this program, we had several constraints. One was financial. One is partnership. One is we have to take into consideration the experience of B&W, which many of us or our contractors didn't have. And we think it is for this reason -- we wanted to design a full-scale for several reasons, not only because it was scaled this or that, but there were other aspects to take into consideration.

But we are also following the other approach. We have the approach of fat and short. We have additional data we should be looking at, phenomena interpretation in the candy cane.

So, we are not putting all of our eggs on this facility, but we should have many scaling studies in parallel in connections with Maryland and Argonne, which may do some other scaling analysis and comparisons of data.

So, we should be able to address these questions over what are the limitations so we feel comfortable with the results we obtain and find out if we have security that our codes are really predicting different scales.

But the answer is not really clearly cut. We wish

it is, but it isn't.

But we should try to use information from different facilities, different codes, different models and scaling philosophies to put kind of a wrap on this problem.

MR. WARD: Good. Thank you.

Chuck, we're right in the middle of your presentation, but I think we have an hour or more to go before lunch. So, let's take a five-minute break.

MR. MICHELSON: Another hour before lunch?

MR. WARD: Sure.

(Recess.)

MR. WARD: Chuck, go ahead please.

MR. MORGAN: In addition to just the steam generator behavior, there is some natural circulation phenomena that are elevation dependent. The one that has been talked about extensively is interruption of natural circulation and the attendant change into the boiler condenser mode.

This is a representation of an interrupted natural circulation, where we have interruptions to natural circulation occurring. The minute the water stops spilling over the top of the U-bend -- excuse the spelling on this, I didn't get back in time to have the draftsman fix it. But here is the boiler. That interrupted natural circulation will remain until the water level in the primary system gets below the secondary pool or is hit by auxiliary spray. Anyway, until it gets down in this region here.

The point I want to make is, just to get to this point here --

(Indicating.)

-- the minimum elevation at which the boiler condenser mode could begin is some 14 1/2 feet. So that volume over that length of time will be the length of time that the natural circulation is interrupted before the boiler condenser mode begins. And in GERDA -- I mean in MIST, excuse me. In MIST the volume in this downstream portion of the hot leg is concerned. We get some benefit because a lot of the

volume in the actual plant is in the upper head of the steam generator. And in the 19-tube design there is not very much volume in the upper head so that we were able to conserve the volume on the downstream portion and conserve the elevation so that while the volumes on this side are not preserved, what is going on over in this side --

(Indicating.)

-- is. And I think again the length of time to traverse this 14 or so feet is a lot longer than the length of time it takes to drain when the flashing in the hot leg U-bend begins. That length of time, to create the interrupted natural circulation, is relatively short. The longer period of time, the 10 or 20 minutes or something like that, is for this level to go down. And the elevation scaling, full elevation scaling, will maintain that.

MR. MICHELSON: Will the test facility allow you to spray at both the top and intermediate positions?

MR. MORGAN: Yes.

MR. MICHELSON: Because I guess most plants are at the top, but there are still one or two that are at mid-plane.

MR. CARTER: They are very low, approximately five feet.

MR. MICHELSON: From the bottom?

MR. CARTER: (Nods affirmatively.)

MR. MICHELSON: Is that where most of them are?

MR. CARTER: Most of them are at the top.

MR. MICHELSON: And the others are five feet from the bottom?

MR. CARTER: Five or six feet.

MR. MICHELSON: Thank you.

MR. MORGAN: Another point, if you reduce the scaling to the extreme that was done with SRI-1, you could conceive of how these there wouldn't be enough elevation to have a separation occur. You would go from separating almost immediately into the boiler-condenser mode and you could be -- you could almost miss interrupted natural circulation all together. So from that point of view also, we felt the full elevation scaling was important.

Another place where we feel it is very important is the pressurizer surge line piping. Since there is a loop seal in there, we have also found -- in the MIST studies -- that the elevation of the cold leg spillover and the relative lengths there are important in determining what phenomena go on. Okay.

Another major point, that Bill brought up, that has been a concern is the vent valves. Again, my understanding of the TAG issues were, as far as the vent valves were concerned, the local analysis programs, whether that is B&W code CRAFT or RELAP or RETRAN or TRAC. All of these codes, when applied to small break Loss of Coolant Accidents, show

enhanced core cooling due to an internal circulation path provided by the vent valves. And the NRC wanted some verification that this path was indeed there.

I will refresh you on the B&W design. I will have to lose the title to see, but in the core support sheet, there are vent valves located that will open with very small pressure differentials. And anytime you are in the natural circulation mode, where the velocities are small enough that the density differences provide the changes in pressure, these vent valves will open and this gives you a flow path of the incoming HPI and the cold leg can go up, down the downcomer, up through the core, through the plenum cylinder, out the vent valve and internally circulate around.

That path has been calculated to be a very effective means of cooling the core and is a unique safety measure of the B&W plant.

MR. MICHELSON: Is that phenomenon now in the code calculations?

MR. MORGAN: Yes.

MR. MICHELSON: And of course, it does not really remove heat, per se, but simply --

MR. MORGAN: Keeps the core covered.

MR. MICHELSON: -- keeps the core covered or it keeps water moving through, but it does not remove heat. The code recognizes this, I am sure.

MR. MORGAN: Yes.

MR. MICHELSON: So it is almost a misnomer to call this a path for core cooling, because it really doesn't cool the core.

MR. MORGAN: If it weren't there, the core could heat up.

MR. MICHELSON: It's enhancing the circulation to the core.

MR. WARD: It provides a better distribution, or assures distribution.

MR. MORGAN: It assures the core remains covered. If you don't have the core covered, the portion which is not covered will heat up.

MR. MICHELSON: I'm not sure that it even --

MR. MORGAN: The heat is being removed. Some of the energy is being removed out of the break.

MR. MICHELSON: That, plus energy removed by the steam generator is all --

MR. MORGAN: In the interrupted natural circulation calculations, the flow-through, this flow path --

(Indicating.)

-- will continue to keep the core covered and the temperatures low. You continue to bring the cold water in from the HPI and circulate that around. You lose water and some energy out the break, so whether you want to call it core

cooling or not, it ultimately keeps the temperatures in the core down.

MR. WARD: Maybe we are diverting here, but I can see where it provides a greater mass flow through the core, and maybe greater distribution, but it seems to me whether the core is uncovered or not is a function of the inventory in the whole system.

MR. MORGAN: By keeping the pressure in the upper plenum down, it helps get water -- it helps get inventory into the core.

MR. WARD: I'm not sure I understand.

MR. MICHELSON: (Nods negatively.)

MR. SCHROCK: If the pressure in the upper plenum is low, the vent valves will be closed.

MR. MORGAN: Well, it keeps it from building up to very high levels. If you don't have a release path in there, the steam generated in the core will continue to collect in that upper plenum area, the pressure will go up, and that will tend to keep the level in the core lower.

MR. SCHROCK: But as you approach the condition --

MR. MORGAN: It doesn't do that because the vent valve is open, that's right.

MR. SCHROCK: But as you approach the condition of core uncovery, the only thing that can be venting through the vent valves is steam and that will not contribute to a

natural circulation mode of cooling the core.

MR. MICHELSON: Not significantly.

MR. MORGAN: It will allow the HPI water, from the cold leg, into the bottom and will allow circulation. It has been computed to happen. It has been observed, in the GERDA facility, to happen and this is what the NRC, to my understanding, was interested in, verifying some of these calculations. As I say here, we will be able to verify these things. We will not look at the mechanical operation of the core. We will not look at the pressure drop characteristics, only the mechanical operation of the vent valves. We will not look at the pressure drop behavior of the vent valves. Those things have been investigated in other, separate effects, experiments.

What we do have in the test matrix, is several different settings on the vent valves, requiring different pressures to open them. So in this way we can quantify what effect different characteristics of vent valve opening would have on this natural circulation -- not natural circulation, excuse me, on this recirculation path within the pressure vessel.

MR. SCHROCK: I think it is a matter of semantics we are arguing here. I don't think there is any question that the vent valves alleviate the steam binding problem, so you will not tend to build pressure in a steam bubble in the dome,

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that will press the liquid level down in the core. But as you are describing it, via this diagram, it comes out sounding as though there were a steady state mode of natural circulation that can occur with a liquid filled system and vent valves permanently held open. And I don't think that is a scenario that stands up.

MR. MORGAN: I wouldn't characterize it as necessarily steady. There may be fluctuations with time, but the net integrated effect -- and this has been verified experimentally -- the net integrated effect is a continuous circulation of coolant to the core.

MR. SCHROCK: Okay.

MR. MORGAN: I am going to go through, now, the various different components. I will go through them roughly in the area of most controversy first, so if we get to whatever your time limit is, if you can just give me two or three minutes to wrap up I think we can safely repeat some of them.

MR. WARD: There is no time limit. Just keep going.

MR. MORGAN: One of the biggest areas of controversy in the MIST design is the downcomer design. We have given this a lot of thought. We have factored in the comments of many different consultants in trying to come up with a satisfactory downcomer design. We have what I believe is a

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acceptable downcomer design. It has some shortcomings, but unfortunately if you are going to build a scale facility which is less than 1/4 or 1/5 size, I think you will run into trouble in trying to come up with a reasonable downcomer design.

I was talking with Mr. Chtau at the last AEC water reactor safety meeting. He is with the French AEC and they are building a SEMISCALE-like rig in France to look at a Westinghouse three loop design. We discussed the various problems and I asked him what did you guys do for a downcomer design. He said, well we wrestled with that for a long time. We weren't really happy with anything they came up with. We decided on an external annular downcomer. It's different from ours because they have a three loop design, so they only have three fins sticking out there trying to separate flow. But it is amazing that no communication whatsoever between different designers trying to come up with a facility of this magnitude, and we come very close to the same sort of configuration.

Some of the driving concerns we had were that the gap in this annulus here would not be so small that we could run into hot wall effects. So this was designed. It has about a 1.4 inch gap here. It has four vent valves. The vent valves are located in the other view. The vent valves are located in an elevation above the cold legs. But they are

in the same relative location. We have had a wide range of comments between. You ought to be able to look at downcomer asymmetries, different vent valve operations, to Thad Knight -- the code modeler -- saying I am going to model this with a 1D code so I would like to see the downcomers as simple as possible.

And what we have done is decided that we will operate this in two different modes. We can operate it with all of the vent valves operating off the same pressure differential signal so all vent valves will operate together. The overall design allows -- well, will remove fluid from the upper plenum, 180 degrees apart. So that is a little more symmetrical and realistic, as far as the way the plant operates. And we will have then the code analyst, when he is doing his first calculations anyway, wants to see a relatively straightforward situation. We have a design that will do that. We have a design that can operate either with each vent valve operating on its own differential pressure signal, or -- we haven't fixed the test matrix in this detail yet, -- but we could valve three of them intentionally shut and just operate with one.

So we can look at some azimuthal variations. Now they are not going to be scaled directly as the plant, but we have the flexibility with this design of trying to satisfy the designers of two different sets of critics.

As Mike mentioned, we have agreed to do some -- or PMG as agreed we ought to do some testing, some separate effects testing of this design. What we need to do, as far as the December-something date goes, all we need to do is fix this outside diameter. We can make modifications to other parts of the design but in order to fit the whole loop up, we have to fix the elevation and the basic configuration. From the separate effects testing we may modify what goes on inside. We may not need --

MR. CATTON: Chuck, I seem to have gotten a different impression. I just looked at my notes from that meeting, and Brian Sheron's inclination was to go simple, keep this thing clean. Norm Lauben had the same view, keep it simple. Saul Levy said you can't do it, don't do it. If you can't handle vent valves, don't try. Keep it simple. Peter Griffith: keep it simple.

Nobody went along, really, with this configuration.

MR. MORGAN: I can't recall exact names --

MR. CATTON: I can give you the names and what they said, if you wish.

MR. MORGAN: We have had other comments from other people.

MR. CATTON: You referred to them as meeting consultants. Those were Lauben, Sheron, Levy, Griffith, Hochrieter, Thad and I, and Sullivan were sitting there. All

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of them said go simple. None of them said to go with this configuration, that I recollect.

MR. MORGAN: Not at that meeting but at other meetings.

MR. CATTON: Other meetings I don't know about, but don't refer to the three-day meeting as coming to this conclusion because it's not correct.

MR. MORGAN: I didn't mean to refer to the three-day meeting. I meant to refer to the sum total of all of the comments we've had on this design.

MR. CATTON: So the PMG Group, and others involved, are in essence not following the advice of the group of consultants brought together at the meeting in Bethesda, a couple of weeks ago?

MR. MORGAN: And the fact that we are ganging the vent valves together, for some of these studies, I think we are following their advice.

MR. WARD: Do you agree with that?

MR. CATTON: Ganging the vent valves together?

MR. WARD: Yes, that if you gang them together you have the simple configuration that people want?

MR. CATTON: Some people said don't even try the vent valves. Another thing that came in was that if there were vent valves, they should operate on Delta P and they shouldn't be driven by Servos. I didn't really keep very good

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track of them, except that the message I am getting here is different than the feeling I left the meeting with.

MR. SCHROCK: Certainly no one supported the Servo idea, that I can recall.

MR. CATTON: That's right.

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MR. JONES: Dr. Catton, this is Bob Jones, NRR.

While it is true in the initial meetings, Brian Sheron and Norm agreed to go with the simple, after further discussion on the Friday PMG meeting, I know Norm and I both endorsed this design on the Friday session.

MR. CATTON: Then in conveying the results of that meeting, I don't think you should say the consultants in that group were in agreement.

MR. MORGAN: I don't think I said that, Dr. Catton. I think I said, at least as far as keeping things simple goes, we took their recommendation into account.

Well, I heard if you go to something a little more complex, do some separate effects testing on it.

We took that recommendation, I believe with the vent valves operating. Together we had a design which is fairly simple and in that respect we have taken their comments.

As far as the vent valves go, my recollection was that Larry Hochrieter supported the --

MR. CATTON: Single pipe.

MR. MORGAN: I am not talking about the downcomer now. I am trying to address Dr. Schrock's comments on the vent valves. He supported the pneumatic vent valve because you knew when it was open and you knew there was not backflow through it when it was supposed to be shut and I guess B&W has had a strong influence on going to the pneumatic valves.

We have done quite a bit of study on the vent valve situation in trying to come up with something that is better and we haven't found anything.

We think the overriding concern is knowing that vent valve is shut when it is supposed to be and what the flow is in it and we have not found another design which will allow us to obtain that information.

MR. BECKNER: I would like to make comments -- this is Bill Beckner -- on how we, NRC, came to our conclusions to make the recommendations Mike gave.

Basically Lew Shotkin, myself and Mike sat down after those meetings. I think Novak, Zuber and Brian Sheron gave impact at various times. We heard opinions that varied by people and varied as a function of time. We also heard the recommendation that we should run two different downcomers and it was basically two schools of thought.

One was you had to maintain some semblance of a B&W design with the possibility some time of loop to loop interactions.

The other school of thought was this thing would never represent a reactor. You couldn't analyze it anyway, so let's make it a simple pipe.

Now what I think drove us to this design -- us, NRC -- was this had two advantangeous things; that is, number one, it had four vent valves, it had four cold legs,

it had the ability to give you some type of asymmetry.

At the same time we felt that if you ganged the valves together and had them operating in unison, that configuration would be more uniform than a single value because you would have an annulus with water squirting in from all sides as opposed to one side, so I think we came to the conclusion that this gave us really the best elements of both worlds.

We could force symmetry; at the same time we could get asymmetry. It is a compromise and I think that, in a nutshell, sums it up. There was a wide divergence of opinions, I know, and myself, I vacillated back and forth at times also and I think this is what sold it for me and Dr. Shotkin also, because it had two capabilities.

MR. WARD: I guess the third point is the only way you can get the two capabilities is by having Servo operating?

MR. BECKNER: That's correct and I think someone brought up here the other thing about the Servo operation was definite knowledge of when they were open and when they were closed.

MR. MORGAN: Through the piping, you can also measure the pressure drops so that at single phase flow, you have an idea of how much flow is going through them and our experience has been that it is single phase flow through

the vent valves 99 percent of the time which you would have a difficult time obtaining that flow information in a flapper valve and this gives again the analyst, Thad Knight, one more piece of information to check his code with.

MR. SCHROCK: He was very emphatic about needing the flow through those valves.

You will tell us how you will get that, I presume?

MR. MORGAN: Through the pressure drop. It will not be very good for two phase flow but it will be good for single phase flow, which our experience has been it is single phase steam flowing through those valves 99 percent of the time so he is going to get most of what he wants.

MR. MICHELSON: Which time are you referring to when you talk about 99 percent? Throughout the entire small break LOCA, 99 percent of the time it is liquid flow through these valves?

MR. MORGAN: Steam flows through the valves when they are open.

MR. MICHELSON: I misunderstood you, then; in other words, when they do open, it is steam that is blowing through them?

MR. MORGAN: Right

MR. SCHROCK: But you are assuming, are you not, that the flow through the valve is determined for all four valves, whatever instrumentation it is that is giving you

the signal driving the Servo, but for each of the valves, there will be the potential for different pressure drives.

MR. MORGAN: That's right and it is measured on each valve; the pressure drop in each flow path from the reactor vessel to the external downcomer, the pressure drop for each valve is measured.

MR. SCHROCK: You may create such false situations driving the valve this way that you will be getting backflow through the valve because the thing operates with such small pressure differential.

MR. MORGAN: That is why we will run the separate effects --

MR. SCHROCK: You may have the wrong direction when the valve is open for one of the four or two of the four.

MR. MORGAN: That is why we plan to separate effects testing with the valves opening in several different modes.

I think with that we can determine where we are.

MR. YOUNG: Can I say something also?

I am Mike Young. Professor Schrock, that is an interesting question. As Chuck mentioned, we will try to address that in the separate effects testing but also, TRAC will run some analysis in order to try to scope at what kind of effects this vent valve design will impose on the system.

I think there was a very good argument brought up

at that meeting about the valves may very well drive the process instead of vice versa and it is this sort of thing we would like to get a handle on and we certainly are looking at.

MR. WARD: Okay.

MR. CARTER: Dr. Schrock, on the question about the vent valve flows, I think you will not get a reverse flow but you certainly will get a variation in flow between the four legs.

Since you have a common pressure at the reactor vessel itself which is a high pressure point, you may have lower pressures at different quadrants than the downcomer which could cause variations in flows but I don't think you will get reverse flows.

MR. SCHROCK: Well, that remains to be seen.

MR. MORGAN: Okay, to finish out the downcomer, in elevation we have the vent valves, the core flood nozzles, the cold legs all located at their correct dimension. To keep the gap large enough, the volume in this annular portion of the downcomer is too large. For a case where you might have a core uncovery, we don't want to have too much inventory so for the elevations at core level and below, the downcomer will have the volume scaled correctly.

The advantages, I think I have already gone through this, the advantages we see in a downcomer design are we

won't have the hot wall effects and we do have some flexibility and we are going to do separate effects tests to characterize the pressure vessel and the reactor core are correctly scaled for power to volume and for elevation.

We have here a sort of schematic showing the various elevations that are concerned. The core will be a cross-section of a B&W reactor core except it will be electrically heated. It will a 49 mod subsection, so it has the right pitch to diameter, the right pitch, the right diameter.

There will be 45 heated rods and four guide tubes which is in the right proportion for the 817 scaling.

In the GERDA facility, which some of you know a little bit about, the upper plenum area is empty where in the actual react we have an upper plenum cylinder where the flow comes up, goes out, well, there are two flow paths -- or three I guess.

One flow comes up and out these holes, the down and out, the hot leg. There are some small holes in the plenum cylinder directly opposite the hot leg so you get some flow this way, then there is a flow path up into the top plenum, around, down and out.

Since we wanted to look at upper plenum venting and so forth in a MIST facility, we designed a upper plenum cylinder to try to scale some of these effects to go into the MIST facility.

MR. SCHROCK: How does the water get out of the upper head into the hot legs?

MR. MORGAN: There are actually quite a few -- this upper region is just a latticework that holds the guide tubes for the control rods and that goes all of the way across so it is really pretty open and this appears swallowed on this sketch but if you were to look at the actual plan, there is an opening. Just a latticework here through which there is a large flow path for stuff to come up through and down.

MR. MICHELSON: It was my impression the bypass flow that comes from the cold leg normally circulates through the head and back out during normal operation. That is what keeps the head at the cold leg temperature.

You are talking about a reverse of this.

MR. MORGAN: No, I think during normal operation this flow, this bypass flow from the core which comes up around and back --

MR. MICHELSON: That would be at the exit to the core.

MR. CATTON: That is not correct.

MR. MICHELSON: My impression was it was from the cold leg.

MR. CATTON: It may be in between.

MR. MICHELSON: And the bypass comes from the driving function of the reactor coolant pumps in the annulus

and those little bleetles take the water and circulate it around the top and take it back out, is that it?

MR. LOWBIN: Norm Lowbin. That is true of the Westinghouse.

MR. MICHELSON: B&W does it the other way around?

MR. LOWBIN: Yes.

MR. MICHELSON: I see. You learn something new every day.

MR. WARD: Are you glad you came?

MR. MICHELSON: That is interesting.

MR. CATTON: It's magic.

MR. MORGAN: In the MIST pressure vessel, we have these holes. It looks kind of funny but the spill overpoint is at the right elevation because of different sized holes.

The sizes of these holes were sized to pass the same fraction of fluid as what goes through the normal plant.

MR. SCHROCK: Do you have experimental confirmation of that or was that calculated on K factors?

MR. MORGAN: That is calculated on K factors.

MR. SCHROCK: That's not too good.

MR. MORGAN: To the best of my knowledge, I don't know that we have any experimental verification of the fractions that go through the plant other than the overall heat balance.

The hot leg design is a little different than the

last time we presented it. Originally we were going to use the hot leg from GERDA. We found that to fit it together we had to change the hot leg U-bend. That gave us the opportunity to go back and look at the hot leg design in more detail and we found we could live with a slightly smaller pipe. Instead of a three-inch schedule 160, we have gone to a two and one-half inch schedule 80 pipe. It still satisfies the criteria that the pipe be large enough that you are in a large pipe regime; in other words, you are unlikely to get glug flow.

The pressure drop is close to plant typical and by going to the lower schedule we have the metal volume to fluid volume much closer to typical.

It was quite a bit than would be in the plant and now it is only about 30 percent than is the plant so we have moved much closer to typical in that situation.

The U-bend radius is 1.6 feet and with the constraint that we preserve the L over D of the horizontal section coming out of the reactor vessel, this is a region of developing two phase flow and whether you get stratified flow or not could be important.

As to how things develop in the vertical section of the pipe, we felt it was important to preserve the L over D ratio coming out of the vessel.

When we did that we were constrained to make the

upper U-bend radius 1.6 feet. There is no scaling involved. It is unfortunate but you mechanically have to fit the thing together; however the voiding of that U-bend occurs relatively early no matter how you scale it within reason, and the overall length, as I discussed, of the interrupted natural circulation mode is dependent upon the elevation between the top of the U-bend and the surface of the steam generator, which is some 14 feet, and that is preserved.

The cold leg is the same as we have presented before. It is a two inch schedule 80. The major design criteria is that we don't get slug flow where you would not get it in the plant and a two inch schedule 80 satisfies that the pressure drop is close to plant-typical and to get flow measuring devices into the cold let and to get the correct pump head scale or head flow scaling, we have to put some orifices in and by the addition of those we will have the pressure drop met but that design work hasn't been quite completed yet.

The pressurizer is one place where we have deviated from full elevation scaling. The pressurizer is a six inch schedule 120 pipe. The volume is preserved. We feel it is very important to have the right inventories in the steam generator -- I mean in the pressurizer.

The elevations of the surge line piping, which form a possible loop seal, are preserved but if the -- if

you preserve the elevation in the pressurizer, you have a very tall, skinny device which has an extreme atypical surface to volume ratio that would be difficult to get sprays in that would not interact with the walls.

There is a whole host of scaling problems.

In our judgment, as long as the elevation of the bottom of the surge line, I mean the bottom of the pressurizer was correctly located, we could give up some on the total elevation so we went to a slightly -- well, much larger diameter and reduced the height correspondingly.

We do model the surge line diffuser and the sprays. The spray rates and temperatures and the heaters of course are modeled.

The reactor coolant pumps, we plan on going with four canned rotor pumps. One of the major criterion we have imposed on the MIST design has been almost zero leakage of mass other than the leakage at the required leak location and minimal heat losses because in the small break accidents in some cases in previous tests, the inadvertent leakage can rival the desired leakage and it creates a lot of problems of the the analyst.

So, we have been very adamant, I think, in our choice of components that we have put into the MIST facility that we come as close to zero leakage as possible.

MR. CATTON: I think this particular case is one

where you could have very easily have done some simple calculations, one with the pump characteristics you have here and do another set with the pump characteristics scaled from the actual beast itself and compared the impact of those two calculations.

Without having done that, even though you can hardly argue with your reason, don't leak any heat or water out, I think a really sound basis for selecting a pump, that I would certainly like to see what this does to the tests you are going to run compared to a pump with the proper characteristics.

MR. MORGAN: We haven't done that yet.

MR. CATTON: I think you would do that before you selected the pump 'cause maybe just maybe you would want to do whatever you have to do to make the other pump work.

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MR. MORGAN: We have talked to several consultants and some of our people. I am not a pump person, but my understanding is they feel if we get the head flow characteristics correct at the liquid point and the vapor point, that what goes on in between, there will be degradation in both designs and we probably aren't going to see much difference.

MR. CATTON: Why don't you put it on a little sounder basis?

A lot of us have had a lot of judgments about a lot of these things, and a lot of us have been wrong.

MR. WARD: What is not being matched here? I don't understand.

MR. MORGAN: With a canned rotor pump, you cannot match the specific speed.

MR. WARD: Okay.

MR. MORGAN: Well, even if you matched the specific speed with a regular scaled-down version of a PWR, you probably will not have exactly the same two-phase degradation anyway. But there was originally a desire to match the specific speeds of the two pumps to get the two-phase degradation as close as possible.

The investigation we have done have led us to believe if we scale the head flow characteristics for single-phase flow, we are not going to be at both the liquid point

and the vapor point. We are not going to be too far off in between.

And more importantly, we can scale the head flow. We can get the correct lock rotor resistance. We can install these pumps vertically, and I think this is important -- we maintain the spillover locations and the flow paths.

So, we have almost everything we want but the specific speed.

MR. CATTON: Dave, the point that I am getting really perplexed about is that each one of these little steps as we go along has been based on someones engineering judgment. We have 10 years invested in codes, and some are getting reasonably good. Why don't we exercise that code and see whether this engineering judgment is correct or not before we go running off and it becomes welded into place?

It may be okay, but it sure would be comforting to have seen the calculations done to back up this engineering judgment.

MR. MORGAN: You know it isn't all engineering judgment. There have been a tremendous number of calculations.

MR. CATTON: I understand it. But just now I tried to count the number of times you said "I think," and it was like five or six. In explaining the pump to me, when

you say "I think," that's engineering judgment. I'm not saying your judgment is bad, it's just that we do have a tool that we can exercise.

MR. MORGAN: Perhaps I said "I think" because I'm not the one who did the pump calculations.

MR. CATTON: I understand that.

MR. MORGAN: There are a significant number of pump calculations in the design document if you want to go through them.

The actual comparison in a plant I don't think has been done.

MR. CATTON: That is the one I am asking for.

If you think you scaled it, you go ahead and do it. I don't think there is any real question then. But when you come to a point where you are going to put something in the system that you know as atypicalities -- and there were some discussions about it at MIST, and I didn't really pay a whole lot of attention, except that what I did pick up was there are differences -- those differences can certainly be tested to -- within the adequacy of the codes today, to find out if leads to anything. If it does not, you have forever eliminated it from consideration.

If you have not done that, we are going to argue about this for the next five years. And I really would like to see that avoided.

MR. MORGAN: Well, you know, I would have liked to have done more calculations than have been done, too. But we have been on a time -- and, you know, there just isn't an infinite time.

MR. CATTON: December 1 is coming up pretty fast. And if you add up all of the dollars about to be allocated, I think the calculations are cheap.

MR. MORGAN: Okay.

That is a quick, brief overview of the MIST design.

How well will the MIST design answer the TAG team concerns? Of course, this is subjective judgment, and different people may come to different conclusions. But we have a good deal of experience with a similar design, which was the GERDA facility that we built along with the Germans. And in that facility, we did have quite a bit of experience running tests, where boiler-condenser natural circulation occurred.

So, we feel confident that we would also get it in the MIST facility.

We have high-point vents in the MIST facility, both in the upper U-bends and in the reactor vessel head.

So, through the test matrix, we will be able to consider those points.

In the GERDA facility, we experienced interruption

and reestablishment of natural circulation. We did some pretest calculations when we were designing the GERDA facility, and we interrupted natural circulation in the same time frame as we predicted.

We have the ability to put noncondensible gases in the MIST. We have been testing with noncondensible gases in GERDA. We got results which, while they have not been analyzed in detail yet, we saw a buildup of noncondensible gases in the steam generator which lead to degraded heat transfer to steam generator and increase in pressure, all things that you would expect.

So, I would expect that we could see the same sort of behavior in the MIST facility.

By having two steam generators, we have the opportunity in the MIST facility to look at asymmetries -- well, instabilities or asymmetries in operation due to different feed of the different steam generators or steam line breaks, or whatever you want to postulate.

So, I think the facility is well adapted to do that.

MR. WARD: You know -- let me interrupt you for a moment. If I were going to -- I guess I might have expected or I'm a little disappointed you don't just have another column on that table where you have given us some sort of subjective evaluation of how well you think MIST

handles each of those things. You are giving it to us, but it is a little loose and in a form I am not sure of.

MR. MORGAN: At the three-day meeting in Bethesda, we tried to quantify -- "how well does it do" type of thing. And it was characterized as a PR-beauty contest presentation.

Since it is subjective, we decided not to repeat that this time.

MR. WARD: Well, your A, B, C, D are subjective.

MR. CATTON: What you gave us at that meeting was a vote, and I think we were not really interested in a vote.

It was more comments like "I think it will handle loop-to-loop interactions of the following kind well, because. . ."

MR. MORGAN: We haven't gotten to loop-to-loop interactions yet.

MR. CATTON: I just picked it as an example.

MR. MORGAN: I'm giving you the reasons why I think it will do these things so far. (Indicating.)

And we didn't put a subjective rating as to how well -- I thought it would be better.

MR. CATTON: Better than a vote would have been a sentence. And if it cannot handle it well, then where is that information going to come from?

For example, you have SRI-2 and you have University of Maryland. And if you put up a matrix, we

could say, "Gee, this particular thing is not well-handled by MIST. On the other hand, it is well-covered by. . ."

We have requested that matrix we did at Alliance, we did at the meeting before Alliance, and we still don't have it.

Maybe we are just too dumb to be able to think about that many things at one time.

MR. MORGAN: I'm not able to judge how well SRI-2 or the University of Maryland will do, because those designs aren't complete in enough detail yet.

MR. CATTON: Well, somehow, I think somebody has got to put across where this one is weak, where is it covered, what is your backup, who is running the separate effects test, how many are there?

MR. WARD: Yes. Maybe it is the role of the Staff. After all, it is the Staff that is promoting and financing the University of Maryland's test, and you have some reason for that.

So, maybe we need to come back to the Staff after this and ask you .

MR. CATTON: Maybe we need the PMG representative up there, because they should have an overview of the whole thing.

MR. WARD: Who does have the overview? I'm not sure PMG people do have.

Are the PMG people managing the University of Maryland project?

MR. SHOTKIN: We would be glad to give you the subjective.

I think Mike has a slide that goes through all of the facilities.

It even has these things, with little X's on it.

And as Chuck Morgan pointed out, at this meeting Gloudemans from B&W got up and gave B&W's subjective ratings of all of the components of phenomena. And I think it would be very interesting, if you haven't seen it, if we sent you a copy of the subjective ratings. I think there has been quite a bit done on these subjective ratings.

MR. WARD: I don't know if I want so much a copy. I'm not so interested in semi-quantitative ratings, as maybe just a discussion -- perhaps even tomorrow, if we could come back to that -- the sort of thing, if you think the MIST facility -- I mean, granted, the University of Maryland and, I guess, the SRI facility designs aren't fixed. What we would like to have is an indication from you if MIST isn't going to do this, well, are you going to see to it that one of the others will get at it in some way?

MR. SHOTKIN: Do you want to see Mike's slide now or wait?

MR. WARD: Why don't we let Chuck finish, unless

it is just going to be redundant.

What else are you going to say about this, Chuck?

MR. MORGAN: The next one is the one MIST may not do very well.

MR. SCHROCK: Can I ask, before you go to that, when you are characterizing noncondensable gases as something MIST will do okay -- we didn't get into, maybe, enough detail about that at the Bethesda meeting.

It says the -- with regard to what the code develope.s need -- surely, you saw degradation of the heat exchange process in the GERDA facility. You have measured something.

But the question that still remains is will the instrumentation provide the necessary tests of computer code modeling of the phenomena, or will we still have a big question mark with regard to the role of noncondensables in this kind of accident scenario?

MR. TIEN: Actually, I can tell you right now we, at Berkeley, have a project working on this. And I wrote to B&W -- two papers to present in Seattle. I don't think the code will be able to predict anything about effects of noncondensable gases on MIST. You may get some data, but it won't be able to verify anything.

What we find, in the last two or three years of work, is that noncondensable gas heat transfers are highly

two-dimensional. The radial diffusion is much more important than actual diffusion. That means any one-dimension analysis or code would not be able to predict even to satisfaction. It has to be a highly two-dimensional calculation for that -- with our papers -- we will be publishing very shortly.

MR. MORGAN: I agree, it is a two-dimensional process. But we were able to get a reasonable prediction of the amount of degradation of heat transfer that went on in some single tube tests we did do.

We do have sampling bonds located at different points to get gas samples.

Obviously, you won't get concentration gradients of detail around the loop. It is very hard to get through measurements of temperature and pressure. You can infer sometimes the partial pressure of the gas and find out how much is there.

I think there will definitely be information of a qualitative nature. You can definitely find out, for a given amount of gas, will the pressure exceed the pressure at which you can operate the system before you recover heat transfer. Because what happens if you have noncondensable gases in there is you degrade the heat transfer. So, you are still generating heat energy, so the pressure goes up, which gives you a higher partial pressure gradient to help condensation,

higher temperature differences. Ultimately, you reach a pressure where you're able to remove the energy again. You can get an overall balance of that nature, I think, after these experiments.

I am optimistic enough to think that you can also, if you spend time with the data, find out a little more than just those gross effects.

MR. CARTER: Just to comment -- Randy Carter of B&W -- the instrumentation in the steam generator will be very detailed in the upper region where the noncondensable gas may collect. There will be details both of primary fluids and the tube metal temperatures that can be used to help locate where the noncondensable gas is locating and how much the heat transfer service has been blocked by the noncondensable gas.

MR. TIEN: This again symbolizes a question we just asked. Really, you need a matrix of different points of fact. If you want to study how much we can gain from the MIST test, if we cannot have separate-effects tests or other systems will give certain phenomena, certain kinds of indications. I think that information is very, very important.

MR. MORGAN: We did do separate-effects testing on this very issue --

MR. TIEN: Yes.

MR. MORGAN: -- to aid in the analysis.

Well, anyway, let's get to one loop-to-loop oscillations.

If these loop-to-loop oscillations are of the type that some of the TRAC two-dimensional studies have shown, where differences in density exist around the circumference of the downcomer and these density differences induce some loop-to-loop oscillations, MIST, because of its small scale, is not going to be a very good facility to study these types of oscillations in. And I think we said that at the very first TAG meeting.

At this scale level, some of the phenomena involve small variations in pressure around the downcomer annulus, are just not amenable to any facility at this size scale that I can think of.

I think there, though, those TRAC calculations -- my understanding of it was it was a fairly simple monometer type of effect. And I would trust the code if that predicted that.

Of course, when they renoded it, to put some of the correct elevations in, some of those oscillations went away. We might not see that type of oscillation. We might not see them in MIST anyway. That is one area where I think there is a definite problem with obtaining detailed information in MIST.

Two-phase natural circulation -- we have seen two-phase natural circulation in GERDA. Two-phase natural circulation is dependent upon density distribution. Density distribution will be off in the hot leg because of the larger volume, but we plan to get around this by running at several different.

So, I think we will have sufficient information to generate a good understanding of two-phase natural circulation.

The event valves, as I explained under the event valve portion, for the effectiveness of the cooling and providing an alternative path in the reactor vessel for flow, I believe the MIST facility plus the program, which will vary -- vent valve resistance -- is a very good facility for alleviating these concerns.

Now, if you are concerned about vent valves inducing oscillations because there are very small pressure differences around the loop -- again, I think that will not be treated very well. But that concern is of a lower magnitude than the major one, as I understand it. Just the effectiveness of supplying that alternate flow path -- single-phase natural circulation -- GERDA has given very interesting and explainable results. Of course, this is a low priority, because it is very well understood anyway. But we have gotten good information from GERDA on that, so I

see no reason why we wouldn't also obtain good information on MIST.

The rest of the concerns are not so much facility-oriente , but they would depend on how well they answer concerns on the test matrix.

And we are going to have another presentation on that. So, that concludes my presentation.

MR. WARD: Okay.

Thank you, Chuck.

Are there any questions?

(Pause.)

MR. WARD: Mike, how long will you take?

(Pause.)

Okay. Let's go then.

MR. YOUNG: I thought I would put up this slide.

I don't have any copies. I wasn't planning on talking about this.

This was brought up briefly in the last review group meeting we had.

Essentially what this slide does is go through some of the issues which are identified earlier, and it tells which issues we expect the facilities to answer.

And I think what B&W is telling is the MIST design is capable of looking at all of the issues that were identified by TAG. In some specific areas such as the

density differences around the downcomer, that is not something that will be achievable.

And specific RVVV effects on system behavior probably isn't going to be able to be characterized like we would want.

But we do have these other facilities. We expect, in the first grouping I have, the four facilities that have been designed should address those.

The loop asymmetries, possibly RVVV-driven and steam-generator-driven, we expect should be able to be investigated with MIST, SRI, and the University of Maryland. They have different designs, and we feel we will be able to scope out the parametric range of interest regarding these different ones.

Also, to continue this, I have added a couple of other items here, besides what was identified as issues, such as the RVVV downcomer effects on characterization and specifically hot leg and U-bend phenomena.

The separate-effects testing of Maryland on the U-bend looks specifically at that. And I feel like, with the different facilities we have, we are covering quite a bit of the concerns and issues that have been raised.

And certainly I think that the MIST facility does answer or we hope will resolve the issues that were identified in TAG.

MR. CATTON: Will the people who have to demonstrate that their codes do the job be required to address all of the facilities?

MR. YOUNG: No. The plan right now is they will be required to -- at least on TRAC and RELAP-5, they will be required to analyze GERDA, OTIS, MIST, and the University of Maryland. Those are our plans right now.

I think there is certainly talk and discussion as to incorporating SRI, too, in those plans.

MR. CATTON: There have been separate-effects tests in the past run on EPRI, questions of the noncondensables and two-phase natural circulation, loss of natural circulation.

There is now the SRI-2 -- it has a different kind of annulus. They approach the problem of the annulus and vent valves differently than the University of Maryland did.

It seems to me if you are going to prove the code with all of these different approaches to scaling, you really have to demonstrate that you can handle all of them with your code.

And if you skip any one -- particularly, I think, if you skip the SRI-2, we really will not be sure.

MR. YOUNG: I can't disagree with that.

MR. CATTON: I think the licensing people can tell us about that.

MR. YOUNG: That's all I wanted to say.

MR. WARD: You said the other facilities were all covered.

What sorts of costs are involved in, let us say, extending the code validation, or whatever you would call it, to SRI tests?

MR. YOUNG: In our assessment plans?

MR. WARD: Yes.

MR. YOUNG: No, I guess I really don't have a figure that I could relate to you right now.

You know, SRI-2 is -- it has certainly been discussed in the past.

A lot of the features and specifics on that design -- they are going through that process right now -- I believe they plan for a design document to come out about March of next year. So, they are in the process of hardening down on that as it is now. So, I think we have some time, certainly, to review our needs on analyzing all of these experiment.

Certainly, it would provide additional confidence to the codes if they can, indeed, predict the performance of each of these facilities.

MR. WARD: Okay. Thank you, Mike.

end 15 Lou, what do we have left on this topic now?

MR. SHOTKIN: A presentation by Carter on the test matrix, and then Mike has a presentation on the analysis plans and support.

MR. WARD: Will it hurt anyone's feelings if we take lunch now and then come back to that?

MR. MICHELSON: It might if we don't.

MR. WARD: All right. Let's take lunch and come back at 2:30 then.

(Whereupon, at 1:30 p.m. the meeting was recessed to reconvene at 2:30 p.m. this same day.)

AFTERNOON SESSION (2:30 p.m.)

MR. WARD: Mr. Carter?

MR. CARTER: I am Randy Carter from Babcock and Wilcox. I have only four topics I would like to cover.

The first is the MIST Instrumentation and briefly touch on the Data Acquisition System and what the status of that is. And the last two things will be the MIST test matrix and the OTIS test matrix. But first, MIST instrumentation.

What I would like to do is take you through how we came up with the instrumentation we plan to use with MIST. There are several things we have done. We have taken several different approaches to ultimately define what the instrumentation would be. One part has to do with GERDA. We looked at the instrumentation we had in GERDA itself. We reflected on the experience we had in GERDA to define areas that would require some additional instrumentation. Also, through the test advisory group, that has been talked about quite a bit this morning, there was some specific recommendations for instrumentation which I will talk about later. This item of prioritized instrumentation, I will go through that in a little detail, explaining what we did there. That was with the intent of trying to relate the instrumentation back to the issues and events that would happen during testing.

And finally, the input we obtained in October, from

the review group, was also incorporated into the overall instrumentation plan.

Before I go through these, I would like to touch briefly on how we went through the prioritization of instrumentation. Several of the presentations today have shown what the TAG issues were. That was the starting point for what we did. We next looked at test events. I will sort of go back and forth a second. With test events there were 25 events that have been defined. These were the ones that were judged to be most important during the events following a small break LOCA and some of the other testing we will do.

They ranged our subjective ranking of importance from the hot leg U-bend saturation and voiding down to pressurizer draining. Each of these were events we felt were important to be able to measure during the course of the transient. From those test events there were several of the B&W people who would evaluate the various components and locations within the loops. What was done was the loop was broken into 33 different parts, complements, locations, whatever you would like to call them. And some of those are pretty important. They ranged from like the first hot leg upstream and downstream of surge line pressurizer vessel all the way through gas addition and gas sampling system.

Each of those 33 locations or components were compared against the testing issues. We wanted to be able to

-- or test events we wanted to be able to measure. People then evaluated it have found that the instruments or measurements required to quantify those particular events. Out of this effort, we defined basically two different instrument categories. One is the essential instruments. That came directly out of the definition of test events and the evaluators subjective view of what was necessary.

The remaining were weighted based upon the weighting shown on a previous table for the events. A composite instrument factor was used and we came up with a list of confirmatory instruments. So basically we defined essential instruments, confirmatory, and the sum of those two establishes the prioritized list of instrumentation.

MR. TIEN: Are you using those numerical values as weight factors? You have 8, 7, 6, 5.

MR. CARTER: We did, yes.

MR. TIEN: By what process? How do you use those?

MR. CARTER: What we did -- and I will show you shortly -- I will give you an example in a minute -- was sort of putting the different pieces and the instrumentation together. And this is pretty much the presentation we showed the reveiw group about two weeks ago. I f you take first the GERDA loop and extrapolate it, keeping the same linear density of instrumenation, you end up with a composite instrumentation list that amounts to approximately 407 total instruments.

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The majority are fluid thermal couples, differential pressure cells down to count activity probe, and others. The others are things like trimeters, limit switches, that type of instrument.

The second part had to do with the GERDA experience, plus TAG and what was in GERDA. If you take the first, plus the GERDA experience, and the TAG recommendations, you get a list of about 689. The things gained from the GERDA experience had to do with some of the information in the cold leg section. Particularly in GERDA we noticed the cold legs, during some of the small break LOCA tests we observed, there was voiding in the cold leg. There is additional instrumentation added to observe both the distribution and conditions following the voiding state.

Another thing that was done, based upon the GERDA experience, was to extend the range of primary flow measurements in a reactor coolant link. This included the capability to go to lower flows and also to be able to quantify the reverse flows in the cold leg.

The third thing the GERDA experience suggested is the full loop should be guard heated and with this we also added the associated instrumentation that allows us to quantify the performance of the guard heaters over the full loop.

The other thing that was added were the specific

recommendations from TAG. These included enhancement of the measurements and particularly the new steam generator that will be built for this project. And I will patch in a little more detail on those.

In general, it was additional thermocouples for primary fluid temperature measurements in discrete locations within the steam generators. Also, the addition of metal thermocouples on the two walls so we could get indications of possible heat transfer coefficients. Also, the potential for locating non-condensible gas concentration locations.

The third thing that was added, based upon the TAG recommendation, had to do with the addition of extra differential pressures on both of the two hot legs. Those were added to allow us to be able to indicate and better quantify the void fraction in the hot leg. With those you end up with a distribution that looks like this.

(Indication.)

About 690 instruments total.

The last list now shows the prioritized list I talked about. It was a subjective evaluation of several engineers at B&W. I have shown two. The top line, all of the way down, is the evaluator who came down with the highest number of instruments. The second is the evaluator who came out with the lowest total instruments. This evaluator went through each of the test events in each of the 33 component locations

in the loop to find the measurements they felt were required to quantify that particular test event and we ended up with somewhere in the range of 697 to 744 instruments. This was presented to the review group in October, October 14 I believe it was, and there was some very specific comments that came back.

In the previous presentation Mike Young alluded to it a little, comments specifically came from Thad Knight and some of the other consultants. The things we have taken specifically and have now included in the MIST instrumentation list are the ones shown here. One is density measurements. As it stands right now, there are plans to include five densitometers. These will be five two-beam gamma densitometers. The locations are not totally defined, pending the resolution of some of the things Mike had talked about.

Another thing had to do with the thermocouple rates. Specifically the thermocouple rates being put in the hot leg U-bend to see if there are any stratification effects on the hot leg U-bend at the point of interruption and circulation. Also in the cold legs to look at stratification due to high pressure injection or due to cold water spill over at the high point of the cold leg.

MR. EBERSOLE: Are these five gamma densitometers the only place where you will know the density of the fluid?

MR. CARTER: No, it is not. I will show you another

slide as we go through. There are approximately 100-odd number of differential power transmitters through the loop that will be used for level void indications. Particularly on the steam generator and hot leg, the density is very high. Under natural circulation, the frictional effect --

MR. EBERSOLE: Let me ask you this. You didn't say densitometers, gamma densitometers I am asking. Are these five gamma densitometers the only place you could look at the percent void?

MR. CARTER: No. That will give you directly the density of that location. The other things that will be there, particularly on the secondary side of the steam generators and on each hot leg, are narrow range differential pressures. From those you will be able to calculate the local void fraction within the range of those pressure temps.

MR. EBERSOLE: You will get an equivalent measure of the wafted void above that point, versus a pressure at a lower point. You won't really know the spectrum of void fractions will you?

MR. CARTER: You will, to some extent, because within the steam generator -- and I will show you that slide as we get into it -- what is actually there is a bunch of narrow ranges that go up through the steam generator. And within a two or three foot section you will look at the average void fraction as you move up the steam generator.

MR. EBERSOLE: You have the two close together?

MR. CARTER: Very close together.

MR. EBERSOLE: All right.

MR. CARTER: The other area that was incorporated from the review group had to do with the distribution of the metal temperature measurements in the core. These are the ones that are actually within the core heater itself and also the fluid thermocouple measurements in the core. The recommendation for these were to space the rod temperatures close to the top, at roughly every three to six inches, so that you could use those for calculations of the core uncovery. That one has been incorporated.

The other, with respect to fluid thermocouples, had to do with additional fluid thermocouples, low into the core section to basically look for the developing saturation line as you have cold water coming over through the downcomer and back into the core. That one has also been incorporated.

To really see this, in any detail, you will have to refer to the copy in your handout. We have gone through the experience from GERDA, TAG recommendations, the review group recommendations, and have developed the total instrumentation list. As it now stands, for the MIST facility, the types of instruments range from fluid thermocouples, differential TCs that are mainly there for the guard heaters, RTDs or Resistance Temperature Detectors, differential pressures both for level

and flows, turbine meters, on down to the gamma densitometers that will be used for density measurements.

The most prevalent measurement, if you look over in the far right hand column, is the fluid thermocouples. Of the roughly 700 measurements, about 337 or about 49 percent are fluid thermocouples. They are concentrated most densely in the primary and secondary side of the steam generator so we can quantify the heat transfer characteristics in the steam generator.

Looking at it in a slightly different format to show you a little about distribution, in your handout I included this particular slide. This is the one that shows the single point or the point measurements, such as thermocouples, conductivity probes around the loop, viewports, flow meters. The slide that has differential pressure on it -- I will show you that one. Because of your comment, it is also included in the facility specification which we just sent out.

You get a feel, very quickly, as you look at the two steam generators that a very large concentration of the instrumentation is over the length of the steam generators on the primary and secondary side of the steam generators. Particulary up high in the steam generator where the majority of the testing will be done with auxiliary feedwater, is a very large concentration of the instrumentation.

I point out previously that, in the new steam

generator, there is basically three regions that the steam g enerator will be instrumental: to look at effects of wetted tubes, non-wetted tubes, and average bundle tubes; conductivity probes. Some of the newest instrumentation out of the review group had to do with the thermocouple rigs.

In three of the four cold legs, one of these thermocouple rigs -- which you will look across the diameter of the cold leg -- will be upstream of the HPI injection location. One will be downstream of the HPI injection location. In the fourth cold leg both thermocouple rigs will be downstream of the HPI injection location to provide better identification of possible stratificaton.

Also, I would point out the review groups comments, the thermocouple break in the pressurizer -- particularly looking at the conditions at the interface of the steam and water mixture and also at the hot leg U-bend, to look at the potential stratification in the hot leg U-bend.

MR. EBERSOLE: I can understand the interface between the steam and water mixture. Can you get a vertical distribution of the variation and void fraction in what you consider any reliable way?

MR. CARTER: Sure. This is one not in the handouts. We could make a copy. It is also in the facility spec. It is looking, now at the facility. Looking at the differential pressure measurements that will be included in the facility,

one of the questions has to do with looking at void distribution. As I mentioned earlier, for example, on the secondary side of the steam generator there are a number of narrow range differential pressures. As a matter of fact, in the lower part of the steam generator these are located so you are looking at the average density void between each support plate.

Also in the hot leg, both upstream and downstream of the U-bend, there is one narrow range differential that is both upstream and downstream of the hot leg U-bend that looks to void within the curvature itself. They become a little wider range as you move away from the area of particular interest.

MR. EBERSOLE: Thank you.

MR. CARTER: Sure.

MR. MICHELSON: Do you have a drawing somewhere to show where the gamma densitometers are located?

MR. CARTER: At this point, the gamma densitometer thing is a little undefined. Currently, we are thinking of five gamma densitometers, all five of which are two-beam. There are some potential locations.

MR. MICHELSON: That is to be 14 locations. Is that right?

MR. CARTER: In the range of 14 or 17 possible washer locations, as I remember. Potentially, some of the

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five locations may be in a horizontal section of the hot leg. Another may be actually in the hot leg U-bend. Others that have been discussed have to do within the cold leg section, particularly at the interfact of the downcomer. I believe one was mentioned particularly at the top of the core and possibly in the vent valve.

MR. MICHELSON: Will there be an attempt to locate them where there are also differential pressure instruments to calibrate one against the other?

MR. CARTER: Conceivably that is very possible.

MR. MICHELSON: That is your intention then?

MR. CARTER: I really don't know the answer to that yet. The only thing that has really been discussed on that is the possible washer locations. And until we evaluate that we haven't pinpointed where they are going to go.

MR. SCHROCK: Those can't be installed on the steam generator?

MR. CARTER: That's right.

MR. SCHROCK: It would be such a dense packing.

MR. CARTER: But potentially, in the hot leg U-bend there exists a narrow range differential we can compare to potentially, if you're interested in the cold leg. There is a range over that cold leg elevation.

MR. MICHELSON: If you're getting pretty good correlation in the pipe, that would leave you a little better

feeling over in the steam generator. You are probably doing a fairly good measuring job, too.

MR. SCHROCK: Randy, in your table it indicates ten gamma densitometers?

MR. CARTER: Right. We count those. There are five actual gamma densitometers. Each has two beams, so we count each beam of the gamma densitometer as an instrument channel. That is what we are counting there.

MR. SCHROCK: And one is across the center and another is on a chord?

MR. CARTER: No. At this point, they are on two different diametrical chords. The exact details I don't know.

MR. EBERSOLE: Is this the standard way of measuring two-phase mixtures of very low quality, using differential devices like this?

MR. CARTER: We had a lot of discussion about that at the review group. There is definitely a difference of opinion. We have had good experience within B&W. Also quoting some of the stuff Larry Hochrieter was talking about from Westinghouse, he has also had good experience using differential pressures. Definitely from Thad Knight -- he felt strongly about the desire to have the gamma densitometers to provide local density measurements.

MR. EBERSOLE; To correlate with these?

MR. CARTER: Well, to correlate and to have the specific 10 point measurements to compare the code with and I think we are trying to include both extremes.

MR. EBERSOLE: Do you regard the gamma densitometers as sort of calibration devices to the DPs?

MR. CARTER: No, we are now treating them as independent measurement devices.

MR. EBERSOLE: What will you do if they disagree?

(Laughter.)

MR. EBERSOLE: Which will be the base line?

MR. CARTER: In my opinion, it would probably be the differential pressures based upon past experience, but I think a lot of that will come from the experience we had

in testing the phase.

For us, there are really two key questions right now: can we get the gammas in without having a leak potential and the other is, what kind of impact are we going to have for calibration?

The most desirable is you would like to calibrate those before and after each test and that is a very expensive proposition for us.

MR. SCHROCK: Your DP cell depends on their existing a negligible momentum and the frictional contribution to the pressure?

MR. CARTER: That's right, which appears to be very accurate.

MR. SCHROCK: Which you can verify through various means.

MR. CARTER: The only time that probably will not be a good assumption is during forced circulation conditions. There definitately the frictional changes will be sufficient enough; you won't be able to use them for void fractions but the calculations we have done and also the experience from GERDA during natural circulation, the frictional momentum parts are not measurable at all within the ranges of the gravity void fractions we are looking at.

MR. EBERSOLE: Do GE's heated thermal couples do any good and those the ones they are going to use for

level --

MR. CARTER: I'm sorry?

MR. EBERSOLE: Heated junction thermocouples.

MR. CARTER: Right now, we are leaning away from heated junction thermocouples. There are five instruments that we call stall flow detectors. One will be in each of the four cold legs and one of the downcomers. The intention of those is to provide and indication when the flow truly stalls.

As it stands right now, we are planning to use cool thermal couple junctions. The reason we are staying away from the heated junction is that fact that a lot of times, the flow is saturated.

You potentially start boiling off the probe and you get some false indications from that but our tendancy right now is to the cool junction.

MR. EBERSOLE: Yes, thank you.

MR. CARTER: Just a couple of comments on the data acquisition system again.

The meeting we had in October, we presented to the review group the overall basis for the data acquisition system. What I would like to do here is to tell you the basic objectives of the data acquisition system and relate to you where we are now based on another meeting we had on November 14.

MR. CATTON: October 14.

MR. CARTER: I'm sorry, we had one on October 14 and another one on November 4.

The data acquisition system within a MIST facility provides quite a few capabilities over and above just acquiring data.

To give you an idea of what we plan to do with it, one is, it needs to provide the operator support both during the instrument calibration period and also during the tests setup period.

In GERDA and also during MIST testing we will do a lot of in situ calibration of instrumentation. During this period the acquisition system is necessary to help support these efforts. One of the primary things is to acquire the 700 instruments. Channels we were talking about previously allows us to acquire those at a sufficient rate to quantify what is going on in the loop and allows us to come back and do post-test analysis after the test is over.

Another area that we want to be able to do is the real time test display instrument error checking. During GERDA, we started implementing this in the sense that the operator was able to see the conditions in the loop and this proved to be a very favorable way to get an early indication of the types of things that were happening both as expected events and also surprize events.

The other thing we want to be able to do is very

early in the game deal with flagging an instrument if it has failed or it is out of range. That is what we will be doing in a real time sense.

After the test is over, the system has to provide us with the capability of going from raw data to engineering units and also allow us to calculate if necessary the rod parameters that allow us to check the consistency the data and evaluate what happened during the test.

The remaining things are more of a bookkeeping type thing, but being able to archive the large quantity of data we will acquire. If you can imagine if you acquire 700 data channels over an eight hour test period there is a lot of data that has to be archived and distributed to outside users such as the NRC, EPRI and other participants in the program and basically maintain the database and rerun the database if there are identified errors in the data.

As it stands right now the overall configuration that was presented and is still being considered right now is basically a two computer system. The lefthand side of this figure shows the part of the system used to acquire the data and store it in a raw format.

The basic computer is a digital equipment corporation, VAX 11/750. He is tied together with an analogic 5400 AWV conversion system. Those two components basically provide the capability to acquire data over the test duration at rates

up to ten hertz and some differentials.

The other things like the retrographics, the VT 100 IDT are the terminals necessary for real time feedback and operator interaction with the loop.

The upper righthand part of this is the second computer that has been considered so far. It is also a VAX 11/750. This is used for a large part of the data processing of post-test analysis that is done after data acquisition.

The last machine shown here, the VAX 11/780 is an existing machine used during GERDE. It will be used mainly for the bookkeeping functions to archive the data from disc to Mag tape and also for preparation and transmittal to the outside users.

I have had quite a few comments from the review group, particularly having to do with some of the things I have listed here.

One was to consider some alternate hardware configuration. One suggestion was made that there is possibly a better way to go other than digital equipment VAX's, computers such as Apollo's HB 9000s were a few of the ones thrown out for possible consideration.

We have looked at those such as the Apollos and the HB 9000s.Mainly because of the operating systems they use currently, they cannot support real time activities.

Also the Apollo has a limitation in its ability to sufficiently address large enough disc storage. There are a couple of other computers that we did run across. Both in discussions with people at the November 4th meeting and also in some of our digital reviews, those are particularly computers such as SELL, Herk & Elmer, which have not been totally resolved at this point, may provide an alternative to the computers we are considering right now.

Another area that was brought up in the review meeting, I have here a review of the 2D/3D, it actually should be review of the TDF data acquisition system.

We were given the name of Jim Colson out at EG&G. We contacted Jim to find out what they were doing on that system. Their system turned out to be a VAX 11/750. They are using a slightly different analog to digital conversion systems than we are using. They were going basically for much higher speeds than we were doing and that is the reason they changed the A to D.

They also considered the same A to D hardward we were using for MIST and GERDE but there was a lot of similarities between what they were doing on the LPTF and what we were doing on the MIST facility.

Another area that has only been partially reviewed at this point, it is outside software packages. There are a lot of companies to develop standard packages for converting

raw data to engineering units. We have looked at that and certainly you can acquire packages that allow you to do that in a standard format. However, most of what we do is specialized and it comes in the calculations of the derived variables such as energy, mass, balances and that is where the expensive part of the software is developed and that is where you cannot get the outside canned packages of software.

This one, there is a little more work to do at this point but it does not look like there is going to be a canned package that can be totally taken and used for MIST.

Those are the slides I had on the instrumentation and data acquisition systems.

If you have any questions, I will be glad to answer those or go on into the test matrices.

MR. WARD: (Nods affirmatively.)

MR. CATTON: How much is it going to cost?

MR. CARTER: The data acquisition system?

MR. CATTON: (Nods affirmatively)

MR. CARTER: What was in the contract is approximately, I am not sure how much we can talk about dollars here. I don't guess there is any problem.

Bob Turner, is there any problem quoting dollar figures here?

MR. TURNER: What is the point, Mr. Chairman?

MR. CARTER: The question is, how much does the

data acquisition system really cost?

MR. TURNER: Do you think it is really relevant to go into that?

MR. CATTON: It is a simple question.

MR. TURNER: Sure, a lot of questions are simple. I am asking the Chairman whether he wants to go into that.

MR. WARD: I won't require an answer, I guess, but I am a little puzzled what the problem is.

MR. TURNER: The problem is the numbers aren't firm. We are trying to deal with some of the comments that came out of the review group meeting. Some of the comments Dr. Catton made was we should try to go out and look at some other systems and I am just not sure what kind of press we would get on these numbers.

If we are really serious at looking at other systems, why should we talk about this now?

MR. CATTON: At the time of the meeting there was a lot of comment about gee, this is a Cadillac piece equipment; what are we doing, are we going instrument Alliance, Ohio for the indefinite future? I am just curious of what it is going to cost because if it doesn't cost too much, then those kinds of comments are too much. If you don't hear an answer all I could suspect is there may be credibility in the comments, so he can answer if he wants or not. I don't care.

MR. WARD: Well, that is a little -- I wouldn't feel constrained here.

MR. CARTER: I will answer it. We can answer it. If you look at the basic two computers, the associated mass storage devices with them, the associated communication devices and their associated system consoles. The things I am really excluding from the price I will give you are the RDT conversion hardware and the associated peripherals for real time feedback. I am just taking the top line; it is about $300,000 -- two computers, the associated mass storage. That includes their operating software, diagnostic software, ready to run type operating systems, no application software but operating systems software.

MR. WARD: What is all the excitement about?

MR. TURNER: We had been told that is too expensive. Let's change directions a little bit and talk about OTIS and the MIST test matrix.

I will talk first about the MIST test matrix and then finish up with the OTIS test matrix.

Within the MIST test matrix, there are several categories. You have heard about them several times today.

One is the mode transition. I will go through each of these individually as we go through the presentation, a small break LOCA, the tube rupture, feed and bleed -- there are two other areas we haven't talked about too much. One

is a single test to look at guard heaters off. That is one test that will be basically a repeat of these tests from the small break LOCA series.

We will look at the effect of guard heaters on performance.

There is another area of planned tests currently undefined. There are five of those right now. Those are the tests that have been brought up but not finalized. They include potentially some of the tests that we will do to relate SRI to University of Maryland and MIST.

Also it will be potential if here we would look at the power or pressure effect on the void fraction in the hot leg. Those are the kinds of tests that will ultimately be included in this particular unplanned or undefined at this point.

Also other things that come up during the course of the test program that are felt to be very important will be included in that particular category.

MR. MICHELSON: What is phase three here?

I heard this morning about phase one and two tests, were to follow some time after phase one, and here we have phase three?

MR. CARTER: No, these are just test series.

MR. MICHELSON: I am talking about your title up there. Am I reading that wrong?

MR. CARTER: Oh, I see your confusion. Within the MIST project, and these are different than the phases Brian Sheron was talking about before.Within the contract, there are three phases: the first is OTIS, the second was the MIST facility specification and the third was actually performance of the MIST project, so that is the phase three we are talking about here.

Yes, I am sure that would cause confusion.

The two areas of tests I will talk about really are the basic, or what we are calling the composite tests, which is this group (indicating) and also I will touch briefly on what we have been calling the characterization tests.

End 17.

Prior to running that list I just showed you, there are approximately 38 to 40 characterization tests. This is the currently defined list of characterization tests we are considering. Those will be redefined and worked, I am sure, as the facility is put together and there is more detail about the facility.

As it stands right now, they range from overall items such as quantifying what the component volumes are, what the volume vs. elevation, component heat loss is, loop leakage. The overall number of irrecoverable losses in the loop, in situ calibration of some of the thermocouple valve recycle response times, characterizing the reactor vent valve loss coefficients which will be important for us to allow us to calculate vent valve flows.

The last several of these, the last four, are some of the steady state characterization tests that will aim at providing some of the reference points mentioned by the reviewers at the last PMG meeting in the area, basically steady state heat transfer and steam generator, steady state natural circulation, steady state boiler condenser, and steady state effects of noncondensable gases.

MR. CATTON: Where do the repeat tests at the same power or repeat tests but in a different pressure, where are they in the scheme of things?

MR. CARTER: Right now the way those would fit in

would be back into the area of what we call planned, but undefined. Now there are a total of five tests out of 41 composite tests that are not defined. Potentially that could be the alternate power, alternate pressure benchmark between SRI, MIST and University of Marvland tests.

MR. CATTON: I really think that alternate power, alternate pressure, a couple of those ought to be run at the beginning so you have a chance to assess whether or not it should impact on the things you are doing.

MR. CARTER: Right now there is an alternate power, but it's not the kind of power we talked about two weeks ago, in the sense that you would need to change it quite a bit to effect a void fraction.

MR. CATTON: Maybe you should try the alternate pressure then, all things constant except pressure.

MR. CARTER: I understand the comment, and I think that ultimately will be with PMG's direction. Where they want to test first. But right now we do have those at least considered as possibilities.

MR. CATTON: I think that recommendation was a pretty strong one at the meeting.

MR. CARTER: Yes, I understand.

MR. EBERSOLE: Please explain to me -- I see up there, what is it, 19 or 10 small break LOCA tests?

MR. CARTER: 19. 19, 6, 4, 1 and 5.

MR. EBERSOLE: So you have about an even number of small break LOCA tests and other tests?

MR. CARTER: Right.

MR. EBERSOLE: However, you establish a loop characteristic on small break LOCA tests only, don't you?

MR. CARTER: Are you talking about the characterization?

MR. EBERSOLE: Yes, because every one of those started with small break LOCA. When you were looking at the original definition of loop characteristics, you did it by identifying all of the accident sequences, beginning with small break LOCA, and here you have an equal number of things that don't start with a small break LOCA, and you didn't characterize them that way to begin with.

MR. CARTER: Within these type of tests, we are talking about the mode transition. The small break LOCA to rupture feed-and-bleed is a little different. But if you take these mode transitions, small break LOCA and tube rupture, the events resulting from those to some degree are very similar, particularly from these two (indicating).

Actually, mode transition is a subset of this test (indicating). You just decide how far you will let it go to. The rupture is similar. Some of the events are a little different. Feed-and-bleed, I agree with you, that's sort of a beast to itself.

What I would like to do is go through each of these test categories and give you a little more detail about what we will be doing.

If you further subdivide the small break LOCA tests, there are really five subsets to that. Looking at the leak configuration, reactor coolant pump effects, noncondensable gas, and venting effect, the effect of auxiliary feedwater, and the effect of reactor vessel vent valves. Within the leak configuration part, there are a total of six tests, and here we are looking at the effects of leak size, location, and when the leak might be isolated during the course of the transient. The base line tests are three leaks, three tests at different leak sizes, ranging from 5, 10 to 50 scaled square centimeters.

All of these will be located at pump discharge in one of the four cold legs.

The second group of tests would be looking at the break location. There are two tests with 10 square centimeter breaks located one at the cold leg section, and one at the PORV site in the pressurizer.

In a sense, there is a third test going back to the 10 square centimeter located in the cold leg discharge.

The last one is a leak isolation test. There is one of those tests. It is a 10 square centimeter, and the

cold leg discharge allows us to go back and compare it to the nominal or reference case, and so we did not isolate the 10 square centimeter cold leg discharge.

Each of these started with the loop and forced primary circulation. The initiating event is the opening of a leak. The curve for the power decay is initiated, emergency core cooling systems are available, pumps will be tripped, at the loss of subcooled margin. And at that point the operator will be interrupting with the design ATOG procedures to maintain pressure and temperature in the loop.

MR. WARD: You say the curve for power decay is initiated at the time of your leak, but you don't have full power.

MR. CARTER: Right.

MR. WARD: How is that transient similar?

MR. CARTER: The way we went about that in GERDA, and we have thought about it in some detail for MIST, but it is not finalized, we basically matched the loops up at the point of loop saturation.

What we basically do is, for an example of 10 square centimeter leaks from our predictions at the time in which the loop saturates and the temperature at which it saturates, you can then determine the temperature that the MIST Loop will saturate at.

You then pick up that point where it reaches saturation, and the decay power curve follows on. So it is really at the point of saturation that you tie the loop to the plant conditions.

MR. SCHROCK: Are these scaled on a system volume?

MR. CARTER: I'm sorry, the leak sizes? Yes, they are.

MR. EBERSOLE: Can I ask a question? I'm interested in this identification of aux feedwater you cited.

MR. CARTER: Yes, sir.

MR. EBERSOLE: In your designs, do you impose on the other participants a requirement that they not fall back to auxiliary feedwater unless they are forced to do so? And due to lack of response capability of the main feedwater? I'm anxious not to go to my alternate sources of coolant until I have to.

MR. CARTER: I'm not sure I understand the question. Will you repeat it?

MR. EBERSOLE: It's not axiomatic when you get in trouble that you go to aux feedwater if you have main feedwater, is it?

MR. CARTER: In MIST, we will.

MR. EBERSOLE: I don't mean that. I mean in real life, which you are trying to synthesize.

MR. CARTER: I'm not sure I know the answer to that.

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MR. EBERSOLE: Well, certainly it would be bad practice to command your emergency systems to function when you don't have to.

MR. CARTER: Right now I think in all of the cases we have defined, we are assuming we have lost main feed.

MR. EBERSOLE: You can make that assumption.

MR. CARTER: And that is what we have done at this point.

MR. EBERSOLE: It probably would make a difference, but in real life it does make a difference.

MR. CARTER: The only effect it would have in these tests is the effect of its impact on thermal centers and natural circulation. We do have a test that will look at aux feeds below the steam generator which is really the same as main feedwater at a lower feed rate.

MR. EBERSOLE: Don't put away your central until you have to, because it may be because of the elevation of the spargers when you get in trouble, you have to go to it. I don't know. If so, you will have a detriment in your reliability, because you have lost your ordinary source of feedwater, which is not the right way to go.

Is that true?

MR. CARTER: Correct.

MR. WARD: Do you want to get a comment from that on anyone else?

MR. EBERSOLE: Do anyone else have a comment to make on that? When you interrupt emergency, you are thrown to the final line of defense, which is aux feedwater, and you have lost your normal line of defense, which is main feedwater.

MR. JONES: Bob Jones, NRR.

On B&W, it is my understanding that the aux feedwater system be actuated on ASFAS.

MR. EBERSOLE: The result of that is you throw one of the babies out the window, which is main feedwater, and a source of coolant, which is valuable.

Is that a good design basis? You see, now you are vulnerable to the same thing CE is, although they don't have PORVs. You make yourself totally relying on aux feedwater.

MR. SHERON: Brian Sheron.

You are not throwing it away completely.

MR. EBERSOLE: Do you have them both?

MR. SHERON: No. What you are doing is, the system is automatically transferring, tripping off main feed and going to aux feed. There is nothing that says you can't get main feed back manually if the operator wanted to. It's not like you've thrown it away forever.

MR. EBERSOLE: It isn't that easy to recover, is it?

MR. SHERON: Not necessarily. I don't know the details of what an operator would do in the control room to recover it, but I do know that a lot of times -- well, the logic, in many respects, I know in some Westinghouse plants is that you do this because the initiating fault was in the main feedwater system.

MR. EBERSOLE: Sure. In that case, you have no choice. But that was not the case.

MR. SHERON: But sometimes it is very difficult for the plant protection system to determine what caused the fault.

For example, in a steam line break, you might be detecting it by steam flow, feed flow mismatch, and you don't know. The control system can't determine if it's excess feed flow due to a feedwater control malfunction.

MR. EBERSOLE: It doesn't know which direction it's going?

MR. SHERON: Or whether it's the steam line causing excess steam flow. All it knows is there is a mismatch on the board, and it would automatically switch to aux feed.

So there are events which I think would cause you to automatically go to aux feed where it is not 100 percent necessary.

MR. EBERSOLE: It makes me feel like I'm jumping

out with a parachute -- and --

MR. SHERON: A lot of times, too, you are going on decay heat. At decay heat levels you are going down to, what, three or four percent power. In order to not overfill the steam you would have to throttle the main feed back to equivalent levels. It's hard to throttle back from what was 100 percent back to 4 percent and maintain it accurately.

MR. EBERSOLE: True.

MR. SHERON: So there are benefits of going to an aux feed system which don't have a design flow --

MR. EBERSOLE: Do you do risk benefit assessments of these various ways of responding?

MR. SHERON: Golly, I can't answer that.

MR. MICHELSON: On the 205 plants, we move the auxiliary feedwater now to the top on all 205s?

MR. CARTER: My understanding is that will happen, they will move them up.

MR. MICHELSON: So you no longer have to worry about that mode of steam generator operation?

MR. CARTER: Chuck, are you aware of that?

MR. MORGAN: The 205s, I believe, yes.

MR. MICHELSON: They will all be modified?

MR. MORGAN: (Nods affirmatively.)

MR. MICHELSON: And to the very top?

MR. MORGAN: All the domestic ones.

MR. MICHELSON: That is what I am talking about.

MR. MORGAN: Right.

MR. MICHELSON: Thank you.

MR. CARTER: The second subset -- this is still a small break LOCA test now -- is looking at the reactor cooling pump effects.

Ultimately what we are trying to determine is the effect of the pump's operation on the overall response. There are a total of four tests which will be performed. One is basically doing a small break LOCA. The pump would be tripped on the loss of subcooling margin and remain off during the entire transient.

Another test will be done the same, except the pump, during the course of the transient, would be bumped to see if they could promote circulation and cooling of the core.

Third would be the reactor cooling pumps would be run during the full course of the transient.

And finally, the last one would be the reactor cooling pumps will be operated until it is felt to be the most critical point in the transient, and the pumps would be tripped.

MR. EBERSOLE: Let me ask you a question:

If you will pull that slide down a little bit, I notice you say that is RC pump effects, in an unqualified

context.

MR. CARTER: Okay.

MR. EBERSOLE: Suppose I pick the highest possible physical break vs. the lowest possible physical break. Wouldn't I get an entirely different response to pumps?

MR. CARTER: Potentially there could be an effect.

MR. EBERSOLE: Why isn't that qualified to the RC pump effect according to where the break is?

MR. CARTER: In this particular case it would be with the leak at what we call the nominal location, which is the cold leg discharge on site.

MR. EBERSOLE: I think you should qualify it.

MR. CARTER: Yes, I agree with you. There will be a definite effect according to where the leak is. As I go through this, if there is not a specific reference to the location and size, it is taken as a nominal cold leg discharge at a 10 square centimeter size. Only in the previous one where we changed the leak size and location do we parameterize on those two variables.

One thing that is also worth noting here is other than those characterization tests I showed you at the beginning, there is also in discussion right now a separate characterization test of the reactor coolant pumps.

One of the things we have discussed before is the fact that we need to know what the reactor coolant pumps are doing. We certainly will know with single-phase head flow characteristics. It's like rotor characteristics. We also want to know what that pump will do under two-phase performance characteristics, and that is a discussion going on right now between the PMG.

The next part of the small break LOCA is the effects of noncondensable gases and the venting location.

Basically the thing we are going after here is the effect of noncondensable gases on the loop heat transfer and cooldown characteristics. And also on the effect of steam binding that may occur during the course of the test.

The first four tests are based upon using different vent settings. By different vent settings, this could be a reactor vessel head vent; it could be the hot leg U-bend vents; it could be a combination of those vents to see how the overall loop will respond to venting of the noncondensable gas and steam that may be present in those locations.

The fifth and last test is basically a test with steam bonding only, and this would be looking at that effect of the noncondensable gases during the nominal tests I have talked about so far. The auxiliary feedwater to both steam generators will be balanced and it will be

adjusted so we maintain a constant level in the steam generator.

There are two tests defined. We will evaluate the effect of auxiliary feedwater. The first one will be to perform a test with the level in both steam generators and with control, and this will let it feed to a high setpoint which is currently about 36 feet, is the one we are considering.

It will allow it to steam down roughly one half a foot, feed back up half a foot. We did some similar testing and it does have an effect on the overall performance and effects of the loop.

The second one is asymmetric feed. This would be to assume one steam generator is affected, it is isolated, and you only feed to the unaffected steam generator.

The last effects within the small break LOCA series is reactor vessel and valve effects.

Here we would want to determine the sensitivity of the system to reactor vessel and valve flow, and the way we will do this is by varying the resistance, nominal, and then at variable pressure differences at which the vent valves open.

The next basic series or test is the feed-and-bleed test.

Here we are looking at the mode of cooling without

a leak,

In this case we are assuming there is no axuiliary, available auxiliary feedwater flow available throughout the entire transient. What is on the particular handout and slide is describing roughly the events, the way the test would go.

Basically it is an issue of beginning to ramp down the core power according to the ANS decay power curve. The reactor coolant pumps are being tripped, based upon the loss of reflood cooling margin fully installed, the high pressure injection would be started. In MIST this will be set at about 2300 to 2400 psi. The system is designed for 2500, and we'll stay away from code safety if we come under that slightly. The port would stay open throughout the test except in the cases where the HPI throttling PORV are needed to open.

We cool down the loop to about 200 psi.

MR. EBERSOLE: Are you going to hold level in the pressurizer?

MR. CARTER: Not in this case, no. You would be feeding out the PORV in some cases.

MR. EBERSOLE: Driving it right on through?

MR. CARTER: Right.

The next several tests are variations of that.

This one is basically the second part, the same

as the first, except now we are going to use --

MR. EBERSOLE: Can I ask you a question?

MR. CARTER: Sure.

end 18

MR. EBERSOLE: Is it possible if you were to drive it toward the normal pressurizer levels, you would find something interesting like a marked improvement in inventory loss?

MR. CARTER: I'm not really sure.

MR. EBERSOLE: Do you follow me? You would be doing single phase flows through the PRVs as a high energetic release per unit of coolant loss.

MR. CARTER: As you push the flow through the pressurizer, at various times you will have steam or water.

MR. EBERSOLE: I am invoking that the system may have a pretty good parting surfact that acts as a separator.

MR. CARTER: And you are assuming steam going out the PORV vent.

MR. EBERSOLE: And I would drive it to that condition, which is a safety condition anyway, and maybe a better one.

MR. CARTER: Certainly there would be an effect on the overall energy release, compared to the energy condition.

MR. EBERSOLE: I think you might find you would cope with a liquid line break, where you have a higher loss problem.

MR. CARTER: I can't disagree there would be a difference in energy release and its effect over possible pressurization and cooldown. I agree.

MR. EBERSOLE: It does you no good to force it

clear on up for a two-phase discharge.

MR. CARTER: I think, in this case, we would be trying to follow the operator guidelines to maintain pressure temperature.

MR. CATTON: Maybe they ought to change.

MR. CARTER: Potentially.

MR. EBERSOLE: They don't know how to measure level in the pressurizer?

MR. MICHELSON: I said maybe that is the problem.

MR. EBERSOLE: Well, they had better know now.

MR. CARTER: The second test would do basically the same as the first, except now we are using an evaluation model for HPI, which is half of the capacity of fully installed. The third test is the same as the first, except we now have a delay in the initiation of HPI. The last one is the same except now we leave the reactor coolant pumps on during the full course of the transient.

MR. EBERSOLE: By the way, if you did that, you would stop some of this loss by reactor cooling pumps because you would have better separating effects. It would influence the picture with the pumps on and pumps off.

MR. SCHROCK: Your pressurizer is short for the volume it contains so its ability to promote phase separation is really better than the actual separation, the actual pressurizer.

MR. CARTER: Correct.

The OTGS-2 rupture series, there are a total of six tests within this series. The first test would be considering ten tubes with a break initiated at the top of the steam generator. The scenario would be after the initiation of a leak, power would be ramped down, reactor cooling pumps would trip the loss of sub-cooling margin, activate the full HPI. Feedwater would be isolated to the affected steam generator and the main steam generator, the good steam generator would have the feedwater raise to approximately 95 percent operating level.

The second test is the same as the first except that we would basically use a leak area similar to 1-2. The third one would be the same as the first except now we will use the reactor cooling pumps throughout the test. In this case, it is the same as the first one except the effect to the steam generator is initiated with a 95 percent level whereas in the earlier cases the nominal conditions for all of these transients is you assume you've lost main feedwater. The levels are low and you are starting from a low level. In this case we would start it with level close to the normal 95 percent range.

The test we would be doing here is both a tube leak concurrently with a simulation of a steam line break. This would have quite a bit different asymmetric effects on

the loop. We are looking at that.

Finally, the last test is the same as the first except now the leak is at the bottom of the steam generator instead of the top. Looking at the basic effect of enthalpy out the leak, or energy release.

Finally, specifically the mode transition test looks at all of the pieces in a little more detail. We have talked about the HPI cooling. We have talked about the feed and bleed and basically the mode transition test gets all of these particular conditions together. We have looked at the specific conditions from the start, the primary force circulation into the natural circulation, the loss of natural circulation, the boiler condenser mode, and ultimately to refuel of the system.

Included in the handout -- and I will not go through them all here -- but just to give you an idea, this shows the matrix of the small break LOCA series. The only thing I really wanted to point out is basically the parameters that are considered within the small break LOCA series. We have talked through them pretty much. We will consider the leak size, leak location, the emergency core cooling model, the status or condition of the reactor cooling pump, whether or not the leak is isolated during the course of the transient, the resistance and the opening pressure for the reactor vessel vent valve, the status or mode of auxiliary feedwater, whether

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or not we have non-condensible gases in the loop, and finally the combination of vents that will be used -- either none or vents at the hot leg U-bends, the upper reactor vessel vent, or the combination of the upper reactor vessel and hot leg U-bend.

And the last is an independent hot leg vent, one hot leg vent open and the other closed.

One of the things we try to do is go back and look at the tests we just talked about. And the numbers I have shown here for MIST tests are those test series where 1 is transition, 2 is a small break LOCA, 3 is a rupture, and 4 is the feed and bleed. We went back and looked at the TAG issues, which have been shown many times today, and tried to relate which of these test series will go back and address the TAG issues.

As you go through them, single phase natural circulation is an example. The first three categories, the low transition, the small break LOCA, and tube rupture, are addressed. Feed and bleed really does not get into the natural circulation evaluation. Another example is break size. This is particularly addressed by the small break LOCA test series. We have talked through that. There is actually a series of tests that looks at break size exclusively. Feed and bleed is addressed specifically by this test and tube ruptures is addressed specifically by a series of tests for

tube ruptures.

MR. MICHELSON: Let me ask you about a test, which I don't think you seem to have on your list. And that is a test which begins to develop an understanding of what happens if the operator is trying to recover from a small break LOCA by refilling the system and so forth. And what kind of behavior do we expect? We will lose the reflux condensing modes somewhere along the way and we will go back and try to get into some kind of natural circulation. Is there some intention to try to reestablish? Is that one of these tests and I just didn't recognize it?

MR. CARTER: I probably wasn't quite clear enough on most of these tests. As a matter of fact, the small break LOCAs and the mode transition tests, in each case they are carried back to the point of the refill condition and the restart or consideration of restart.

MR. MICHELSON: By restart, you mean restart of natural circulation?

MR. CARTER: Restart of natural circulation typically. What we did in GERDA -- and I think it will probably be the same guideline we followed here -- is we take the test back to the condition that the loop is refilled. The upper head is also refilled. In the upper head you have the void gone in the hot leg U-bend. You are back to roughly a normal pressurizer level and we stay at that condition for at least

30 minutes to make sure we are not into a repressurization, resaturation condition.

MR. MICHELSON: Okay.

MR. EBERSOLE: Let me postulate an addition where the operator is in a state of consternation because he has had a small break and is losing inventory. So he is juggling with everything he can, to find ways of putting water in and the level is coming down. What he does not know is two feet away is comfort. When it gets that low --

MR. CARTER: The boiler condenser line?

MR. EBERSOLE: How are you going to keep him from getting so excited?

MR. CARTER: The operator of the facility or the plant operators?

MR. EBERSOLE: The plant operator. How will you tell him don't be too unhappy, down the road there is a haven which is --

MR. CARTER: I certainly think the kind of test results we saw in GERDA and the kind of test results I think will come out of this test program will provide the operator with an idea of what is going to happen during a transient. Certainly in GERDA we saw our operators, in a saw, in a state of consternation when they thought they had pressure hanging out the loop but was really not hanging down. But we well knew, in front of us on the color graphics, we were rapidly

getting to the point where the primary and secondary levels at the steam level will reach boiler conditions.

MR. EBERSOLE: So you will find ways of telling him that will be the case?

MR. CARTER: I think from the test results, that kind of information can be fedback via operator training and guidelines. And I think there should be a vehicle provided for doing that.

MR. MICHELSON: That question leads to another question, of course. That is, is it really better, if you experience a small break LOCA, to settle down to an indefinite boiling condensing arrangement or should you be forcing yourself back into natural circulation as a preferred mode of operation? I guess one of the things you will do is try to get that answer from all of these tests, perhaps.

MR. CARTER: I'm not really sure of the answer to t hat right now. I know relying on GERDA situations, stress situations in both natural circulation and also in boiler condenser, no problem. You can remove t he heat. The loop is reasonably stable. You can sit there and remove the heat. Ultimately there is not question. You have to return to a fully water solvent system.

MR. MICHELSON: Why is there no question about that ultimately being after a few days?

MR. CARTER: I am talking about further down the

road where ultimately you want to consider returning to full power operation.

MR. MICHELSON: But it would appear that once you get yourself into a stable boiling condition, which you were forced into because of the break size, you are tickling the tiger to try to go back into a fully filled natural circulation.

MR. CARTER: There is no question. You can sit there and decide exactly what you want to do.

MR. EBERSOLE: However, in real life what is happening to the boron?

MR. CARTER: I am speaking not for the plant but more in the experimental standpoint of removing the heat and I'm not quite sure about the boron question.

MR. EBERSOLE: It doesn't go through the phase change does it? It stays at home.

MR. CARTER: I would defer that to someone else.

MR. EBERSOLE: Some of it is carried over and you have other problems, I think.

MR. CARTER: I'm not sure I can answer that one for you.

MR. SHERON: Carl, one point. You can't stay in a stable boiler condenser. When you reach the boiler condenser mode, the system has saturated out. One of the key instructions we've been telling operators is don't throttle HPI unless you

sf191b10

have a subcooled system. So the operator won't start trying to throttle HPI, trying to maintain a level at the steam generator if he knows that's not where it is. He will let that HPI rip and he will leave it ripping until he fills the system up and gets the stuff cooling.

MR. MICHELSON: Once he gets level indicators on the vessel, will that still be your instruction?

MR. SHERON: I think it would be.

MR. MICHELSON: When does he stop his HPI? Only when he gets subcooling? Will he go water solid and blow off the release before he finally stops? He could possibly do that. I f you don't want to bleed level indicators, you can get yourself into that mode of operation.

MR. SHERON: He has a subcooling criteria and a level criteria.

MR. MICHELSON: What's wrong with the level on the vessel?

MR. CATTON: Or the candy cane?

MR. MICHELSON: I thought after the level indicators were on there would be an acceptable mode of operation wherein the operator merely controlled the level at the top of the vessel.

MR. SHERON: I personally wouldn't feel too comfortable if I were an operator trying to sit there maintaining levels just above the top of the vessel -- above the top of the

core, I should say.

MR. EBERSOLE: What about in the pressurizer, what you were talking about a moment ago? You wouldn't feel comfortable there either, would you?

MR. SHERON: Why not?

MR. EBERSOLE: It's the same old problem. You are at saturation.

MR. SHERON: If I have indications I am subcooled in the rest of the loop --

MR. EBERSOLE: Oh, you are not just from gravity head?

MR. SHERON: No.

MR. EBERSOLE: I am saying you are saturated in the pressurizer but you have level there. Would you hang up at that point?

MR. SHERON: I have got to measure level in the loops.

MR. EBERSOLE: Let me say I have reached the condition where I have pressurizer level but I have no super pressure. I have no pressure above that. Would you stop there and discharge single phase steam out of the PORVs?

MR. SHERON: If I was subcooled in the hot and cold legs and I had a pressurizer level indicated, then I would have fairly good assurance that my system was filled. I didn't have any steam bubbles chasing around the system somewhere I didn't

know. I would throttle the HPI back.

MR. EBERSOLE: Then you would invoke boiling out of the pressurizer?

MR. SHERON: I don't --

MR. EBERSOLE: From a level in the pressurizer.

MR. SHERON: I don't understand what you are saying, boiling out of the pressurizer.

MR. EBERSOLE: I have a condition when I am injecting high pressure injection. I have no aux feedwater.

MR. SHERON: Oh, oh. That's dirty pool.

MR. EBERSOLE: Well, this is feed and bleed.

MR. SHERON: That is a whole different story. On feed and bleed, sure, I'm going to push everything out of the pressurizer.

MR. EBERSOLE: Wait a minute, I thought you were going to stop at --

MR. WARD: He didn't realize you were talking about that.

MR. SHERON: If I'm at feed and bleed, I will not get subcooling in those loops, which means I will not throttle HPI. I will leave it running.

MR. EBERSOLE: You just said you would not stop the pressure level in feed and bleed, although it may be the best mode.

MR. SHERON: You are confusing me. I think you

invoked a condition which was no aux feed, which said that you would not get subcooling. I did not say that you would throttle HPI if you did not have subcooling indicated in the loops If you don't have subcooling we tell the operator do not throttle HPI, you've got a void somewhere in the system.

MR. EBERSOLE: Then he just said you cannot stop at a given pressurizer level.

MR. SHERON: That's right. You may pump the system up and push it out the safety valve.

MR. EBERSOLE: You are committed to go full board.

MR. CARTER: In feed and bleed.

MR. MICHELSON: Brian, can't you get a situation where you have subcooling because your bubble in the head is controlling the pressure? Just because you have subcooling doesn't mean you necessarily have no voids in the system.

MR. SHERON: That's right. As a matter of fact, we saw that.

MR. MICHELSON: And the subcooling indicator could indicate you are subcooled because the pressurizer is not controlling pressure. The vessel head is controlling pressure.

MR. SHERON: Right. But you are measuring subcooling in the hot and cold legs.

MR. MICHELSON: Generally, I thought you were using your subcooling meter to measure it.

MR. SHERON: But that is based upon thermocouples

in the hot and cold legs, right?

MR. MICHELSON: Hot leg and pressurizer.

MR. WARD: I think we are off on a tangent somewhere.

MR. MICHELSON: Yes.

MR. WARD: Let's go back.

MR. MICHELSON: I just thought you could control the reactor by vessel level indicators, but you tell me you're not really going to use those?

MR. SHERON: No.

end t19

MR. CARTER: Take a brief look at the OTIS test matrix.

OTIS we talked about in the meeting in July, so I will not go back and repeat what OTIS is as far as the exact configuration.

OTIS, in general terms though, is taking the GERDA loop we performed for the BBR contract. We made a few modifications to make it look a little more similar to domestic raised-loop conditions, and we will perform some additional testing on that.

There is a total of 13 tests planned for OTIS. They are broken into seven tests series, and I will go through a little bit about each one of them.

First or the tests or test series is a benchmark test that will be performed on OTIS. To relate back to the GERDA loop, this particular test will be steady-state boiler-condenser mode. You are primarily looking to see if any of the modifications to change the characteristics we observed in the GERDA program.

The second test has to do with a characterization test of the reactor vessel high-point vent. In this particular test, we will be looking at the attempt and effect of removing the steam bubble from the upper head of the reactor vessel and its effect on the overall loop performance.

This particular test does not utilize noncondensable gases.

The next group of tests has to do with the leak configuration and location. There is a total of five tests in that series -- utilized with two different break sizes.

Currently, we are talking about a 10- and 15-square-centimeter scaled leak size to perform one test where the leak is isolated during the course of the transient. And we will be looking at three different locations. These will be the cold leg section, cold leg discharge, and the PORV site.

I can give you a little more detail about that. I have another slide.

Looking at that matrix, three parameters, as I mentioned, are the leak size, leak location, and leak isolation, and break location.

We will utilize 10 and 15 square centimeters. Either the leak will be left open through the entire transient or it will be isolated at the point that the primary flow stalls.

And the three locations are the cold leg suction, the cold leg discharge and the pressurizer.

The next series of tests looks at the secondary characteristics in a similar way to what we did in the MIST test matrix, looking mainly at the effect of auxiliary

feedwater.

There are two tests in this particular category. One is with the steam generator level at 25 feet. Basically, it is there with a constant-level control.

The second is with a level control at approximately 36 feet, with the steam generator either controlled in a constant level or a banned control.

The first test is with the steam generator level at 36 feet, constant level.

The second test is with the steam generator at 25 feet and using the band width control we talked about, similar for MIST.

There are two tests associated with high-pressure injection. One evaluates the capacity. The earlier test used a fully installed HPI capacity. This test would use a lower head, lower flow capacity.

Finally, the HPI pressure-injection cooldown test, the last two tests are what we call composties. And throughout most of the OTIS testing, we do not utilize ATOG guidelines per se. But in the last two, or the two composite tests, we will try to utilize the ATOG procedures as far as pressure-temperature boundaries as we cool it down, trying to relate, also, the OTIS test back to the TAG issue -- the example, again, of looking at these particular tests, first, looking at the single-phase natural circulation.

The test associated with the characterization of the reactor vessel upper-head vent will current give us information on the single-phase natural circulation.

The leak location, leak isolation, leak sizes will give us information on that.

The secondary flow conditions, whether we use constant-level band width control, high feed, low feed; also, the high-pressure injection test and the two composite tests -- will provide us information on loop natural circulation characteristics.

MR. MICHELSON: In the design of the test facility, was there a direct attempt to simulate proper proportions of stored energy in the piping systems, as opposed to the real plant that affects the natural circulation?

The thermal distribution around the loop is affected by the stored energy around the loop just before the transient started.

MR. CARTER: Certainly, at the beginning of the transient, the stored energy is an important question.

Again, the way we attack that in OTIS is try to match the loop and the plant at the time of saturation. And this is accomplished by setting the temperature at which point we want the loop to match. Sometimes we miss and go back and try to reinitialize it.

MR. MICHELSON: That's all right for the initial point, but now the energy input to the loop thereafter is determined by the stored energy in the metal.

MR. CARTER: To some point it does.

Typically, though, as you go through the transient and move out further -- the stored energy question is not nearly as important as it is during the first few moments.

MR. MICHELSON: I was thinking in some of your tests you were talking about simulating the bubble in the vessel and so forth. And that, in turn, is controlled by stored energy in the head.

MR. CARTER: Specifically, it turns out in OTIS, which is really taken from GERDA, that the upper plenum section of the reactor vessel has the right metal mass -- it has scaled metal mass.

And one of the qualifications made is the addition of guard heaters in the upper region.

MR. MICHELSON: How did you scale? On what basis did you do the scaling?

MR. CARTER: For the metal mass?

MR. MICHELSON: Yes.

MR. CARTER: Basically scale proportionately -- volumetric mass, plant to upper plenum in OTIS.

MR. MICHELSON: It has to be scaled somehow in

proportion to the number of rods you put in the core, doesn't it?

MR. CARTER: I misinterpreted it.

The actual core section will match the decay power curve, also.

In the upper head, we will try to initialize the correct temperature in the loop.

The stored energy in the upper plenum part of the reactor vessel should be scaled because we have the correct volume to mass in the upper plenum, scaled upper plenum.

MR. MICHELSON: The volume of metal is in the right proportion to the volume?

MR. CARTER: It is proportioned by the scale factor for OTIS, which is 16-86. It is very, very close to having the right metal mass in the upper plenum.

MR. CATTON: Do you have the right surface area to volume?

MR. CARTER: No, he does not have that.

MR. CATTON: How will that impact on things like formation of the bubble, ability to get rid of the bubble, and things like that?

MR. CARTER: The coupling between the fluid and metal temperatures will be much tighter -- closer in this loop than the plant would be.

MR. CATTON: Is that important?

(Pause.)

Are there calculations made to show whether it is or is not?

MR. CARTER: No, sir, I haven't done any calculations at this point.

MR. CATTON: That might be a nice calculation to do.

MR. CARTER: I understand --

MR. CATTON: Because I think you could have more metal mass if that is what would be needed in the upper region. You could even fin it to give it more surface area, if that is what you needed.

MR. MICHELSON: Something is needed.

MR. CATTON: They need to do calculations.

MR. CARTER: One final slide to serve as a summary or conclusion of the test matrix.

We feel the test matrices that have been defined have been defined in response to the issues raised by the TAG group.

We think it has addressed the major and all of the issues they have brought up, and those issues have really been used to drive some of the work on the test matrices and ultimately to the facility design. And we've gone through those a number of times today.

MR. WARD: Any questions?

MR. SCHROCK: At one time, we discussed the question of whether the guard-heating control did or did not properly simulate the transient features, which really is the heart of the question.

And you were going to tell us what changes you were making in the scheme.

As I recall, at Alliance, you told us, yes, you agreed, there was a need for some change and you were redesigning that part of the system.

MR. CARTER: We agreed there was a need to evaluate the guard heaters from a transient standpoint.

In the document we sent out in the facility spec, we presented the analysis done so far. And basically, that study stated this point.

We evaluated the effects of whether there is a water phase present, a steam phase present, the effects of fins for thermocouples and pressure taps that come beyond the guard heaters.

The part that is going on right now -- and we identified the additional work required -- is exactly that, the transient analysis, whether there is excess thermal storage because of the guard heaters, what is their response time.

SRI is using the heat flux meters of the delta P controllers. That work is going on.

And we have talked before. I will certainly send you a copy as we complete that work.

But granted, yes, we will recognize the question. And that work is ongoing for this project.

MR. SCHROCK: As you said, the coupling between metal and fluid temperature is much tighter in the MIST facility than in the real system. And you know that transients involving conduction within the metal require hours in order to achieve penetration through the thick metal walls in the real system.

Consequently, if you put as much metal storage capacity in the experiment as exists in the plant, you are going to be putting a lot more energy into the fluid in your experiment in the short term as the transient involves over the long pull. You have a finite amount. It is scaled, as you say. But the way it is introduced into the fluid will be distorted, and it will come in much earlier than in the real event, hours earlier.

MR. CARTER: Yes, that is a really difficult problem. No matter what facility we talk about, it is inherent with a scaled, high-pressure facility.

We have made some attempts in MIST design by going to lighter gauge or lighter schedule piping to try to remove some of the excess metal. But even with that, MIST has some excess metal. And you are exactly right, in the

early parts of the transient, it is a real question of how you initialize the test.

MR. WARD: Jesse.

MR. EBERSOLE: I am going to say something and have you shoot me down if you can.

I think your feed-bleed experiments will grossly distort downwardly the value of the feed-bleed process, the reason being as you are sticking grimly to the thesis that I have to hold on sensible heat transport and can't depend on phase change. Therefore, you are grabbing all the water you can find in HPCIs and running it through the PORVs. And I don't know when you'll quit, by the way. Sooner or later you will have to fall back and say, "My goodness, I can do this and this." You might well have done less than that before that time by falling back to a phase-change concept of heat release and going to a control level in the pressurizer, which is what we talked about a while ago.

MR. CARTER: I'm not sure I can shoot you out of the saddle, from the sense that, in the experimental standpoint, we are defining test we think is reasonable. I think more of what you are talking about is the licensing consideration, how the plant operator should --

MR. EBERSOLE: Whoever I am asking, I will ask NRC, too.

You shoot me out of the saddle.

You are grossly distorting the value of feed-bleed in the downward direction.

MR. SHERON: I don't really agree. I still maintain the system -- that we are not designing these plants to feed and bleed. Regardless, we will take what we can get with them. It is a last-ditch condition, after you have done everything to try to get back all of your feed-bleed water, which you apparently have lost for some reason.

MR. EBERSOLE: Well, I will let more qualified people follow on that.

MR. WARD: I guess maybe we should let this go and promise ourselves that this subcommittee will have a chance to interact with whoever it is that knows all about the feed and bleed.

I think we devoted a meeting one day a few months ago on that.

MR. EBERSOLE: Ivan, what do you think.

MR. WARD: I give you 30 seconds.

MR. CATTON: No, I agree.

In the steam generator tube rupture, we saw the same thing. We saw them treat feed and bleed in a way that put feed and bleed out of the picture. And that's nonsense.

MR. EBERSOLE: It's another evidence of the process we saw in CE. If you don't want to do something, you

can maldesign it.

MR. CATTON: That's exactly what happened.

MR. WARD: All right.

Mike, how long do you have?

If we let you go --

MR. YOUNG: Probably about 10 or 15 minutes.

MR. WARD: Then, that will wrap up the MIST presentation?

MR. SHOTKIN: (Nods affirmatively)

MR. CATTON: Before MIST is wrapped up, at some stage I would like to hear a little bit more about their schedule.

We heard before something like a test per day until they are all done. And I would like an opportunity to comment on that.

I think that is nonsense. If you try to run one test per day without doing an analysis of the tests completed, you will get to the end and find out you have to do half of it all over again.

I would like that question to be discussed at some point.

end 20

MR. YOUNG: I will give a response to that right now in the sense that as the testing schedule is defined right now, there is approximately one year.

The first three months are aimed at debugging them basically. The second three months are aimed at doing what I call the characterization tests, the steady state heat transfer test, the steady state boiler condenser mode tests.

The next nine months are then associated with the testing of small break LOCA mode transition and the tests we just went through.

The way we will operate the facility conceivably is 24 hours a day, five days a week. As testing occurs, conceivably we could do one test per day, but it really means over the course of it on the average, we do one test about every two and a half days. That is the way the testing schedule is laid out.

This is pretty much the approach we used in GERDA. Concurrently, there are people reviewing the data both in Alliance and Lynchburg within B & W. They are looking at the data very quickly. That is a part of the requirement, that our data acquisition be very fast and we have a target within 16 hours after the testing is completed . The analysts have data which they can begin reviewing, so there is some very early feedback.

The other part of the picture is the data

acquisition also provides the Alliance people feedback immediately as the test is going on, so in a real time sense we are watching the tests transient. We have benchmarks of what we anticipate should happen. In some cases in the GERDA program, they didn't happen. The next morning we were on the phone with people in Germany talking about the next test. So there are some very quick things that happen based on testing real time feedback data available to the analyst the next day to start reviewing it.

But on the average we are talking about a test approximately every two and one-half days.

MR. CATTON: When you start running your tests, at that rate, and I have no doubt that you can do it and you probably can accomplish the tests you are setting out to run, but I have not seen any -- I think we need to hear from the other side, from the analysts who will be using the data how fast can they receive it, interpret it and give you feedback, because if you run your tests too quickly, you may not be running the right tests for them and I think the test matrix needs to stay flexible until some of this analysis has been done.

Let's face it, we have yet to get calculations on the system to help you with a design much less to analyze the data you are getting.

MR. YOUNG: Just a little more in response to

that. Within the GERDA, what we call phase one, which is like the composite test in MIST, we had a total of about 112 tests. Those were performed over about a ten or eleven month period and of those tests, after the analysts had really reviewed the data over a period of six to eight months, there were only five tests discussed for possible reruns.

As it ultimately ended up, none of the tests were rerun, so we have some good experience on testing this way.

MR. CATTON: It could be that the industrial experience leads to a better experimental program than either universities or national labs.

MR. WARD: That is probably a good assumption.

(Laughter.)

MR. EBERSOLE: There is a stronger feeling of urgency.

MR. MICHELSON: A different kind of pressure is involved.

MR. YOUNG: What I would like to do is present to you the separate supporting programs that NRC is funding that has to do with the MIST program itself.

I will divide these into analysis support programs and also experimental support programs.

As far as analysis support, we plan on using two codes in this analysis effort, TRAC-PF1/MOD 1 at LASL and RELAP 5/MOD 2 at INEL.

In the specific tasks that have been identified to LASL, with regard to this analysis effort, the first thing that is shown here is the downcomer, RVVV design analysis.

The purpose of doing this analysis is to put together a model of the design as we showed earlier today, the baffle guadrant design and to investigate what kind of flows, what kind of pressure differences they predict occurring in that design.

In addition, I think there is another interesting thing which an analysis could provide to us and that is, do we really have a problem with cold leg communication; that is, the justification behind the fins that you see in that design.

We certainly have very low flows. That is what we will be dealing with.

There is the engineering judgment that we do need to inhibit this direct communication between cold legs however . There hasn't been any, as Ivan pointed out earlier, direct analysis done on that and in addition there really hasn't been any separate effect type experiments to verify this.

MR. SCHROCK: Isn't this a 3D effect though? How do you do that properly with TRAC-PF1?

MR. CATTON: PF2.

MR. SCHROCK: He says PF1.

MR. YOUNG: You still have the 2D and 3F component

capability in PF1. Isn't that right?

As we mentioned earlier, the deadline date you have seen was for November 30 on this facility spec for when major procurement activities would have begun and I think Chuck or Randy indicated to you that is true on the downcomer, particularly the outside dimension elevation, the height of that component. The internals of that component don't have to be firmed up for about another six months and our goal is to run some of these analyses and also the separate effect experiments prior to that time so we can make a better decision as to what the details of this downcomer are, are we justified in using the fins?

MR. CATTON: Will you be able to take that downcomer apart and replace its internals or will it be welded shut?

MR. YOUNG: The plan is to weld everything shut.

MR. CATTON: Will you be able to cut the top of it off and change it?

MR. YOUNG: I think that is certainly possible.

MR. CATTON: I think at this stage you have to leave options open.

MR. YOUNG: We are going to try to get ar answer to that. That is the purpose of this analysis and separate effects before we actually commit to that design or to using the vanes.

MR. CATTON: That means the separate effects and the analysis are going to go one hell of a lot faster than you might have a right to expect.

MR. YOUNG: Okay on the RVVV design analysis LASL we'll be looking at the impact on the motor driven vent valves, which will be used in the MIST facility, particularly there is the question on how those valves affect the kind of transient.

As I mentioned earlier, I have the valves driving the process or is the process driving the valves and what we would like to do is, given the GERDA data, which will be formally released to us in about a January timeframe, model that system.

We do have a model built of GERDA now which is on TRAC and considering the 15, I think it is a 10 to 15 second cycle time on the valves, run an analysis and compare it to the data and vary that cycle time, put in a reactor vessel vent valve which would typify a check valve type and get a handle on what kind of influence that would have on the system transient.

In addition to that, LASL will be running some limited amount of OTIS's scoping studies following the experiment, also to do some follow up post-test analysis.

Later in this fiscal year they will be putting together the MIST data and once that is done we hope to get

some comparisons between MIST and the plan completed.

Also the University of Maryland facility, they are scheduled to be generating some data in the Spring of next year around March or April time frame and they would like to perform some facility cross check type of analysis between MIST and the University of Maryland.

In addition to this, we plan to rely upon LANL to do some GERDA data review. As I said, we plan to get that data around January of this year and we really haven't had a chance to look at that in detail.

We certainly feel it is important and we plan on having some of that work done at LASL.

At INEL, as we mentioned earlier, they will be providing us with the support and a form of advanced instrumentation, primarily the gamma densitometers, specifically, five of them right now, which is what the DMG agreed to just recently.

This acquisition is a mistype. It should have been automatic data qualification.

Ivan, I think one of the points you were bringing out earlier is a very good one. One of the things we feel NRC research is very important, is that we develop a system in this testing program whereby we can be equipped with data qualification of each test so that we can be able to provide an answer in a timely manner, such as perhaps within a week

on whether a test was indeed a good test or was deficient in some manner.

We feel like automatic data qualification is indeed an important tool that must be a part of this program. Not whether it would be the ADQ system presently used out at Idaho or LOFT or whether it is the automatic data qualification which B&W plants use, that needs to be decided on.

We plan in the very near future to review that in detail to be sure that it is sufficient to qualify that data.

MR. CATTON: That is the first off. The second half is making sure your analyst, whoever will be doing the analysis of the data, gets a quick shot at it before too much time passes.

MR. CARTER: And B&W is planning on doing that. That is part of the program. They will also look at the data, the kinds of trends or phenomena that occurred and make a decision as to whether or not it was indeed a good test as far as support programs go to serve that capacity.

I think there is a place for it. We haven't really defined exactly what capacity that would be but I agree with you, we are certainly in a mode of fast testing and it certainly needs to be worked out.

MR. CATTON: I would telecommunicate the data right to Los Alamos or whoever will look at it.

MR. CARTER: We plan on putting the data on databank

as quickly as we can.

MR. TIEN: Would you mention what B&W automatic data qualification system means?

MR. CARTER: What the system is all about?

MR. TIEN: Yes.

MR. CARTER: I really can't answer that right now. I am not at all familiar with it. As I said, we have a meeting that will be coming up shortly to learn about that system. There will be several experts from Idaho National Engineering Laboratory that are familiar with their ADQ system to review the merits of what they propose and we also have an onsite representative at the Alliance research facility and as a matter of fact, he just got to the facility last Friday, so he is there now and INEL in addition will support us in the capacity of some analysis using RELAP 5, MOD 2, some limited type of OTIS and post-test type calculations and the MIST plant comparison type analysis at Argonne National Laboratory.

We have recently commissioned Dr. Ishii to take a look at the GERDA data when it becomes available, which is fairly soon, with the primary purpose of looking at the scaling implications, which a particular facility design may have on phenomena.

We have had a lot of discussion on this. Ishii has derived his scaling relationships and based upon some of

his facts and requirements for scaling, we feel it is certainly worthwhile to have him look at this data and try to get a feel as to what kind of impact he feels the GERDA facility had on the phenomenon.

MR. CATTON: Don't you sort of need to do the same thing with the MIST data?

MR. YOUNG: I think that is a good idea and we will. If we get this done first, this is a more short term thing in the next year or year and a half, two years.

MR. CATTON: When will you start testing MIST?

MR. YOUNG: 1985.

MR. CATTON: It is a year away.

MR. YOUNG: '85 is two years away.

MR. CATTON: I would certainly feel more comfortable if you had someone like Ishii take a look and decide on how to use that extra five tests. If you are going to run one at another power, what power to pick and why and the same thing with the pressure.

MR. YOUNG: I think that is a good idea. Certainly on some of the results he comes up with on this kind of analysis should provide some good arguments for either additional testing or perhaps a modification of a test.

MR. TIEN: Some of that probably can be done now, before the tests .

MR. CATTON: If the tests don't start until 1985,

there is a year to do that.

MR. YOUNG: Two years.

MR. CATTON: Two years, and I would think it should be the same person who is also looking at the University of Maryland and maybe SRI-2 to decide which test is the one common to all.

MR. YOUNG: There was supposed to be another bullet on here --

MR. CATTON: Commonality?

(Laughter.)

MR. YOUNG: -- because he also will be looking at the University of Maryland facility to study what implications that facility has.

MR. SCHROCK: How about SRI-2?

MR. CATTON: What about SRI-2?

MR. YOUNG: The plans are not necessarily for SRI-2 right now and I will touch on that in about two minutes.

First, we got into the experimental support. We got as far as NRC sponsorship goes. We are, as you know, supporting the University of Maryland to conduct an integral type testing program on a 2x4 loop.

Some of the major features, which differ from MIST are the annular downcomer. It has four reactor vessel vent valves, which are the flapper type valves. It is a short but fat type of facility. It's pressure capability is

at 300 psi. It is a power to volume scaled facility but the scaling criteria of the relationships for two-phase conditions that Ishii formulated Maryland does indeed match those requirements.

As I said, Maryland will begin construction on the facility next month. They are planning to start about the first of December, when most of their piping should be arriving. The intention is to begin testing end of March, 1984 and the first parts of tests we have planned for them to do are a characterization type test on the vessels and valves.

In addition to that, we are interested in them fairly soon afterwards looking at the effects of downcomer. I recall they do have the capability of varying that downcomer gap in there.

Also, at the University of Maryland we have the separate effects, the hot leg candy cane rig where the primary purpose there is to look at the phase separation flow interruption and the establishment of that flow.

In the last meeting, let me see, in the last ACRS meeting, you had a report on some of the results that came out of that and in addition there was a small presentation which was made during the October meeting. The SRI-2 facility is independently funded by EPRI.

We feel that the University of Maryland facility

in itself certainly provides the support we need on a support experimental facility. It is not in our plans at this time to use the data from there however. We feel like if the SRI-2 facility does come off, if we do indeed, I am not exactly sure where they stand right now, they may, I believe they are in a conceptual design type phase. They have a pretty good idea, they know they are using Ishii scaling but they don't have a design document as yet.

MR. CATTON: Will they use freon or water?

MR. YOUNG: I understand they are using water; however, should results come out of there, I am sure they would be useful when we consider using them at that time.

End 21.

If you have any other questions on this, now is a good time to ask them, because I only have one other slide, and that is on the schedule.

MR. TIEN: Who is coordinating all of the support programs for the MIST Program?

MR. YOUNG: I am.

MR. TIEN: And the manager of PMG is primarily for the MIST; is that right?

MR. YOUNG: That's right.

MR. TIEN: I think it is very important to have a strong structure to coordinate the support programs with MIST, instead of MIST running everything, overpowering the support programs. I think that is very important. Not just with any structure, but with strong people to really decide exactly what should be done and so on.

MR. YOUNG: As I said, this is a very general slide, to give you the feeling of what are some of the major goals or milestones that we plan to see completed.

OTIS, the major milestone there is testing. We plan to be started in February. It is a two-month testing schedule where they should be finished at the end of March.

The MIST facility specification report. That was issued about one week ago, and I think some of you may have received that. That report is due to be reviewed and concurred upon by the end of this month, and the MIST

facility testing, facility construction, that is, is planned to be completed by August 31, 1985, with testing to commence right thereafter.

As Randy indicated just before I started talking again, the testing is a one-year duration which would include the debug characterization and composite tests.

Following that, data analysis and reporting to complete the program. The contract would be completed in March of 1987.

And that concludes what I have to say.

MR. WARD: All right. Thank you very much.

MR. SCHROCK: Could I ask --

MR. WARD: Yes.

MR. SCHROCK: Could you tell us briefly what MIST has, as an integral facility, that the University of Maryland does not have, other than the pressure differences?

MR. YOUNG: One major difference is instrumentation. There is really no comparison in that I think there is certainly a lot to be said for the design of their facility. The guard heaters which they use, and certain design features of the facility which Maryland wouldn't be using, they will be insulating their piping, but that is the extent of it. They will be able to do that because of funding. It is an integral system program.

Perhaps Maryland is more attuned to the separate effects type testing they would be performing, whereas MIST may be more limited in that area, such as Maryland may be easily accessible as far as getting in and putting additional instrumentation in and changing the downcomer out, adding resistance to those or weight to the reactor vessel vent valves, that sort of thing. I think that is an advantage at that sort of facility.

MR. SCHROCK: Will they be able to follow the vent valve flows? Will they know whether the valves are open or closed?

MR. YOUNG: Maryland?

MR. SCHROCK: Maryland.

MR. YOUNG: Maryland will have fuel imports, so they will be able to see those valves, and they also will have DP measurements on each side of those valves to get a measurement.

As far as velocity flow coming out of there, that is a pretty difficult thing to do. Now, we are looking into the feasibility of using an OVA measurement; but, as I said, that is being looked into right now. We've got one available to us, and I think we're going to at least try to use that.

MR. CATTON: Can you contrast a little bit SRI-2 as well?

MR. YOUNG: SRI-2, from what I understand, they

are more designed toward the Ishii scaling logic. They will use an annular downcomer now. They do use a different valve concept.

It's hard for me to explain without that picture. I think you will recall the concept they planned to utilize.

They have the capability of utilizing two different radius of curvatures in that piping leg. They will have two different piping legs which they can --

MR. CATTON: With a different-sized annulus?

MR. YOUNG: On the downcomer? No, I don't believe they are planning to do that. I believe that is, indeed, a difference.

Also, the last I heard, their maximum pressure was at 100 psi.

Other than that, I can't think right now of what some of the major differences are.

MR. TIEN: For the University of Maryland, SRI-2 system, other than budgeted funding, is there any instru instrumentation limitation?

MR. YOUNG: For Maryland?

MR. TIEN: Yes.

You mentioned, because of budget --

MR. YOUNG: It is primarily budget.

MR. TIEN: So, you think, if they had more money,

they could instrument much better, to learn more?

MR. YOUNG: Sure.

MR. SCHROCK: Earlier, I asked about this benchmark test. And I think you promised to comment on it later. Are you going to?

MR. YOUNG: Should we -- as I mentioned earlier, what was the action out of that last meeting, it was that NRC and Maryland would propose a benchmark test.

We did agree to try to use one of the tests of the MIST test matrix. We felt that was a more reasonable way to approach this. That is something we still need to do. We really haven't spent the time yet to really dig into this inner facility comparison test. But that is where it stands right now.

NRC will be providing the recommendation for that and the facility test comparison.

MR. SCHROCK: That is independent of EPRI; EPRI will not participate in that?

MR. YOUNG: No. It is a recommendation, as I said. It will be put before the PMG.

Of course, EPRI is a member of the PMG.

MR. SCHROCK: But the EPRI test is not under that PMG control; is that correct?

MR. YOUNG: That is correct, just as Maryland is not.

not.

MR. SCHROCK: So that was the intent of my question.

Do you hope to cooperate with EPRI on SRI-2 and its benchmark tests? At one time, you clearly did.

MR. YOUNG: Yes, I am sure that would certainly be one of the purposes if the SRI-2 test program does come off. And yes, indeed, that is one of the purposes of this benchmark test -- not only Maryland and the MIST facility, but certainly that SRI-2 be involved in this.

MR. SCHROCK: I think the suggestion Dr. Catton made of involving Ishii in this would be very useful since it could help understand the scaling implications.

MR. YOUNG: Yes. And really that is the primary purpose. We decided to get Ishii involved in this program.

He has certainly done a lot of work on scaling regarding this facility. And we would like to have him look at the facilities we would agree to now and also the GERDA facility, as we've gotten data now that can be looked at.

MR. CATTON: When we have data from -- well, at least two facilities, MIST and the University of Maryland, the question ought to be asked -- licensing -- are they going to ask to prove that the code has been verified or validated or whatever, that it does computations for both

or all three?

I guess Brian would be the one to ask.

MR. SHERON: Which code?

MR. CATTON: I was always under the impression the reason the code run was being run was so that it could verify some code?

MR. SHERON: Yes

MR. CATTON: If you are going to verify some code with all of these scaling questions in mind, I would think you would require that calculations be made for MIST and, at a minimum, the University of Maryland -- and SRI-2, if possible.

MR. SHERON: For the research codes, TRAC and RELAP-5, I will let Research answer. It's their code, and they are responsible for verifying it.

MR. CATTON: I am referring to the code you are going to use a licensing tool when extrapolated.

MR. SHERON: I don't license -- back off a second. I don't license plants with my tool.

MR. CATTON: But you believe others' calculations.

MR. SHERON: Well, when you are saying "others," it is B&W's codes.

What are we going to ask B&W to do with their code?

MR. CATTON: That is basically the question.

MR. SHERON: I think right now we are going to sit

back and see what B&W proposes to do with their code. We have made no requirements on what specific tests they are required to compare their code to in order to claim that it is verified.

We have laid on them, I guess, a general requirement that says, "You need to compare your code against integral system tests."

Now, they have not come back to us yet formally, in a licensing arena, and said, "NRC, here is what we propose to compare our code to to demonstrate tc you that it is verified. Here are the specific tests we will compare it against." That hasn't been done yet.

MR. CATTON: It seems to me that should be done before MIST starts, because may when they come and tell you that, you will say, "Gee, MIST doesn't quite do it."

MR. SHERON: Oh, well,

MR. CATTON: Why is MIST being run? I guess I just don't understand.

MR. SHERON: If they come in and make a case that MIST, by itself, is sufficient, fine, we will evaluate that on its merits. They will have to justify why that is acceptable.

If they come in and say, "We need MIST and we need the University of Maryland," then, you know, we will review that.

Why not SRI-2?

If they come in and say they need all three, we will review all three. We will have to make a judgment.

MR. CATTON: That judgment has not been made as yet.

MR. SHERON: Correct.

MR. WARD: Okay?

MR. CATTON: Well, I understand.

MR. WARD: All right. Before shifting gears, I would like to get any reaction or further reaction from consultants on what they have heard about the MIST and associated programs.

So, let's do that now.

Chang, shall we start with you? Any general or specific comments you would like to make?

MR. TIEN: I still come back to maybe the last slides.

If MIST is going to go, I think the NRC, of course, is going to put a lot of funding into it. And it needs a real strong oversight group, or maybe committee, to really coordinate the support program and so on, because MIST is not going to be starting testing until, say, 1985. So, you can still do a lot of things on that.

But so far I am not really that convinced about scaling and that sort of thing. I'm not really convinced

those sort of things may be able to be done through a strong support program; but it needs a strong hand, or it will make people do a lot of calculations.

What I fear of MIST most is I think a lot of relevant calculations have not been done to really pinpoint the differences or the phenomena and so on.

Right now it is mostly based on experience. I think that is important. But after all of the experience, we have to translate our experience into a more tangible understanding of some phenomena. And from that we can go on.

I just feel not sufficient evidence is shown here to do that. But that doesn't mean this whole program will not be successful. It can be very successful.

But I think if we decide this will be the case to go, you need a very, very strong oversight committee.

I just fear maybe that MIST will overrun the whole thing, and the other program will become relatively unimportant. I think something should be really assured on that particular thing.

MR. WARD: Thank you.

Virgil.

MR. SCHROCK: My feelings concerning the design choices for the vent valves and the upper part of the downcomer will remain pretty much unchanged in a sense. I

suspect I will end up liking what they are going to do better than an even simpler downcomer that has some prospect for showing some of the interactive capabilities that the vent valves and asymmetric cooling and the different loops may have.

But it does not seem to me we really have a design which is the outgrowth of a scaling study which begins with the objective of identifying what are the key things that have to be presevered in the performance of the integral system. That is, what are the phenomena you do not wish to have obscured? And then to, through some kind of a systematic approach, come to the conclusion that a given configuration will produce the phenomena we are interested in studying -- not without distortion, because we all know that is not possible to achieve. But the important things won't be obscured.

So, I am not convinced that there is not a possibility that some important things could be obscured with this particular design.

And I guess my main reason for thinking that is that I think the distortions -- that this outcomer, which is pretty complicated, the upper part of it, has, in contrast to a real plant, is quite significant geometrically. With regard to what the codes have been able to show in this respect, I find it surprising that we are hearing TRAC-PF1

is a 3-D code. I don't think that's correct. And I guess I would like to hear that reiterated very clearly if I am incorrect about that. But I don't think that is correct.

MR. SHOTKIN: TRAC-PF1 is a 3-D code.

MR. CATTON: 3-D core annulus.

MR. SHOTKIN: Just the vessel is 3-D.

MR. TIEN: The rest of the component --

MR. CATTON: The piping is one-dimensional. The vessel is 3-D.

MR. SCHROCK: Does that mean that it calculates three-dimensional flow field in the annulus in the downcomer?

MR. CATTON: Well, really 2-D, I guess -- around and up and down.

MR. SHOTKIN: It typically is used with one radial node in the downcomer. So, the downcomer is typically calculated in just two-dimensional.

MR. SCHROCK: Okay. With that assurance, I think some of my concerns are perhaps alleviated.

The geometric differences I think are still significant, and I don't know to what extent we already have calculations using PF1 thathave modeled this specific design. That is something that is not clear to me.

Has that already been done?

MR. SHOTKIN: We have a commitment to come back tomorrow with calculations showing 1-D versus 3-D.

MR. SCHROCK: I'm sorry. I did hear that.

MR. SHOTKIN: I hope we will have something for you by then.

MR. SCHROCK: Good.

Well, then, I think certainly it was encouraging to learn about the addition of the densitometers as a firm commitment on instrumentation.

There are other aspects of the instrumentation that I think sound very promising.

So, in most respects, I would say it seems to me that the missed facility should produce results that are useful for testing codes. I really never doubted it would do that. In fact, I think the GERDA facility has already produced results that are very useful for testing codes.

What isn't really very clearly fixed in my mind yet is the fact that we will not have some significant phenomena obscured still in this integral test facility.

I think with regard to the interaction of the smaller experiments that have been called separate effect experiments, that it seems to me we need to have somewhat clearer definitions of how that interaction is going to work.

Also, I am gaining the impression that the cooperation which seemed to be well established in the earlier meetings that we had on this topic appears to be

weakening. And I would hope that the cooperative spirit between NRC and EPRI on the SRI-2 experiment is not lost, because I think that SRI-2 experiment will be a very important one.

And unless a strong cooperative arrangement is maintained, I think we have the possibility that we will end up with differing test results that conflict and leave open some new questions that will require still further experimentation to understand which of the two facilities are producing sets of facilities -- I am counting Maryland in with MIST -- whether we are getting the right interpretation of how good the codes are from one or the other if they turn out to conflict -- and I think that could happen unless there is a little better cooperation.

I guess that's all I have.

MR. WARD: Okay. Thanks.

Ivan.

MR. CATTON: I think Brian stated his needs clearly -- or at least I thought so in the beginning.

In my view, MIST is not a stand-alone experiment, primarily because of the problems with the downcomer and some questions about the hot leg and the U-bend, because it is not a stand-alone.

I think the support programs are necessary to accomplish what I think the goals are of NRR. And in order

to do this, I think I have to echo what Tien said. We have to make sure that the support programs play a strong role in the overall program and they are not driven by MIST in some way.

What is being done with them over the next year or so has to be used in some way to interact with the test matrices being planned for. And the test matrices, because of the skewed scaling, I think we need to back up and take a good look at how to construct a test matrix to accommodate some of the skewness in the scaling.

An example that has been given is pressure. The repeat tests should be run at the front end so you know what the skew scaling is doing to you.

The power variation should be run at the front end as well. There is really a strong need for some calculations to be done before the fact.

I am still amazed that PF1 has not been used to check out some things -- like the pump characteristics and what the impact of pump characteristics are and whether they are important or not.

I think if you do this ahead of time, you can eliminate a lot of the discussion. You are either right or wrong.

I don't know. I don't think I can add much more to what has already been said.

MR. WARD: Thank you, Ivan.

Carl?

Jesse?

Do you want to say anything?

MR. EBERSOLE: No.

MR. MICHELSON: (Nods negatively.)

MR. WARD: This would be a logical time for a break, but let's go on to the next topic, because I think some of our speakers are going to need to leave.

So, the next topic is the nuclear plant analyzer and the data bank and NRR needs.

And after 20 minutes or so, we will take a break.

I just said it would be a logical time to take a break. I didn't say we were doing it.

MR. CATTON: Had you said it any slower, I would have been out the door.

MR. EBERSOLE: Logic is not the way we proceed.

end 22

MR. WARD: It's a different sort of logic.

MR. SHERON: I have two slides here, both of them were attached to my handout from this morning. So if you have that, it was the last two slides on that package. We were asked to comment on the data bank and the plant analyzers being developed by RES. I think the genesis of the question was our comments on the long range research plans, where we indicated our support for these areas was of -- I guess -- relatively low priority. So let me try and explain our comments, what it is we are -- what our feelings are about the data bank and the plant analyzer and the like.

The data bank, as you know, was this device which is going to store up data on power reactors and experimental facilities like MISTs, or whatever, and presumably by code users accessing the data bank, the data bank will automatically take plant data and configure it into an input suitable for the codes, particularly even these plant analyzers. As I understand it, it doesn't go 100 percent of the way. There is still about 20 percent the user has to set by hand which would correspond to the actual transient conditions you are trying to simulate in your calculation. But this would do things like automatically nodalize it and the like, from given piping dimensions and volumes.

I think, in general, we agree with the concept.

MR. WARD: This is set up to run what? A TRAC version or a RELAP version?

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MR. SHERON: It could be TRAC, it could be RELAP.

MR. WARD: Do you see what you are looking for would be a data bank that could supply input to any of several versions of these codes? Or is it designed just for one code, or what?

MR. SHERON: The details of that, I would ask RES if they could answer. I don't know whether it's designed right now to input to many versions of the code or if there is a particular version it is designed for.

MR. WARD: All right.

MR. SHERON: I think, in general, we support the concept of a data bank from the standpoint that it makes our life easier. It reduces the resources we would need to set up a plant input deck. Right now a plant input deck for these large codes, like RELAP 5 or TRAC, if you want to start from scratch, and even presuming you had access and had the raw data, can take anywhere from six months to a year to set up and we are talking maybe at least $100,000 for just an input deck for a plant. It is not a cheap thing. It comes very expensively and you want to be very judicious about which plants you choose to set up and try in your calculations.

MR. CATTON: Have you asked RES for standardization?

MR. SHERON: Standardization on --

MR. CATTON: On both the front end of the codes and the data bank.

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MR. SHERON: I think that is part of the overall design of the plant analyzer and the data bank, that interfacing standardization.

MR. CATTON: I wasn't thinking so much of just the plant analyzers. It seems to me if you are paying the freight you ought to be able to have a standardized input routine to whatever code is going to do the computation. And then anytime a plant has been looked at, you can look at it. You could redo calculations with any one of your codes. I think you need standardization of your codes, as well as your data bank.

MR. SHERON: Possibly. Except normally we are not going to do -- if I have a deck set up for RELAP 5, there is very little right now that compels me to say gee, I had better run that on TRAC, unless there is a 3D phenomena I am worried about.

MR. CATTON: Like PTS in the Annulus or some of the things we are talking about today.

MR. SHERON: But when I get in those areas, all of the PTS calculations are being done by research. That's their worry. I know it sounds hokey.

MR. CATTON: It does. You're right.

MR. SHERON: But that is real life. Extensive calculations like that --

MR. CATTON: Gee, I thought NRR was in the driver's

seat by writing user need letters. I think there is a real user need for standardization. That is enough.

MR. EBERSOLE: Brian?

MR. SHERON: Yes?

MR. EBERSOLE: We are talking about -- in general -- we are talking about plants across the board now, aren't we?

MR. SHERON: Yes.

MR. EBERSOLE: I understand we are drifting toward the realization that these are unique.

MR. SHERON: Yes.

MR. EBERSOLE: We are going to have unique PRAs, et cetera, et cetera and we have given up the notion we can always talk in generic aspects. Isn't this falling back to the notion that these things are generic when they are not?

MR. SHERON: Well, yes and no. They can be generic. When you start asking where the plant's unique differences, it may be in the control systems.

MR. EBERSOLE: Is it worth that much, to try to work from a generic basis?

MR. SHERON: From a generic basis it is. From a plant specific basis, I'm not sure it is worth it.

MR. EBERSOLE: I'm saying are we going to be working from a plant specific basis on the realization? That is the only way we can do it.

MR. SHERON: Right now I'm not sure what basis we are going to be working from.

MR. WARD: Isn't that what this is doing?

MR. EBERSOLE: No. This is going back to generalized.

MR. CATTON: No, no, no.

MR. TIEN: (Nods negatively.)

MR. EBERSOLE: I read it as a data bank that will attempt to homogenize.

MR. WARD: No, no. It is a bank of specific data for each of the plants out there.

MR. EBERSOLE: You just pull them together?

MR. WARD: No.

MR. CATTON: The pieces of information will be going in different bends. It will be different.

MR. SHERON: One of the goals of the data bank is to take the existing LWRs and try to categorize them into types of plants. I think the first attempt was made by research to do that. And we just got a document over saying do you have any comments on this. And I think it broke the plants down into -- what was it -- 21 categories, Lou?

MR. SHOTKIN: Something like that.

MR. SHERON: It took the 80 or so operating plants and tried to subgroup them down into about 21 categories of "generic plants."

MR. EBERSOLE: The motivation there is to do one job

for that many plants?

MR. SHERON: Yes, sir, if I had a deck for a set of BWR-4s, that would cover say three, four, or five plants, however many there are. And the same thing with the raised loop plants and the lower loop plants, the Westinghouse two loop, three loop, four loop, the 14 foot core plants, which right now is just South Texas, okay? So there is that effort going on, which is to try to generically categorize all of the plants.

MR. EBERSOLE: This is purely in the thermal hydraulic context?

MR. SHERON: Yes, I see a --

MR. EBERSOLE: Go ahead.

MR. SHERON: You will probably hear a little more about the details. I understand it to be thermal hydraulics but there may be more to it. But as I said, we generally endorse it from the standpoint it makes life easier for our contractors when we have to run calculations. When we are doing analyses, like looking at the benefits or detriments of PORVs on CE plants, it would be nice to have a data bank that one could just call up and say I want to look at Calvert Cliffs or Palo Verde and have it, instead of having to have the contractors -- during the initial phase of the program -- just setting up a deck.

Two things you should know. One is we have no plans

sf231b7

to take over this data bank. Data bank management, like any other program, requires somebody to sit there and monitor it and oversee it, tend to the care and feeding of it, if that is the way to describe it. This does require resources and right now these are the kind of resources which we just do not have to spend. So we would expect that the data bank, at this time at least, would be maintained and run by research, not by us.

And secondly, is that we have no plans or anything right now to go out to utilities and require them to give us the data we need to put into the data bank to make it work.

MR. EBERSOLE: When you say research, you mean NRC research?

MR. SHERON: NRC research.

MR. EBERSOLE: Does NRC research have such plans?

MR. SHERON: I believe they do.

MR. WARD: We will hear from them in a minute.

MR. SHERON: The reason I put this up here is I have heard, through various other sources, that some people have said gee, NRR is going to take over the data bank. And I just wanted to go on record saying no, we are not.

MR. CATTON: Setting it up and maintaining it will not be a pleasant task but it's probably one of those things someone has got to do.

MR. SHERON: That is right.

MR. CATTON: Better them than you, right.

MR. SHERON: That's right.

(Laughter.)

MR. SHERON: Like I said, with respect to obtaining data from all of these plants to put into the data bank, I guess that is another question mark. How does one get that data? We don't plan on going out and requiring utilities to give us all of the data we need. So it is probably going to be a catch as catch can. When we do obtain data, we would certainly forward it to research to put in the data bank. But it would be data that is picked up during the course of our reviews.

PTS we obtained through some cooperative arrangements with utilities. We did get some data. We occasionally -- on reloads, when plants use the RETRAN code, they will provide us their RETRAN decks. And if one can convert the RETRAN deck into a data bank deck, that is another way we could get the data.

MR. SCHROCK: Don't you need a substantial part of that to do an audit of the owner calculations, licensee calculations?

MR. SHERON: Yes, if we were doing audits.

MR. SCHROCK: At some time, for every licensed plant, we have done that.

MR. SHERON: No. We don't do an audit for every

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licensed plant. Basically our policy on audits is we only do an audit if there is some express reason why we should, if there is some concern raised as a part of that plan that would force us to say gee, we had better look into that more. But as part of a routine review, no, we don't go off and try to duplicate the results of licensees, in every case.

MR. WARD: But you have audited the codes they use for reload, say, for on a sample basis or something. Isn't that true?

MR. SHERON: A lot of times, when we review the code -- when the code was submitted, for example on CESEC. Combustion submitted the CESEC codes. There is a classic example. For that code we did audits with RELAP 5, I think it was -- for which plant? Norm, do you remember?

MR. LAUBEN: I think they did it for several.

MR. SHERON: Okay, several plants. So what we did was we audited the combustion code, at the time it was submitted for approval, and we convinced ourselves we were getting the same kinds of results Combustion was for those specific examples that we looked at, at the time of the code review. After that we don't go and audit every calculation or submittal that comes in that has analyses done with CESEC. Our feeling is we have already compared -- we have already audited and compared our analysis methods with theirs and convinced ourselves that their analysis methods were acceptable.

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In the same sense, with RETRAN we are doing the same thing. Our contractor, which is doing the work with RETRAN, has done some comparisons with RELAP 5. As a part of our SER for RETRAN, we would show these comparisons and show why we were convinced that the code was properly calculating thermal hydraulic phenomena.

So the audits are done -- basically, right now they are done as a part of the code review. The other place they are done might be in areas like the PORV issue for combustion. The specific problem we had to understand the response of the plant. We had to make sure we were not getting -- well, let's put it this way. We wanted to get our own results on the response of CE plants to installing PORVs, having PORVs installed. So we did our own calculations. We did not rely entirely on Combustion to tell us what their plant was like.

Westinghouse has their NOTRUMP code, new small break code. We have done their calculations with RELAP 5 and we have picked up some problems. Westinghouse has gone back in Los Alamos. So we are starting to get some responses from the vendors on how they are going to operate their reactor coolant pumps following small breaks. They should be presenting analyses. We will be doing audit calculations for TRAC, to see if those look reasonable. So it is all in that contract. It is not in any plant specific applications that we

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do audits.

MR. SCHROCK: How can you be sure they have correctly applied the calculations for a specific plant that has some plant specific features that may be different?

MR. SHERON: I will address that question.

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We wrote a generic letter earlier this year. We told the industry when you run a code, there are two sources of errors. There are the errors in the code and the guy running the code who screws up because he is not qualified or doesn't know what he is going and we said when we do our reviews and stuff of the codes, we try and address the latter part.

We try to make sure there are no errors in the code.

MR. SCHROCK: Isn't there a third one though; he is qualified and his code is qualified but someone told him the wrong thing about what the plant is.

MR. SHERON: Yes, that is a QA question.

What we have been doing is, anytime a utility -- remember about 1978, we went out as a result of an error in a Westinghouse code, we went out and did a QA audit on every NSSS vendor plus Exxon and there was a big, big fat report which was issued in 1980 on the subject and we said, we are going to continue doing this, which we did do.

And what we have been doing since 1980 is every time we get a code in for a review, every time we get a reload analysis in from a utility, it says, hey, boy, I've got RETRAN now I am going to do my own reloads and save money.

What we do is call up Region IV and we say, will you please go out and inspect such and such a licensee, such and such a utility? Will you please go out and inspect them and tell us if their QA program for developing, using and

maintaining these analysis codes is acceptable, whether they are following accepted standard QA practices and whether their procedures in place follow the standard accepted QA processes and are they indeed following those practices and for each one of these utilities, they write an instruction report where they tell us yes or no.

Yes, these guys do good work, follow QA practices, doublecheck their data and the like, doublecheck their output, whatever they are supposed to do, or they say well, this guy is so-so, he does this but not that. We found some deviations and we make sure they correct them.

Before we approve that code for use we make sure Region IV has given us a favorable finding.

MR. CATTON: So you basically approve a package, people and codes?

MR. SHERON: Yes, people and codes. It is not just codes.

End 24(1)

MR. SHERON: Nuclear plant analyzers, I think we have a bit of a misperception about what a nuclear plant analyzer is. I still do. I don't like the word analyzer, but I live with it.

The analyzers are designed to make TRAC and RELAP 5 more user convenient, to have interactive capability and also to speed up the run time, make them run faster.

What we endorse, what we like, with these, what I will call analyzers is the concept of code user convenience.

Again, it is a matter of being selfish. We don't like to spend a lot of money with our contractors, having them fiddle around with the code trying to get the input set up, trying to initialize it and getting the thing ready to run and then have to sit there and manipulate the output into the right formats and all of that.

We very much like the idea of user convenience, user-friendly features in the code to make them easy to run.

MR. WARD: Do you see running faster in terms of running in real time or something less than that as an important part of user convenience?

MR. SHERON: I don't like to measure time in terms of whether it is real time.

You know, I measure it in dollars -- how much does it cost me to do a calculation?If one calculation breaks my budget for the entire program, that is not too good.

MR. WARD: Okay.

MR. SHERON: I think what I am doing is I want to keep the cost within reason. Let's say less than $1000 per calculation.

MR. WARD: So you are saying it is cost and not something like real time per se that is important to you. That's an answer, that's fine.

MR. SHERON: I think the two go hand in hand. If you have a code and you want to run a transient, like a small break, out to 10 seconds and the code runs 100 times slower than real time, you are talking some big dollars, so we would like to have the codes run faster for the convenience and money and I think we also get the run time that goes with the real time.At the same time, we do not right now have a specific need for an interactive capability. By interactive capability, I mean some of you have seen the demonstrations where someone can sit down and actually sit there and run a calculation in real time or very close to real time and interact with that calculation.

In other words, they can stop it, open a valve, and then start it up and see what happens and stop the calculations, start a pump or stop a pump, open a valve or close a valve.

Originally, this looked like it might be a very useful feature. We were in the process of reviewing the

Emergency Operator Guidelines and this feature looked like it would be very condusive to checking out guidelines and procedures - - gee-- I could sent a contractor off with the guidelines and say, here, go melt the core, find a way for me to melt the core. Run some crazy transients, put some multiple failures in and see if these procedures or guidelines are as fool-proof as the vendor claims they are. See whether they really cover all of these multiple failure situations he says they do. Go run some, follow it, do exactly what the procedure says to. If the procedure says, start a pump or close a valve or turn off HPI, turn it off, see what happens.

So there was that potential use for it.

Now, as you know, since the SERs on the guidelines were all issued, the responsibility for guidelines went over to the Division of Human Factors. We no longer have the responsibility to say whether the guidelines were good or bad. We did our review. We have issued our SERs, so if there is any need to go back and confirm it, I think any user need for this should come out of Human Factors, the Division for Human Factors, and I will be quite honest. I cannot speak for them on this.

MR. WARD: What you are saying is the time was not right?

It conceivable was not right by a long shot.

MR. SHERON: If I had this about a year and a half ago in a production form so I could use it, it would have been very useful in reviewing the guidelines , but it is after the fact so it still may be useful but again I would say Human Factors would have to identify the need fo it, not us.

MR. EBERSOLE: I thought it was an important aspect of emergency operations that the operator had the prerogative to make a mistake, observe the effects of it and reverse himself.

MR. SHERON: Yes.

MR. EBERSOLE: And you are saying you are not much interested in that?

MR. SHERON: I am not saying I am not interested in it.

MR. EBERSOLE: You are saying someone else has got to ask for it.

MR. SHERON: What I am saying is, we have reviewed the guidelines to the extent thatwe could review them sitting at a desk and tried to work through in our mind whether the operator had adequate instructions to -- what if they made a mistake, would the procedure track them back, correct it and take the right action?

What we haven't done is, we have not confirmed it through an analysis in this interactive mode using some

interactive terminal.

MR. EBERSOLE: Do you have to confirm it through analysis?

MR. SHERON: Not necessarily.

MR. EBERSOLE: You don't always have to do that, do you?

MR. SHERON: No, not always. It is sort of an audit. It is a spot check. We have reviewed a set of guidelines which are supposedly good for a broad spectrum of accidents, multiple failure and the like. Because the new guidelines are symptom-oriented, the operator is told to treat symptoms. He doesn't have to know what the specific failures are.

He is told to treat the symptoms.

MR. EBERSOLE: He is supposed to do something and observe the effects thereof.

MR. SHERON: Right.

MR. EBERSOLE: Which may not always be what he wanted.

MR. SHERON: Right, so in other words, this would be useful in just spot checking, doing audits to see how well these guidelines really worked.

The last item is the nonuniformity of computer hardwares as being a potential problem. This has to do with what I guess in computer lingo is called a work station,

which is when you are try to deal with these computer codes or databank or the like if you want to make sure you have, I guess what Ivan was talking about, the standardization of hardware for input and output.

I can't have one person working on a plant analyzer for TRAC telling me I need a fancy terminal over here with this type of printer and a guy running it for RELAP-5 up at Idaho, telling me no, I need another kind of printer, another kind of terminal because I drive the people on the sixth floor in our computer division crazy because I turn around I ask for a new piece of equipment.

So one area we think that needs to be addressed is to get these guys flying with a set of standardized work stations, as we would call them, so that we can have a pretty uniform set of equipment.

On the BWR analyzers, again the concept to the approach is very similar to what's been proposed by the PWRs. That is, to have a fast running capability to analyze BWR transients and some accidents and I think as an objective we certainly agree with that.

Again, it is being selfish. We don't like to pay a lot of money to our contractors to do calculations, so if we had such a tool I think it would be desirable and we would like it.

MR. MICHELSON: In talking about this analyzer,

are you thinking of a dedicated computer for it?

MR. SHERON: No, I am not thinking of anything for the TRAC and the RELAP-5 analyzer, I think they are not restricted to any unique computer other than -- in other words, it is the same computer they are run on now, the same type, which I guess is a large main frame.

MR. MICHELSON: I am trying to get a feeling for what is so special about this. It is really a software program, isn't it?

MR. SHERON: What, the Brookhaven?

MR. MICHELSON: No, the analyzer.

MR. EBERSOLE: We are trying to categorize the analyzer.

MR. SHERON: It is a program, another version of RELAP-5 or TRAC but it's been reprogrammed with regard to the computation, to get the computation speeded up and I think there is also supposed to be a lot of work done regarding user friendly parts.

MR. MICHELSON: It is just a very special software program I can put on any computer. It is compatible with, is that it?

MR. SHOTKIN: We have a big presentation. Can you wait?

MR. MICHELSON: Yes, if you are going to tell us more, I will be glad to wait. I was just trying to get my

mind square. It is awfully late in the day to fathom this.

MR. SCHROCK: It's only 2 o'clock.

(Laughter.)

MR. SHERON: The BNL program, their analyzer was originally designed to do this. It was designed to take the RAMONA code and reprogram it into a machine language compatible with this superfancy computer they have there and right now I think what we are doing is, we are saying the objectives of the program are still very admirable but we are not sure at this time whether the program is going to be productive, cost-effective.

Some of the concerns we have expressed are that it is for a specific computer that is at Brookhaven, although I understand eventually it can be made so one can access it through telephone lines and operate it from a remote station like Washington or another laboratory.

Right now, I understand there is some hard wiring of data. It is not flexible from the standpoint of you don't just pick up and run a BWR 4 and say, gee, I will run a BWR 6 now. There is a lot of hard wiring that has to be fixed.

As I pointed out, transient capability has not been completely demonstrated. That is not to say it is not there. We are only saying we haven't seen it yet.

The assessment, we are not really aware of any

assessment that has been done on it from the standpoint of the way we normally think of what constitutes an assessed code or a verified code, be it developmental assessment or the followon independent assessment.

We have seen in the past, the BNL purpose for the program was inconsistent with what we thought our needs were.

In other words, it has been advertised in the past of being of use to utilities and being put in control rooms to -- gee, we can analyze accidents while they are occurring and predict when the core will melt and everything, and we have kind of taken exception to that as not being a very good use for the analyzer and it really shouldn't be developed for utilities.

We are not in the business of doing that.

And then there is always the question of, with this analyzer, and I guess I would say this is a question Research has to answer, what is the most cost-effective way to get a BWR analyzer? I have TRAC, there is a TRAC BD-1 version out. They are developing a new code and going through all of the subsequent developments more beneficial than running with a code like TRAC, which has the assessments done but may be slower and cost more in the long run to run, I don't know.

I think in fairness to Brookhaven, I know they have a lot of hard time with these bullets, these are kind

of rough on them. I think in all fairness to Brookhaven, they haven't had what we call their day in court yet on this from the standpoint of they haven't come forward and said, we are ready to demonstrate this to you now and give you a production code to work with, NRR.

So some of these criticisms may be premature and they may be fixed for all I know. I know these were some of the criticisms we had the last time we sort of looked at this BNL analyzer.

I am sure you will hear from Dr. Odar a more up to date status on what it can and cannot do and what its schedule is for completion, so we are willing, I think, to recommend that it be given its day in court provided that day comes fairly soon and is not years out into the future.

MR. TIEN: I would like to clarify it a little bit.

When you talk about analyzer, do you mean just somewhere you have this software program, but on the plant perhaps you have work stations somehow not working with these analyzers? You don't mean each plant has a particular one for itself?

MR. SHERON: No, each plant would not have this.

MR. TIEN: It is just a work station, really, so you can get onto the computer?

MR. SHERON: Onto the computer?

MR. TIEN: Yes.

MR. SHERON: There could be one in Bethesda, one in Silver Spring, one in Oregon.

MR. TIEN: So it is just going to all different plants so they can have --

MR. WARD: Not for the utility to use but for NRR to use, is what he is talking about.

MR. TIEN: Yes, yes.

MR. SHERON: This is obviously something funded with public funds, so if the utilities were interested, they could take a coup --

MR. TIEN: So interactive did not work?

MR. CATTON: The code itself allows you to interact with it while it is running and it's fast and that all.

MR. MICHELSON: I will ask a question and maybe he can tell me.

This is not quite the engineering simulator we used to talk about. It is kind of, sort of in-between, is that correct?

MR. SHERON: It is not a simulator.

MR. MICHELSON: That's right, but it does allow you to interact with it which means that you can vary some of the variables in the program and therefore get new outputs to see what is happening.

MR. SHERON: Yes, I think if I were ever going to

predict a logical extension of this it would be if somehow this thing could be tied to a simulator, a control board and the whole bit and you would have the best of both worlds.

You would have the actual control room environment and you would have a simulator which was telling you plant behavior based upon solutions to constituative two-phase equations.

MR. MICHELSON: What is the status of having an engineering simular?

MR. WARD: That is what we will hear about next.

MR. MICHELSON: All right.

MR. WARD: Let's take a break now, until 25 of.

(Recess.)

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MR. SHOTKIN: I will try to give a companion talk that discusses RES needs and program direction for the Plant Analyzer and data bank. And, as a part of this, I will try to explain what the Plant Analyzer is. As far as RES needs, we would like to have a fast running, Boiling Water Reactor analyzer that is being developed at Brookhaven. We would like it to have the user convenience that Brian mentioned and we would like to have the interactive capability to do calculations.

Similarly, we would like a fast running pressurizer analyzer and that is being developed at the Los Alamos in Idaho. And the same way as the Boiling Water, we also want it to have the user conveniences and interactive capability.

I will just try to reiterate what we mean by user conveniences and interactive capability. The meaning is a little different for Brookhaven then for Los Alamos in Idaho. The only difference is -- to my way of thinking -- just the software that is used to perform the plant calculation. As far as the user conveniences, we want both types of Analyzer to have ease in setting up input decks and ease in interpreting the output of the calculation. We would also like the ability for the analyst to start a run and while it is going on he could stop it, restart it, change something, and then start again. And that is the interactive capability.

We do a lot of calculations. They are committed

calculations for a facility like MIST. We are doing the PTS calculations. We occasionally get user requests from Brian's shop. The PTS came from another shop in NRR, not Brian's. That's why he couldn't discuss too much about that.

In all of those cases, we feel that having an interactive capability, having a fast running code, having ease in looking at the results in a diagram, watching the flow go around, seeing oscillation, releases a lot of time in figure out what is going on in the calculation.

Now if you talk about the total cost of a calculation that includes the time to set up the input deck, the time to run the calculation. But actually, most of the time is spent on figure out what went on in the calculation because these large codes spew out a lot of data and sometimes, if there is complicated oscillation going on, or interaction between loops critically -- and I have done it myself -- you just make view graphs or xeroxes of points: pressure versus time at several points through the system; void fraction versus time. You lay them out on the table and try to figure out what went on.

That is, in the 1980s, a very primitive way to do it. And what the Analyzer is designed to do -- and you will hear about it more in the next presentation -- is to display the results in a way that the guy who is analyzing it can pick up what is going on very quickly. And along that same

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line, we have the same problem of interpreting test data from integral facilities like SEMISCALE. And you will see that one of the first uses of the software and the techniques of the Plant Analyzer at Idaho -- and you will see a movie on this -- was to take data from a SEMISCALE test, put it in a loop diagram, and according to the analyst looking at it, they felt they learn much more by looking at that. And it did save them a lot of time in figuring out what went on in the test. And Charlie Troutman will show you one of their power lock series test.

And I have probably told you a lot of what Charlie was going to tell you, but I hope that gives you a feeling for what the Plant Analyzer is. It is not a training simulator. We have no need to run exactly, in real time. We don't have it hooked up to a control room simulator.

MR. EBERSOLE: It is a dedicated computer, without dedicated output?

MR. SHOTKIN: No.

MR. EBERSOLE: No?

MR. SHOTKIN: There is a slight difference here again. Brookhaven happens to have their machine, their Analyzer, working on a dedicated computer and you have heard this described a little. It is Applied Dynamics 10. It is a machine much cheaper than a large mainframe computer. It is at Brookhaven. They can use it anytime they want. No one uses it.

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At INEL they are using the typical mainframe, the CDCL 100, or the Craig. That's available, and whenwe do use it we right now don't have it dedicated so we have to fight with other people.

MR. WARD: Do you see it being dedicated, as an essential feature of a useful Analyzer, or not?

MR. SHOTKIN: If there's enough use. If there's enough use that we dedicate a large mainframe machine to it, sure. Right now, I can assure you, it is not being used. It is still being developed. We are going to review all our programs at the end of next year and continue those that are being used. With the funding reduction, if they are great concepts that no one is using or interested in we will have to review them very carefully.

MR. WARD: The difference in approaches for the BWR and PWR, is it something inherent in the PWR and BWR or is it just the different approaches the laboratories have taken?

MR. SHOTKIN: It is the historical approach.

MR. WARD: So it could have been the other way around?

MR. SHOTKIN: I will get to another option, for the BWRs, later.

MR. WARD: All right.

MR. SHOTKIN: Now the program direction, for the

Plant Analyzer is, we expect to have a demonstration of the BWR capability for so-called Chapter 15 transients except LOCA in this fiscal year. We will have some dates for you.

We also expect to have a demonstration of the PWR capability for TRAC, PWR and RELAP 5, also in Fiscal '84. And this is the Los Alamos and Idaho version of the Plant Analyzer. In Fiscal '85 and beyond, we would expect to continue improvement of capabilities. But again, based upon user requirements and I think we are taking that seriously. Our software has to be used in order to continue support for it.

So continuing in '85 and beyond, we will have to have people using it. We are considering other needs for these Plant Analyzers. Right now, the software is geared to looking at transients before there is any fuel damage. But there are codes being developed to look at severe accidents after there is fuel damage and we are considering whether to have a separate Plant Analyzer that just has the codes that look at severe accident phenomena. And there we even had talk of maybe having two of those. But right now this is just we are considering these needs.

And finally, on the BWRs, Brian mentioned essentially our official BWR code, the one we developed at Idaho but with some help from EPRI and GE, is TRAC-BWR. And right now that still has about another year of development to

speed up its running time and finish the modeling. At that time, we considered using it on the Plant Analyzer, the BWR. That is a BWR code. In my thinking, I don't think this is inconsistent with having also the Brookhaven Plant Analyzer, because I think the Brookhaven Plant Analyzer will have features that this will not have, and vice versa. But again, we will have to see what the market is.

MR. WARD: Do you see the speed of these programs somewhat as Brian Sheron described it?

MR. SHOTKIN: I see accuracy and reliability as being more important than speed. We have to make sure the answers we get are rescindable and understandable and that requires -- in our programs -- a lot of assessment against data, a lot of use and practice. Doing sensitivity studies may be helpful for maybe the Human Factors people, or PRA, but again the answers have to be reliable, they have to be accurate, and they have to be assessed.

MR. EBERSOLE: In these contexts, can you give us an estimation of the reliability and dependability when you look at the PWR codes versus the BWR codes, the feel for reality you get out of them?

MR. SHOTKIN: Let me talk about the TRAC, PWR, and RELAP 5 as the PWR codes. TRAC-PWR has gone through a fairly long period of assessment against data. You have heard presentations by our assessment people on the relative

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accuracy and reliability of that code, as compared to data, and it has been utilized to analyze a lot of plant transients. The RELAP 5 code has been closely connected with the experimental facilities at Idaho, SEMISCALE, and LOFT. We have a lot of experience analyzing the data from those facilities. We've used it to perform analyses of plant transients.

I think that, as far as the PWR codes, I am confident. Again, there is the question of accuracy. You have to have someone who knows how to use the code. He has to know the facility he is analyzing. He has to have all of that correct and then there is the modeling and the code. And all three of these contribute to the reliability and the answer and all three have to be present to get a good answer. You have to have someone who knows the code, who knows the facility, and the code modeling has to be reasonably reliable.

On both of these codes I have seen in PTS, where answers depended more on the engineer understanding what the PWR plant was than either one of these codes having good or bad models. Now the BWR code -- and let me just talk about TRAC-BWR for a moment -- that has had a limited assessment, as compared to the PWR codes and much use on analyzing actual plant transients.

MR. EBERSOLE: Why is that?

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MR. SHOTKIN: Partially it is because we get more work to do on PWRs. There are more experimental facilities, that we analyze that are PWR facilities. And there are more licensing issues we have been asked to analyze with these codes that are PWR license issues.

MR. CATTON: There is just less problems with BWRs too

MR. EBERSOLE: The fact of life is that the BWR is just not as fruitful a field for problems, is it?

MR. SHOTKIN: We don't create the problems, we just analyze them.

MR. CATTON: That is a non-committal answer.

MR. SHOTKIN: I will let a BWR expert answer that.

MR. ODAR: In comparing TRAC-BWR to PWR, I would say they are very comparable. We have done a limited assessment, using MIST facility data and the results seem very satisfactory.

MR. EBERSOLE: But the phenomena in the BWR are very similar?

MR. WULFF: Different.

MR. TIEN: I think because the TRAC-BWR was also developed later. However, they learned a lot through the original TRAC-PWR. So I would agree, the accuracy is comparable, although they developed later and they perhaps used much less compared with experimental data. But they do have the advantage of getting a lot of experience from the

previous working of the PWR-TRAC:

MR. SHOTKIN: I won't say anything about the Brookhaven -- or I won't say much -- because they've just got it working. There is very little assessment on it and, as Brian said, we still have to give Brookhaven their day in court on this. Of course, there is much less use of that, but it has potential.

Now, the data bank. RES needs are to have a central repository for plant geometric and operating data. I think we need it for the same reason Brian or anyone else needs it. When we are asked to do a calculation, sometimes it is for generic plants. Lately, especially for PTS, we are asked to do it for very specific plants. Once we have an input deck set up for a specific plant or the plant data for a specific plant, we would like to put it in one space where we can manipulate it and remanipulate it. Use it once to analyze one scenario with one code and use it again to analyze another scenario with another code.

So we have, I think, fairly complete data for the three plants we are doing the PTS calculations for. I have found bits and pieces of data on several other plants. It is probably more than bits and pieces, but compared to the PTS data it is much smaller. And we would like one place where we can store all of this data in a standard format where it is available to anyone who wants to use it.

NRC has had to pay and repay to do analyses where data exists in one notebook and isn't available to the guy sitting at the next desk, let alone someone at another laboratory. The main use, however, is for the automatic generation of input deck, right now for TRAC and RELAP.

I don't want to tilt it toward the Los Alamos Plant Analyzer. We could also develop them for the Brookhaven Plant Analyzer. Program Direction: and you will hear more about this from Charlie Troutman -- is primarily finish the software development in '84 and this is software that manipulates stores and develops the input decks. We are not going to set up a program to instruct the code users on the format of this nuclear plant data bank, data sheets, and we have sent this up to NRR for comment.

Then we will enter the plant data already in NRC hands.

Now is probably a good time to answer some of Brian's comments, if I could, just for a few minutes. He said RES must run the data bank program and that NRR has no plans to require the utilities to submit plant data. At some point, after we have entered all of the data in our hands, and if we want to do a systematic job, we will have to go out and somehow get the data from the utilities.

MR. EBERSOLE: You would probably have to get it by subpoena.

(Laughter.)

MR. SHOTKIN: I think the best way to do this is to do it in a cooperative way, to try to sell them this for their own use, because somebody has to make sure the data in there is up to date and it is QAed. We would much rather have the utility do that.

But getting any systematic program to collect the data is still about one year away. Well, I don't know, I've probably taken enough time.

MR. WARD: That is all right. The Plant Analyzer again. Some of the early concepts -- maybe everyone had their own concept for a Plant Analyzer -- were something that I guess included more models or had models of more systems in an actual plant than -- you know, something more like a full scope training simulator where they have TRAC and RELAP model only the principal thermal hydraulic processes in the plant.

MR. SHOTKIN: No. The latest versions of the codes now have modeling capability for the balance of the plant and the control systems. Now it is modeling sufficient to perform safety and licensing analyses. It is no where near the kind of degree of modeling in a training simulator, where they have every valve and piston in the plant. We just put in the major secondary site and control systems that are needed to perform something like the pressurized thermal shock calculation. And I think we have presented some of those models to this

subcommittee.

MR. WARD: So the versions of let's say TRAC and RELAP you are talking about are much enhanced over the Appendix K versions of TRAC and RELAP?

MR. SHOTKIN: Oh, yes. These are the latest versions, TRAC Mod 1 and RELAP Mod 2. And both of these codes have demonstrated capabilities for modeling the secondary site, the balance of plant, and trips and controls.

MR. CATTON: And neutronics, right?

MR. WARD: And neutronics?

MR. SHOTKIN: Well, point kinetics.

MR. WARD: Just point kinetics?

MR. SHOTKIN: (Nods affirmatively.)

MR. WARD: Any other questions?

(No response.)

MR. WARD: All right. Thank you.

MR. SHOTKIN: Would you like us to continue?

MR. WARD: Yes.

MR. SHOTKIN: Charlie Troutman has a multi-media presentation.

MR. TROUTMAN: First of all let me tell you I am a computer jock. If somebody has a question dealing with reactor significance or interaction of the bubles, turn around, ask Lou. Don't let him leave the room.

The reason I was put on this project as a monitor for the plant data bank and plant analyzer was because it was seen that we needed an interface between the codes to the modern world of presentation devices, full use of telecommunications, the things that at that time we thought Brian wanted, specifically easy input, verifiable data and auditable models. By that I mean that the geometric data for a plant is put in just once, like in a bank. They issue the check only once.

But what we had out here in the labs was that everyone who had a code and worked on the reactor had to develop his own data base. He had to look at engineering drawings to get those numbers, the elevations and lengths of pipe.

I understand this is a hard problem. We only wanted to do it once, put it in once and for all and have everyone agree it is right. Here is the source of this verifiable data. You can go to the source and read it, drawing such and such, just like a bank uses ADP, that is how they wanted to go ahead.

When a fellow constructs a model and then goes into a different business, we want that model to live behind him and leave an auditable trail.

An auditor could go in and see, step by step, how he constructed this model, what data he used -- what version of the data, if there were changes made.

And then, finally, of course, we want the automatic generation of the input back.

I will show you later it is worth paying attention to, that they claim now -- the contractor -- that in four hours he can develop a TRAC input that from scratch, once he is given the geometric data that describes the plant and the operating data, he could generate a TRAC Mod 1 PF-1 model in four hours and a whole different deck in ten minutes.

When they were doing this by hand, a lot of time was spent looking at drawings. But a lot of time was spent calculating noble volumes and things like that.

So, of course, it took many months, as Brian pointed out.

After the easy input is done, the verifiable, auditable input, then we want easy operation.

Brian Sheron isn't here to defend himself, but he is the guy who came to me when I used to run Computer Services and said, "There's no way I'm going to go through this batch process of sending data down to Sandia, interactively, into the 6600 and then having that carried into the secret computers, the big runs having the RELAP run, and then having them print out on the tape onto a

different machine, and then I get it back some days later. There's no way I could put up with that.

What we started was just the opposite. We would give them all of the advantages of personal computing. It's really your machine -- or at least it has the appearance of being your machine.

So, this is our answer to Brian -- the old Brian, when he was a worker and not the chief.

(Laughter.)

During this operation, I should point out that we want to be able to renode the system.

You could see you could rerun the code more quickly if you had some points in the transients.

We want to save time and money -- mostly user time. If a guy is running in batch, he is likely to set a big time on it. So, when he comes back overnight he has a lot of stuff -- if it works okay. If it didn't work okay, he has a lot of garbage. But he takes the chance.

If he's sitting in front of a terminal, he saves money, because he sees things going wrong on line.

Another thing I don't think Bruce brought out is he could change his mind about how he wants the display to appear. While he's on line, running the big code, TRAC code, he could change his mind and instead of saying "I want these colors to represent pressure and temperature, I'd like to

see the color display show velocities and void fractions," for instance.

So, we are experimenting with the contractor on these matters. But I should say we insist they be the same, that there be a common way, a dictionary of the meaning of colors and symbols. We are trying to generate a common user interface for the plant analyzer at both Los Alamos to TRAC and Idaho for RELAP.

MR. CATTON: Would that interface be the same at Idaho and --

MR. TROUTMAN: Yes, we hope the interface will specifically be reactor-oriented.

You say turn-on times. You say start execution. You say speed up the ratio simulation time to real time on my clock or vice-versa.

Incidentally, the question of speed, to answer your many questions on the subject, I think most of these TRAC runs we have seen or RELAP runs run much too fast.

There's so much going on during the run that you can't digest it at real time. And I will show you an example.

MR. CATTON: I just want to back up a little.

So, bascially, what your charger is is to develop a translator from sort of some common input/output device to TRAC or to RELAP. So, if I'm at one place, I have just to

call up the RELAP translator and plug in. If I'm at the other, I call up the TRAC translator and plug in. And then I do nothing different at either place?

MR. TROUTMAN: That is our ultimate goal.

MR. CATTON: I think that's good.

MR. TROUTMAN: You will see how far we have progressed.

MR. WARD: When you say you speeded up during the course of the transient -- that is, if the analyzer, the guy who is sitting there knows this is part of the transient where he needs a lot of detail to have it accurate, he can tell it to slow down?

MR. TROUTMAN: Wait. There's two things.

One is the renodalization to save CPU time. If the transient is very gentle, you might get by with less nodes. So, you renodalize.

MR. WARD: But he does that on the fly?

MR. TROUTMAN: He can stop on line and do a renodalization of the plant data bank and continue on. That is one specific goal.

The other thing is this question about that real time on my watch and reactor time in the simulation, that ratio. Maybe things are happening too fast and you would like to change that ratio so the display isn't changing so fast. You are sitting at a terminal, like a personal computer,

and just over ordinary phone lines, perhaps a leased line -- so, you want to change that ratio, because it's running by too fast.

We also, of course, intend for you to save it so you don't have to recalculate it again. You can save the output from the code, just as we always have saved the output of the codes as a pipe cost, run cost, to save the output in terms of pressure, volume, temperature, the physical variables. You or anyone else could go back later and look at it -- a different slice.

He can look at the pressure-temperature displays. You might want to be looking at the velocity and void displays, for instance.

That gets me a little ahead. But to do that most economically, we would probably put a great deal of graphic software into the terminal. The main frame will only have to transmit to you the physical values at each of the volumes.

MR. CATTON: So, you are thinking in terms of some kind of a smart terminal.

MR. TROUTMAN: That's exactly right, a personal computer, just what you're familiar with.

We talked about high resolution and high fatigue. It's probably a little better quality than the average home computer display.

You will specifically see, with a plant data bank, with a geometric pipe system, it might be a very busy display, so you would like it on a 44T Techtronix type resolution, 1000 x 700. That resolution costs a little more, but not too much -- in black and white.

Also, we haven't decided whether we should perhaps have two, a black and white and a color -- medium-resolution color and high-resolution black and white for the data bank, low resolution for the pictures or medium resolution.

In case you have never seen this, I am talking about this -- (indicating) -- this kind of display, which comes out pretty well at 640 x 480 resolution. We are talking about $25,000 terminals, $30,000 terminals.

At the present time, we are loaded up with 44 teams that cost $12,000. We are talking about the future smart terminals.

MR. EBERSOLE: Is that physical size of the screen?

I'm hoping you'll have a big screen. Are you?

MR. TROUTMAN: It doesn't help you.

There was this whole argument about television. What good does it do to have a bigger screen? You have to get further away. Otherwise, you see the lines.

I'm going to give this to you right away since I brought it up. It is essentially the same picture done by

two different photographic processes.

Let me pass this one around this way.

And let me pass this one around this way -- so you can see roughly the amount of data we want to be showing -- talking about 100 nodal volumes or 150 nodal volumes and maybe displaying the pressure and temperature at each one of those numerically.

So, that comes out pretty well on the 640 x 480 that is on those screens.

MR. CATTON: 640 x 480 costs $10,000?

MR. TROUTMAN: I think they are less than that.

But with the microcomputer -- what is your question?

MR. CATTON: I am just curious how much a good terminal costs.

MR. TROUTMAN: Well, the contractors are making the study. They are trying to look at all angles: Do we need black and white and, separately, color?

By the time you add the disks, the communications capability -- you know how it is. It's like buying a new car. Every piece you add --

MR. CATTON: The basic car is cheap, but it's twice the price by the time you drive it out?

MR. TROUTMAN: The total package price has kept going down, even while we've had those projects, of an

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estimate 100 to 75 to 50. Probably by the time we buy this -- coming to Christmas --

MR. CATTON: You just talked me out of the 640 by 640.

MR. TROUTMAN: If you go down to the GSA store, you could get one off the shelf, a little IBM PC. It wouldn't have that resolution.

end 27

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MR. TROUTMAN: Those are my introductory remarks.

MR. EBERSOLE: In real life he has to deal with collapsed time problem with a sequential events recorder and he can play back later to understand what the sequence was. I understand on your display, you will have the perogative of expanding the events in some datable time frame.

MR. TROUTMAN: Do you mean stretch it, in slow motion?

MR. EBERSOLE: In essence, put it in slow motion on some defined basis he will know.

MR. TROUTMAN: Right. We have a common command at Los Alamos and Idaho.

MR. EBERSOLE: A time mul[illegible]er or something?

MR. TROUTMAN: Exactly. [illegible]ring replay, also or pause. You can just pause and look at the same picture. Let me go on and describe the plant data bank in some more detail. You will get a little more feeling for that.

These slides are prepared by our contractor, Rapid Information Retrieval Display and the modeling for the various codes. You can use that data, all of the data needed for the geometric structure, the containment structure, operating conditions, getting started. Everything that appears on the screen will be in reactor terminology, not computer jargon.

MR. CATTON: That's good.

MR. TROUTMAN: Organization and storage of technical.

There will be one common organization, so anyone can approach a previous modeler's information and see what he's got. Also ease in locating data items. They always use a 40-14, in present Techtronic graphics and tabular make the model interactive -- I will show you later -- and display the parameters. See what you did generate, in terms of where you put your nodes and how big they are.

And then the final input deck construction -- stop me anytime.

MR. WARD: Maybe you will describe this later, but when you say the model is interactive --

MR. TROUTMAN: Yes. You will see that.

MR. WARD: Will it be through a regular terminal?

MR. TROUTMAN: Yes.

MR. WARD: Or would they be special purpose?

MR. TROUTMAN: No. Techtronics 40-14 is what he uses, with a little roller. And he moves his cursor to the menued item and sends it off.

MR. WARD: All right.

MR. TROUTMAN: And you will see that. I will show that. Yes. First of all, I am telling you what I will tell you.

Where are we now? How far have we got? We have design data in there all set up. Software acquisition data entry. We have a forms book. When the utilities get very

eager about this, we can hand them this book of forms, just fill in the blanks of all of your pipe runs.

Where are we, in interfacing to the codes? We have interfaced and generated a TRAC deck and we will interface to RELAP. We will create RELAP decks by the end of the year. It's not that much different. And then onward, during the year -- during '84 -- at the present time he has just installed and running in Idaho on the Siber 126. But he has a man at Los Alamos, installing the same software there, the data bank and all of the retrieval. So he will be able to dial up Los Alamos and use the data bank, or you will be able to dial up Idaho. This is going to go on the Crey at Los Alamos.

He will also set up to make some modification and I think Lou mentioned control systems, secondary systems, and making sure the users are properly supported if there are bugs in the system and so on.

How do you construct a model? Of course, you start off with the geometric and operating data. The user sits at his terminal and does his nodalization. We have a generic nodalized model which would be good at any deck and then we have the interfact to the specific program to do, plus the specific data that only go to that program, the 15 percent. And if you add that up, you have a computational model.

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Now here --

(Indicating.)

-- is a model which was generated by hand. It is a picture made by the TRAC analyst, Mr. Boyac. It shows the many nodes. It was set up as a target for our first runs, using the plant data bank. And they have generated an equivalent deck. They are now cross-checking it and discovering why there are differences and so on. But that was the hand one.

This more or less repeats it. You dial up it, there's a password. You select the data. You pick a model name. Remember we are making an audible trail of everything you do. You do your complement modeling. You generate your deck and get a look at the computer parameters of all of the nodes.

MR. WARD: What do you mean by sketch the interactions? What does that mean?

MR. TROUTMAN: Sketch the interactions?

MR. WARD: Under component modeling.

MR. TROUTMAN: I guess sketch interactively gets the sketch out interactively. You get the menu -- I think that's all he's meaning is you do that interactively. Whereas the TRAC deck you submit it to Batch. But Batch response time has been getting very poor in Idaho so he is going to convert that to interactive, or interaction, also.

MR. WARD: Oh, sketching.

MR. TROUTMAN: The program that goes through and

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calculates all of the volumes in batch, or background if you like.

MR. EBERSOLE: Is that all feedwater, I presume? It has to be qualified further. Was it all feedwater?

MR. TROUTMAN: A reactor question, Dr. Shotkin, sir? Professor, sir?

MR. SHOTKIN: Charlie is going to show us an example of the sketch interaction where a model is put up and then the user picks out the nodes on that sketch and you will have some slides later to show them.

MR. TROUTMAN: Very shortly.

MR. TIEN: And what kind of a software do you use to hook down TRAC or RELAP?

MR. TROUTMAN: The interface?

MR. TIEN: Yes. What software?

MR. TROUTMAN: It's not a big package. The data base itself is in DATRAN. But everything else has been written specifically by this contractor. He writes in FORTRAN. He writes in BASIC and so on. No assembler, BASIC. No COBALT. Just FORTRAN so it will run on the Crey.

Well, now here is some of the help and instructions to you that makes you generate the names and so on. Again, a part of the audit trail. Our instructions to you, the user actually went down a heirarchy and had said that he wanted to talk to Zion, he wanted to talk to the primary system. He

wanted to look at the piping system and they told him this is what they got in the store. He then said he wanted to look at a piping system sketch, so they gave it to him. Here it is.

MR. CATTON: Is that what pops up in the screen?

MR. TROUTMAN: That popped up on his 40-14 screen when he said that. Then he moved his cursor across here. He actually has a little cross here, on the 40-14, but you could use a light pen and hit here and look next. When he did a return he typed it in. He wanted a model here, so they will bring up part of the piping system, which consists of these two legs. Since it wasn't a very busy piece of pipe it could all fit on one screen easily, so they put it in one. So you get both of those pieces. I'll show you that.

Up comes this piece of pipe, which has the correct scale, elevations, and run lengths.

MR. CATTON: When you dial in, can you dial in at 1200 bod or do you have to have a dedicated line?

MR. TROUTMAN: Oh, no. It dials in at whatever there are at Idaho, which are 300, 1200, and 9600. Well, it depends. If he's showing me he uses 300 or 1200 tapes he has a fancy assembly. He asked the people to drop the line down in the Phillips building, the leased line, at 9600 and runs the same gear -- the 40-14 -- through the higher speed modems and fills the screen faster with these pictures. So they are more impressed.

So it all depends. When he works at home, in Santa Clara, he runs a 1200. That is the most cost effective speed. 300 is so slow, you are burning up telephone units.

MR. CATTON: He needs a dedicated line.

MR. TROUTMAN: No. He can't afford it. He doesn't run enough.

MR. CATTON: So he does the 1200?

MR. TROUTMAN: Yes. At the present time, although I think they have experimented with various countries and sometimes they do have a lease line for a time. But you can run it at any speed. That's just a function of the modem and what speed ports they have in the front and to the Idaho computer.

MR. CATTON: And the kind of telephone ride you are willing to pay for?

MR. TROUTMAN: That's right. Or a satellite or whatever. When we say the contract is overrunning, they always say we will save money. We will find some new communications scheme. So here is a picture of this. The next step is to insert some node junctions -- I think they are called -- at TRAC. Wait a minute. Wrong picture.

While that picture is up on the screen, he does his modeling. And what he did was to move his cross from here to here --

(Indicating.)

-- and pushes the button -- J, there -- telling him he wants this junction. And so on, at these other places. At Los Alamos, when they say this process, they said this is all great, but would you just have us punch the button once and say how many equally spaced nodes we would like in that run and similarly over here. That's all he has to do.

Then he goes on through the whole system, returning and picking out other runs from the main diagram, the big pipe system diagram. Here is part of the audit trail, which h e could get at any time or you could get later. It is preserved historically. The data bank is started off at 11:35. The data bank giving his pipe system geometry, you will recall. Then the user makes a model. He had it executed. The nodal volumes, and so on, from this code -- as my understanding -- executed from this code. Then he got some more pipe system geometry and went on. That is the idea of the audit trail.

Now he goes in. He has a model of the vessel, so here are some geometry -- fixed geometry associated with the regions within the vessel. He is going to make some modifications to that. I mean, he is going to make some cuts. The kind of cuts he can make in cylindrical geometry are layers, rings. Of course, that is looking down and the side view of the elevation.

This came out. This appeared on his screen when he

pushed the buttons. Then he is given these instructions on how he can divide the region into more areas and where he wants to place the layers and the lines he is creating extend to the vessel region.

Here are some of the options he has and the numbers he puts in, the values of elevations, and so on. After he has done this, this is all a part of this four hour process, here are some of the nodes that he created. It feeds it back to him and says this is what happend to you. And he said yes, that is about what I wanted. And he says let me see what the complete set of nodes looks like. And the program goes around and figures out all of the different cells that were created in this model, nodes, geometry.

He prints it out for him. He can look over them and check them. Maybe he has some intuitive feeling.

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And if he likes it or if he gets a deck created, here is the calling card format that TRAC code is looking for. They want to see 80 column cards and here they come with a lot of comment cards and these astirisk cards or comment cards, so he sprinkles them in, depending on their origin.

At this point you could go into an edit mode and change some of those by hand if you wanted to get around somehow what the nodalization process does.

I have forgot or have lost the slide out of order, the one that shows the special questions for TRAC interface only.

They ask the questions. He filled in the numbers and they will appear somewhere in this stack also, the 15 percent and that completes the presentation on the databank.

MR. EBERSOLE: We talked about the interactive aspects.

Can he stop the process at a point in time and do something to see what happens?

We were referring to the operator's desire to see what happens when he does something and the prerogative of reversing himself.

MR. TROUTMAN: At any time he can save the model he has created, up to that point, and return to it later.

MR. CATTON: This is just getting the model set up.

MR. EBERSOLE: This is just getting it set up? He is not working it yet?

MR. CATTON: No.

MR. TROUTMAN: Don't you understand that these are now input cards? His final result of the plant data bank is to generate input cards for the databank. If he runs it with the program he will have in two months, he would have generated input cards to go into RELAP.

MR. EBERSOLE: Right, then later on you will tell me he can't do this then?

MR. TROUTMAN: He puts on his other hat and becomes a plant analyzer analyst and says, wrong track --

MR. EBERSOLE: And then he can do that?

MR. TROUTMAN: Yes, then he can do all of the plant analyzer type of things. I hope I understood his question.

MR. CATTON: You did.

MR. TROUTMAN: At this point, I have some slides from Los Alamos, plant analyzer development, which I would like to show just to fix in your mind that it is common, the same user thing.

There are less than a dozen slides. I hope you will forgive the skewedness.

You see it is just too small, I am sorry, but considering the big preamble we went through, it doesn't say

anything new.

Minimize experience, user-effectiveness by allowing some work to be performed on a local work screen. Facilitate input. You will see it when we get to it. I cannot see these.

Let me back up. The schedules are that they would demonstrate the menu selection and graphics features on a nonintelligent terminal. The main frame has to do all of the work and ship down that picture to demonstrate that this year although we haven't gone out and seen it explicitly, they are approximately ready to do that.

Now the other thing for this coming year is the intelligent work station, like the personal computer, where you will be able to bring up those pictures, a variety of different pictures, rapidly.

The reason for this is mostly that it takes a long time to transmit that 640 by 480 picture in color, so we will do it on a PC type machine.

This one shows a plant analyzer as consisting of three terminals at the user's desk. This was a very early made picture where we thought we would have the primary system in color, the secondary system in color and then a black and white CRT, but I think it is too much. The users won't want it.

Really the best thing would be a single high

resolution color that could give them a nice piping diagram as well as give them the cartoons and if we have a disc drive we can quickly bring up another cartoon. They can look at the secondary for awhile and flip down and look at the primary for awhile.

If you think about it, in the cockpit they don't have multiple displays for every picture you want to see. You just change your mind about the display you want to see of the aircraft's engineering systems or its tactical systems because you can't fly all of that stuff around.

Well, it is hard for a guy to fly three CRTs around in his office too.

Here is a little example of menu selection. He had worked down through his hierarchy and at this point he was going to decide whether he wanted to see all reactors that are in the plant analyzer database or the second selection would be just the B&W ones alphabetically and finally down through some of the experimental labs.

Here is the instructions on how to select. There is no computer jargon. The work byte never appears. And here is the same cartoon that I showed you around here on a Los Alamos CRT.

They also prepared time history curves for us showing, if that is the way you still like to think, time history, we can give that to you but you will see in the

movie, it is very hard to understand things from time history because it takes so many of them, one for each nodal volume and then spread them around the table the look at them all at different slices of time. That's all.

This picture now is from RELAP-5, running at Idaho. There are three movies on here. I will show you two.

The first is, just to show versatility, the fact that we have separated function, we have the code running the reactor, we have the graphics package then, and in between them there is an interface. The interface is very small, hopefully, so it is very easy to connect many different codes to the plant analyzer graphics.

So the first picture will show an actual RELAP-5 calculation and a moving picture of that display I passed around.

The second picture is one showing experimental data through the tiny interface to the graphics package and the communications down to the work station.

(Pause.)

Okay, I have to have my notes to describe this transient in your terms. This simulation only takes 19 seconds of reactor time and it takes very little more than that in the moving picture.

This is a generic B&W 2x4 loop plant. It is a four inch small break LOCA. The colors that you saw are green

for the subcooled liquid, blue for the saturated liquid and magenta for superheated vapors.

Now the flow direction is indicated by arrows. You may have seen that on the IEEE article.

The liquid levels are indicated so you can see the blue fluid going down to the pressurizer after the break and it goes out into the candy cane.

The status of pumps and valves is indicated by color. Black is off or cold. Green is on or open. You only have to remember this for about 20 seconds.

We are going to have a scram after this break and you will see cadmium yellow control rods coming down, at which time the fuel rods, which had been in red at power, 2200 degrees, will turn to blue, eventually heading down toward room temperature, blue, 70 degrees. That is a long time in the future.

The little orange spray that you will see in the lower righthand side is the break. When I turn this on, you will see 10 seconds of steady state initialization which is not physical. The break occurs at 10 seconds. It's small numbers. That is why I had to pass around the pictures but if you were sitting in front of a tube you would be able to see it or if I were back far enough with the projector.

The scram occurs at 16 seconds, pump trip at 17 seconds and it will terminate at 20.

I want you to pay special attention to the vapor bubble in the pressurizer. Remember, that is the hottest part of the system so it forces a hot saturated blue liquid into the candy cane, which will start to void.

Voiding is indicated by tint. The paler the tint the higher the void fraction. White is void. There will be a total voiding of the candy cane by 70 seconds. We will be in the lefthand candy cane, the righthand candy leg does not void. This is perhaps contrary to intuition. You would think the water would run out but it doesn't run out of that side, it goes out of the other.

Okay, zero time.

VOICES: Focus.

MR. TROUTMAN: How's that? Is that better?

I will go up and read it to you. Six seconds, okay, eight seconds, nothing has happened, nine seconds, ten -- the break has occurred. The orange, the pressurizer level went down, the liquid is going into here, the scram has occurred at 16 seconds.

It is still scramming, this changed state and that's the end of it.

Okay, if you have questions about that, I might be able to answer but perhaps you should give it to Lew.

MR. CATTON: What is on the rest of the reel?

MR. TROUTMAN: I will show it to you but I have

got to back up a little.

MR. WARD: Let's see. I think we had better take a break so people can get their cars out of the garage.

You can continue to watch the movie in the break if you are so inclined.

End 29 (Recess.)

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MR. ODAR: First the program objectives. The first objective is to preform safety analyses and audit calculations. The promary objective being the realistic best estimate simulations of operational and accidental transients like small break LOCA. One of the primary objectives was to perform many simulations fast and at a low cost, the reason being they can be used to perform parametric studies, they can be used in risk assessment studies or accident signatures by NRR or control system studies we are performing.

This is a program overview. We started on January 1, 1982 to procure the computers. On March 1, 1982 the PDP 11/34, the host computer, was procured and operating. On March 15, 1982 the audio peripheral processor was operating. Then the first demonstration of this new computational scheme and the use of the new computer compared to the ROMONA code which used FORTRAN language and could run with this installation so when we are making this demonstration, then with that particular program we used machine language together with these processors. That was successful.

The next test was inclusion of kinetics, thermal conduction and heat, stam line dynamics. Another test was last summer, August 31, 1983, the simulation of seven transients. Now, we are just about here the whole loop of a BWR plant for Browns Ferry is completed. Three major control systems are included in this and all operational

30:1

transients except small break LOCAs can be simulated. When I say they can be simulated, I do mean that they are not yet developmentally assessed.

Each transient except one, I believe, has been run at approximately 30 seconds.

And some of the transients have been run for a much larger period of time.

This uses a dedicated computer. It has it's own language -- panel processing and the pipelines and so forth. It runs very, very fast.

panel:

MR. WARD: Fuat, is there some -- this was using the ROMONA as the FORTRAN code.

Could this approach be used as well with the TRAC or RELAP or something?

MR. ODAR: It is not exactly the same approach. I should say it uses the ROMONA code. It really uses the physical principles involved in the ROMONA code. It does not use the numerics of the ROMONA code.

MR. WARD: It uses the modeling?

MR. ODAR: Like the constitutive equations that are used in the ROMANO code have been used in this particular code in order to make this feasibility study.

MR. WARD: But it is a different numerical?

MR. ODAR: Yes. The numerics of this code is completely different.

This slide shows some of the current simulation capabilities. There are 20 transients. The transient was system-pressurized. There are several of them.

This code can simulate the transients with moderator temperature decrease. Several of them can be simulated.

Then, transients with reactivity changes -- again, there are several of them that can be simulated. These are all Chapter 15 transients, not involved in breaks.

The additional simulation capabilities -- the transients are also involved, like loss of feedwater flow or stuck-open SRVs or pressure regulatory failure, which usually causes loss of inventory.

Transients with change in core flow, like the recirc pump control failure or the trips or the inadvertent RCP startup or the seizure of the pump and, in addition, ATWS -- so, it has a very broad range of capabilities. And I should also mention if you look at your overview chart -- and we have now had time to work on it approximately one-and-one-half years after they made this operational and came up with a pretty good product.

MR. SCHROCK: Is the kinetics model like ROMONA?

MR. ODAR: No, it is point kinetics.

MR. SCHROCK: Point?

MR. ODAR: Point kinetics.

ROMONA has, of course, 3-D kinetics.

I should say it is a slightly different point kinetics. There is a different model, which takes into

effect the scram reactivity, the way the reactor scrams. So, it changes as the reactor is tripped. So, it is not purely point kinetics. Maybe I should point that out.

MR. SCHROCK: But it's not 1-D either.

MR. ODAR: No, it is not 1-3 either. There are some limitations.

Let me go over these limitations, which are important, I believe.

The code doesn't have a flow reversal capability, so some of the multiple failures cannot be simulated. We don't know which ones.

All of these Chapter 15 transients, the way they are analyzed now, only require a single failure.

Now, if we impose multiple failures to these transients, some of them may cause flow reversal. And we don't know which one would do it.

But the code at this moment does not have this capability.

MR. WARD: So, when you say these are limitations, you don't see these as inherent. They are limitations for the stage the code is developed now.

MR. ODAR: That's correct.

Some of them could be inherent. I will get to them at the bottom.

But based upon the status we have now and what

these limitations really mean to the transients that I mentioned about -- the next one is no post, CHF E transfer. That is a limitation on some of the ATWS calculations, because in some ATWS we go to post-CHF conditions. This also can be added later on.

No spray -- the result is you cannot analyze a BWR-6 type of plant where the ECCS comes as a spray to the upper plenum. But the transients where you don't have a spray or ECCS still can be analyzed. There is no boron injection. That is, again, a limitation on ATWS mitigation.

If you recall, some of these ATWS analyses require boron injections in the reactor vessel to mitigate the ATWS problem to bring the reactor into shutdown conditions. And this also can be added.

Now, let's go to inherent type of limitations.

Fixed nodalization -- in order to get speed, the nodalization has been fixed. This way the instructions know which to go -- which node, the flow of the program know where to go, which node to follow, and so on. So, you don't have to search for a node.

But there is enough nodalization, like 55 modum in the vessel, so that particular limitation is not -- I don't consider it a limitation for the transients which I mentioned, which is about 21 different transients.

MR. WARD: How many nodes in the vessels?

MR. ODAR: 55. There are three channels. One is the average channel bypass, and the hot channel. Each has 12 nodes. That makes 36. And the remaining nodes are in the upper plenum, lower plenum, downcomer.

The standard POP would -- that sounds like that does a better job than -- what is the GE code? SAFER?

MR. BOEHNERT: SAFER:

MR. WARD: It is a more elaborate nodalization.

MR. ODAR: Yes, it is more elaborate. But SAFER, on the other hand, is a local code. And this is more or less system transient, standard BOP.

Now, this could be a limitation in the sense that what I am going to show you is the type of BOP we have for BWR-4s. That will follow in our next slide.

Now, if we go to another type of BOP, that means the program needs to be changed and that may require development assessment.

I would say what we have is sort of plant-specific, but it really applies to most BWR-4 type of plants.

Again, the same type of limitation, which is difficulty to simulate experimental facilities, if we go to an experimental facility, it's almost like a new ball game. It will require a lot of time to change the code. It requires reprogramming.

So, the assessment of this code will be limited

to comparison of plant data and comparison to other codes like TRAC.

Actually, only TRAC we have. So, we will be using TRAC and also ROMONA if we have three-dimensional effects.

Another inherent limitation is a potential limitation for small break LOCA. Many small break LOCAs require three-dimensional modeling on the upper plenum, because when the sprays come in, cold water goes to the peripheral channels and peripheral bundles. They flow down and quench the rods, and they go through the side entry to bypass. And water in the bypass, again, goes through the side entry orifice of the hot and average channels -- cool those bundles from the bottom. And some of the water, of course, comes from the top, too.

But basically, in the analyses we have seen, in the hot channel, bundles cool from both ends, both from the bottom and the top. It is quenching both ways.

So, there may be some problems in some cases where the small break capability is limited.

Now, let's see what we have. I think we have a pretty good product here.

MR. EBERSOLE: May I ask a question?

I got a distinct shock when I saw that drawing. It has been a long time, like 12 years, since I used to work on Browns Ferry. But I said it can't be the main feedwater

turbine runs off of extraction steam. That's what that picture shows.

MR. ODAR: Yes, that is what the picture shows.

MR. EBERSOLE: Is that a fact?

You know what it means. It means every time you have a turbine trip you lose feedwater and you fall down on that little bitty RCRC, which is no good in the first place.

MR. ODAR: This particular control system information came from INEL, which went to Browns Ferry and investigated all of the components.

MR. EBERSOLE: My first reaction to that is, gee, they are in worse trouble than I thought.

So, I'm going to have a look at that.

You know what the implication is. If I trip the turbine, I've got no feedwater.

MR. MICHELSON: I think you have an answer here.

MR. WULFF: There is none shown on this diagram.

The connection to the crossover feed of steam directly to the containment.

MR. EBERSOLE: From the containment?

MR. WULFF: Yes, it is when the pressure falls downstream of the turbine, below a pressure limit, that I think it is 50 bars or so, then a supply valve opens and you get steam from the containment, from the reactor.

MR. EBERSOLE: You don't mean the containment. You mean the main switch.

MR. WULFF: Yes, but through the containment.

MR. MICHELSON: That can't be right. You've got to be downstream of the main stream isolation valves, but upstream of the turbine stop valves. That's where you need to take it off.

MR. EBERSOLE: What that implies is every time you get a turbine trip I've lost main feedwater and all feedwater, except that, gee, little old aux feed pump -- usually called the RCIC.

MR. WULFF: We have steam. If we lose on the downstream side from the turbine, we have crossover steam to continue the feedwater pump.

MR. EBERSOLE: I will have to look at the diagram.

MR. ODAR: This is also true. I remember seeing ATWS analysis where a turbine trips and the feedwater trips a little later. So, it does trip.

MR. MICHELSON: But that is because the reactor pressure system causes the mainstream isolation valve, and that automatically trips the turbine. But the main turbine trip should not trip the feedwater turbine.

MR. EBERSOLE: The little RCIC pumps is, first of all, not reliable. And yet here it is, the main source of coolant after a trip, which occurs too often in the first

place.

MR. WULFF: But this is from the safety analysis report.

MR. EBERSOLE: Let's just let it go by.

MR. WARD: Would you identify yourself for the reporter?

MR. WULFF: I am Wolfgang Wulff of Brookhaven National Laboratory.

MR. ODAR: That's what I mean when I said it was a very specific plant.

Granter, there may be many variations. And that would require reprogramming. But this is the standard type of DOP that we have found.

MR. EBERSOLE: That design would create a convulsive reaction the first time you saw it up there.

MR. ODAR: Well, I guess everybody digested this diagram, reator, turbine, and all of the components -- condenser, feedwater heater and the feedwater pump. And we do have controls for the pressure regulator here, controls for the feedwater, and also controls for the circulation pump.

This control controls the speed of the pump. Some of the plants have valve controls.

There is also a suppression pool, as you can see over there.

MR. WARD: But that sort of panel would have to be specific for each plant simulator then?

MR. ODAR: Yes.

MR. WULFF: Actually, only the labeling of the panel. These are generic channels. It is only the labeling, with a template, that you can change from one to another.

MR. MICHELSON: That is assuming that each plant has a common secondary site arrangement, which is not at all true. It is quite utility specific, how they arrange their feedwater and extraction steam arrangements and all of that. That is not --

MR. WULFF: But the connection between t he control panel and the machine is software control. So for another plant you have other assignments of channels.

MR. MICHELSON: You would have to write some software so the machine knows when you flip that switch, what you think is happening. So you have to write a whole set of software.

MR. WARD: But you are saying it could be a standard hardware panel and the plant specific nature could all be in software, the labels you put on the thing.

MR. WULFF: Yes.

MR. WARD: All right.

MR. ODAR: This is a sample ATWS that has been run. The first trace of pressure. ATWS, I believe is turbine

trip without bypass, if I recall correctly.

MR. WULFF: No. This is MSIV closure.

MR. ODAR: MSIV closure? All right.

Without trip, the recirculation pump, the pressure rises up, plus all of the valves open, the safety relief valves. And as inventory is lost to the suppression pool, the pressure comes down and these valves and are actuated. They close on and off. And as they close on and off, you have this sort of behavior.

(Indicating.)

Similarly, of course the steam flow in the steam line varies the same way. This is the valve action and the power also changes because as the pressure changes, you have different void reactivities. And of course, the power would conform to that. This is an evaluation of the simulation speed, how fast we're running, using the subplant analyzer. The selected transient turbine trip, from full power with scram, without RSV and without the bypass and reactor coolant pump not tripped.

This compares with ROMONA and HIPA, like I mentioned earlier. HIPA used the 55 computational cells in the vessel with the MPSN language. And ROMONA had 43 computational cells and FORTRAN language. The result that AT-10 was running 110 times faster than CDC 7600, which is a ROMONA case. And when you compare it to the real time, AT-10 was running 10

times faster for this particular case. Now the reasons why the HIPA code can run fast, the first comes from computer architecture by a factor of 25 to 30. That is compared to a general purpose computer. The primary reason is parallel processing and pipe lining. Also, high levels of simulation language and programming adds another factor to influence the speed.

Fast table look up and interpolation of pre-computed properties also heads another factor. They add up to roughly 100 or 110.

For future plans, we have what we call now Mod 0, a very specific product which can analyze all Chapter 15 transients without breaks. We need developmental assessment and produce a manual documentation which we think will take approximately until February of next year. And after a month or so, we will have a review on this whole program in order to determine some options. I have here three options.

The first option which I think is the minimum that should be done is to add an input processor to this capability, whereby different plants can be modeled quite easily, rather than going to the computer programming. Whenever each time a plant comes along, this input processor would permit us to model any kind a plant. The next option, which we will call development of Mod 1, is to have some improved models. That means removal of some limitations you saw in the limitation table.

I would say if we removed the first four of them, then we will have complete capability to analyze all of these Chapter 15 transients with great accuracy.

The small break LOCA capability will have to be reassessed. We may already have reached there, with removal of these limitations. But again, for small break LOCA calculations, we may need -- like I mentioned -- three dimensional, upper plenum modeling capability.

So there are three options. The option goes on this line. The second option you put this line, plus removal of these limitations. And the third line is plus the small break LOCA capability. And by the end, we can have all of these models added and developmental assessment of these models. That would continue all of the way to 1985. Now this will be done by the review group, here at this point, to be decided how many options we ought to have, based upon the budgetary restrictions and many other matters, like whether we should be putting this capability in BWR or whether we should be continuing with HIPA. So we will make the decision about 1984.

That concludes my presentation.

MR. EBERSOLE: I guess the agreed to diagram was not compatible with your other slides. Is that correct? That is, there was a steam supply which was not apparent on your diagram.

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(Pause.)

MR. EBERSOLE: You see, if your diagram represents the way you did your analysis, you would have a loss of feedwater every time you have a turbine trip. And for the ATWS case, for instance, you don't do that in your curves.

MR. ODAR: I do believe that ATWS was analyzed using this particular diagram.

MR. EBERSOLE: With no other supply from feedwater your plant would promptly dry out.

MR. ODAR: The feedwater, I think, was tripped after a while. The feedwater pump --

MR. WULFF: The feedwater --

MR. EBERSOLE: If you hypothesize you lost main feedwater, the diagram would serve it. In real life it wouldn't.

MR. WULFF: May I answer this, Mr. Chairman? For the slide that showed the ATWS calculation, the feedwater was tripped and ran down to zero within the first five seconds. And that was the same way that the GE calculation showed us. And it was initiated by the MSIV closure that you see at the top of --

MR. EBERSOLE: Then it wouldn't matter. Then it is compatible. Okay. I see.

MR. WULFF: And this arrangement is, in fact, in the Final Safety Analysis Report, where the feedwater turbine is supplied from steam coming out of the separators, follow the

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high pressure turbine stage. We should have shown two turbines here, but we just showed it as an extraction. And it has, in addition to that, crossover piping that supplies pressure to the feedwater turbine, if there is turbine trip initiating the ATWS.

MR. EBERSOLE: That is what I was looking for. That was the pipe. I didn't see it.

MR. WULFF: We had to either not show the control systems here, or this crossover pipe. So we have shown here what is normally there. In steady state, you have this arrangement.

MR. EBERSOLE: All right.

MR. WARD: Any questions for Mr. Odar on this?

(No response.)

MR. WARD: All right. Thank you. All right, Mr. Rhee, I believe is next.

end t31

MR. RHEE: I am Gene Rhee from the NRC Research Office. I am working on the 2D / 3D program.

This program has three large scale facilities: two in Japan and one in Germany. I would like to go over the status of each facility very quickly. However, if you would like to know more about the status in detail, some additional details are attached in your handout.

The Japan Atomic Energy Research Institute finished testing for cylendrical core test facility core one test series and slab core test facility, core one test series. They are conducting CCTF core two test series at the moment and they are conducting SCTF test two and expect to complete that by March '84. At the moment, they are designing slab core three test facility. We have another large scale facility in Germany being constructed at the moment. We expect it to be completed in April, 1985.

MR. WARD: Does the CCTF 2, for example, replace the CCTF 1, or are the two facilities still there in parallel?

MR. RHEE: No, this one (indicating) has been completed. All the testing has been completed and this one (indicating) is the next test series and they are conducting tests at the moment.

MR. CATTON: How is SCTF 2 different from SCTF 1?

MR. RHEE: The objectives are very briefly attached to your handout.

MR. CATTON: That says construction.

MR. RHEE: The main difference is this one (pointing to SCTIF 1) is essentially testing for core blockage, flow blockage in the core whereas this one (pointing to SCTIF 2) is essentially for testing two-dimensional flow effects in gravity feed and also force feed tests.

MR. CATTON: Is it physically different than the first one?

MR. RHEE: No, physically they are essentially the same but this (indicating SCTIF 4) wouldn't have any blockage in the core.

MR. SHOTKIN: Could I answer that?

SCTF 1 bundles 3 and 4 have 60 percent flow blockage and SCTF 2, they remove the blockage. In SCTF 2 they remove the blockage.

MR. CATTON: Okay.

MR. RHEE: So they are a slightly different configuration in terms of core blockage.

MR. CATTON: And what is SCTF 3?

MR. RHEE: This one is essentially for the purpose of coupling a slab core facility with UPTF upper plenum test facility. You may recall upper plenum test facility doesn't have a heated core and we were trying to get the heated core effect from this test facility through a coupling procedure.

Next, I would like to go over quickly about the US effort for this program.

We are providing advanced two-phase flow instruments and we have done that for all of these four test series, CCTF 1 and 2 and SCTF 1 and 2.

At the moment we are fabricating instruments to deliver them to UPTF and the slab core test facility 3 and one item to note here is recently we had some change in core because of some perturbation in the test facility.

That is, the Germans changed some pipe plate design in their facility which necessitated redesign of our instruments for these three instruments, drag body and break through detector and delta P and as a result of that, the Germans agreed to take over responsibility of developing algorithms for calculating mass flow across the core and upper plenum interface.

And for that purpose also they agreed to take up additional testing for instrument calibration and in addition to that they agreed to reduce US instruments in their facility.

We were able to reduce 18 stalks of the fuel distribution grid and six turbines and six breakthrough detectors.

This was done essentially to alleviate any cost overrun on our part.

MR. WARD: Let's see, so I understand.

This means the NRC had paid for the replacement or

the redesign of the instruments?

MR. RHEE: That is right.

MR. WARD: And the FRG then as compensation did work the NRC was originally going to do, is that it?

MR. RHEE: That is right. Essentially, they took over these two tasks and in addition to that they agreed to reduce some instruments to compensate.

MR. WARD: Will they supply those instruments now or just run the experiments without them?

MR. RHEE: No, we just have less number of instruments by this much (indicating).

We used to have here 100 breakthrough detectors. Now we have 94 instead of 100.

MR. WARD: Are you satisfied with that?

MR. RHEE: Well --

MR. WARD: You must have wanted all of the instruments for some reason.

MR. WARD: Of course, the more instruments we have, the better we are but because of budget constraints we cannot really have additional instruments.

MR. WARD: All right.

MR. RHEE: Next I would like to go over quickly about the other aspect of our effect, which is a TRAC analysis and we are providing TRAC analysis to all of the test facilities and we have completed TRAC calculations for

our first test series, which is a cylindrical core test facility, core 1 test series. And, at the moment we are performing post-test predictions for SCTF 1 and CCTF 2.

In addition, we are performing TRAC calculations for UPTF design and operation assistance.

Also, we performed some best estimate calculations for a German PWR hot leg break and a US PWR cold leg break.

We have worked on these TRAC calculations since the beginning of the program, which is about five years and in the process of doing that we were able to help significantly in TRAC model improvement and some of the examples are listed here.

As I mentioned earlier, the Germans changed some of their tie plate designs and hence we were able to transfer some of our work to Germany in the analysis area as well.

Next, I would like to discuss briefly about the preliminary test results we have obtained so far and based upon cylindrical core test facility, core 1 test series, we see a very effective core cooling by two phase flow mixture in spite of some steam binding in fact and the fact that the core is not fully covered with liquid.

Another significant effect is we don't see the big effect of 60 percent flow blockage. As Dr. Shotkin mentioned, when we have eight bundles in slab core test

facility and two of eight bundles are completely -- well, 60 percent blocked, and a significant effect was found for us. A nonuniform radial power distribution in slab core test facility was effectively mitigated by cross flow between the bundles.

In other words, in clad temperature readings, it was shown pretty much one-dimensional across the radial direction. Also, we have some TRAC calculation results which showed that best estimate calculations have a wide margin of conservatism relative to licensing assumptions.

Some of the examples listed in maximum clad temperature has a wide difference, 800 degrees is what we found, in best estimate calculations and 1477, of course, our licensing assumptions, the entire core is quenched at about 70 seconds.

MR. CATTON: Why are you running SCTF 2? Why do you need SCTF 2?

MR. RHEE: Well, the SCTF 2, this one (pointing) to effect of 60 percent flow blockage is not significant.

We had a core block 60 percent.

MR. CATTON: If the blockage doesn't do anything?

MR. SCHROCK: Maybe it helps.

(Laughter.)

MR. RHEE: That's true. The effect is not that great but the reason we are doing it in slab core 2 is there

is essentially additional testing we have to perform.

Essentially in all of this, in the slab core 1 test series, we used essentially all of the forced feeding tests. In other words, the downcomers and blocked and DCC is injected into the lower plenum directly and in forced feed manner and in the slab core 2 we are doing other types of injections, gravity feed tests and so force feed tests also.

MR. TIEN: So you have different operating conditions now.

In Item number one, what do you mean "effective core cooling"?

MR. RHEE: Well, core is, we see --

MR. TIEN: That is experimental data, right?

MR. RHEE: This is based upon experimental data and we see the maximum peak clad temperature is something on the order of less than 1000 degrees Kelvin, which is way below this (pointing to 800 degrees and 1477 degrees).

Also we see that the quench is achieved in about 10 minutes depending upon the test conditions, but it is always less than 10 minutes and we see always the core is cooled effectively.

MR. EBERSOLE: Can I ask you, Item 3, could you tell me what drives the cross flow and is that phenomena represented in the various codes you used?

MR. RHEE: Well, of course, there is a circulatory flow path. In thehigh powers zone you have a two phase mixture going upward and some of that water is in the upper plenum and falls back in the peripheral bundles and they do that not all of the way up in the upper plenum but there is a secondary flow field established and because of that, when you have a high flow coming upward, in the high power zone, something would have to feed in to fill up that void and usually the water in the peripheral zone goes to that zone in a lateral fashion and we see that in the TRAC calculations and also we see that in the experimental data.

MR. CATTON: I am not sure how you see it in the experimental data.

MR. RHEE: We have the Delta P measurement.

MR. CATTON: On a small scale, some small scale tests that were run at UCLA, what they observed was quite different than what you calculated.

What they observed was there was a pileup of two-phase mixture and more of it piled up over the hotter regions but that is because gravity tries to keep the quench front flat and tends to feed the hotter regions more two phase mixture and there was no recirculation in the region above the quench front.

As a matter of fact, you could see this effect because the quench front was slightly depressed where it was

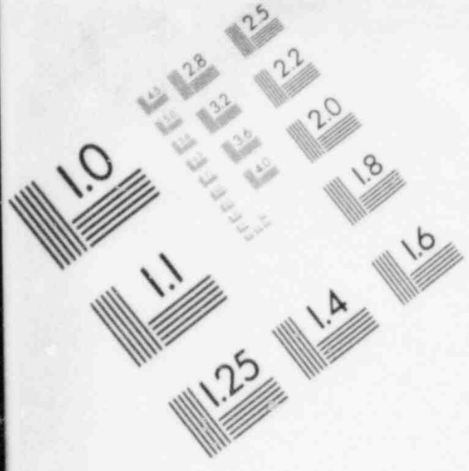
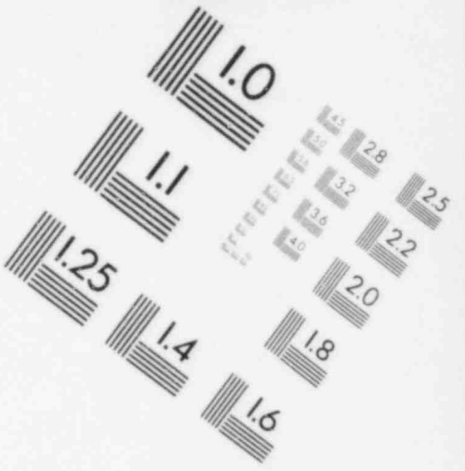
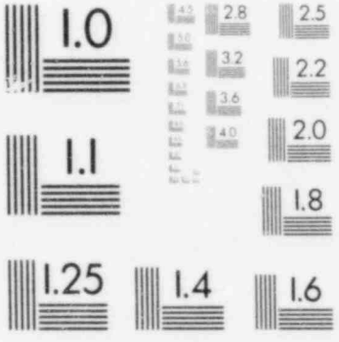
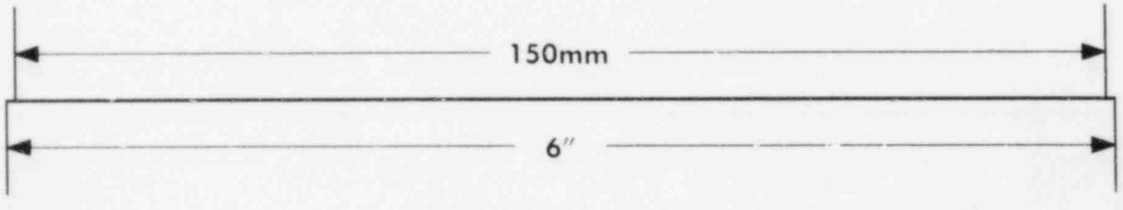
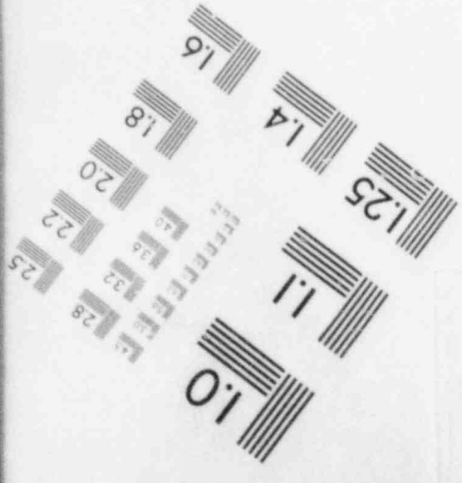


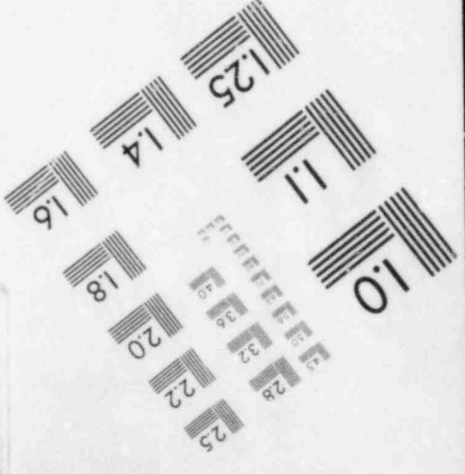
IMAGE EVALUATION TEST TARGET (MT-3)











hotter.

So I think this rapid recirculation that the codes are calculating above the quench front is a fiction of the codes

MR. RHEE: We see the experimental evidence that the key clad temperature is uniform across the --

MR. CATTON: You are absolutely right. And the quench front moves in a one dimensional way and no water is fed in the hotter regions.

As a matter of fact, the quench front trails a little behind, just enough it gets fed more water.

MR. TIEN: I think the code could not keep the details correctly on the quench front so you do not get that description and then on the other hand, continue requiring you to get some feed somewhere so then you have this artificial cross flow.

MR. CATTON: Right, and with such gross nodes you use when you model the core, you couldn't pick up that kind of recirculation anyway in a meaningful way.

MR. RHEE: Dr. Slotkin?

MR. SLOTKIN: I don't want to compare a small experimental facility in California with a big one in Japan, but the fact is in this case the code predicted the cross flow before the experimentalist looked at their DPs carefully and saw it, so that one year and one-half ago, TRAC

was predicting this cross flow as an explanation for why you have this one dimenstional behavior in the slab core and just a few weeks ago the Japanese came with their DP measurements that they looked at very carefully and showed this cross flow from these measurements.

MR. CATTON: The DP shows the amount of two phase flow above the quench valve, it doesn't tell you anything about flow.

MR. SLOTKIN: This is the horizontal Delta P, the cross between bundles.

MR. CATTON: I have to think about that.

MR. RHEE: Apparently there is some inconsistencies between your facility and --

MR. CATTON: We just looked at movies. It was a transparent system.

End 32.

MR. RHEE: We will have to look at it further to see if any inconsistencies really exist or not.

Next I would like to go over data analysis procedures.

Usually test facilities run tests and then that qualifies raw data from instruments and then transmit the boundary and initial conditions to Los Alamos Laboratory for TRAC calculations, and then they reduce raw data to engineering units and then transmit the data tape to Los Alamos for comparison with the TRAC results, and then they issue a quick-look report and data reports and evaluation reports.

Quick-look reports contain essentially the important instrument data reports contain all of the instrument data. And evaluation reports contain some of the analysis.

And then Los Alamos Laboratory will perform a TRAC post-test.

Predictions based upon initial and boundary conditions from the facility and compare the calculation results with test results.

And finally NRC and Los Alamos and MPR, who is our contractor, will analyze data for each test series and draw conclusions. That is roughly the procedure we are following.

Then, we expect to have these results from our program.

And next year, in 1984, we will draw some conclusions of the flow-blockage effect and the two-dimensional flow effect.

And then, in 1985, we will have an assessment of TRAC calculations in two-dimensional flow. And then we will draw some conclusions on the effectiveness on alternating ECCS designs.

Some examples are listed here. (Indicating.)

In 1987, we will have results from the ECCS bypass. And then the rest of the results will be produced in 1988:

The three-dimensional flow effect and the assessment of a TRAC and three-dimensional flow calculations and the trainment of liquid in upper plenum, the steam-binding effect, the countercurrent flow limit in hot leg during a small break LOCA and, finally, assessment of small-scale data, as compared with larger-scale data obtained in this program.

And this is my last slide -- unless you want to discuss the attachment, which has a little more detail and the facility's status.

MR. CATTON: What is the difference CCTF I and CCTF II?

MR. RHEE: Well, CCTF I is essentially reflood. They had performed all of the reflood tests.

CCTF is, of course, a system -- integrated system facility, which has a loop and steam generator and so on.

And CCTF II will have an additional test, particularly in this alternate ECCS concept and the refuel tests, which we think are important.

MR. SCHROCK: Could you describe for me the way you think the 60 percent blockage is produced?

Do you solidly block 60 percent of the cross-section of one LOCA region? Or is it 60 percent of the cross-section blockage over the -- more or less distributed over the entire cross-section of the experiment?

MR. RHEE: No.

MR. SCHROCK: Is is concentrated?

MR. RHEE: That's right, concentrated in bundles 3 and 4.

We have eight bundles in sort of a slab geometry. And near the middle, bundle 3 and 4, we have 60 percent flow blockage along the same plane.

So, it is not a complete 100 percent block.

There is a 40 percent blow.

MR. SCHROCK: What I am trying to learn is, locally, where the blockage is placed -- is there some group of rods that have total blockage to accomplish

SFjl 33-4

60 percent blockage in a bundle or two bundles?

MR. RHEE: No. Each rod would have essentially the same configuration with that bundle, bundle 3 and 4.

MR. SCHROCK: So, it's 60 percent blockage on a localized basis. Each sub-channel gets 40 percent?

MR. RHEE: That's right.

MR. SCHROCK: Okay.

MR. WARD: Any other questions?

(No response.)

MR. WARD: All right.

Thank you, Mr. Rhee.

Lou, do you want to wrap it up?

MR. SHOTKIN: Yes.

This is to be in closed sessions.

(Whereupon, at 8:00 p.m., the hearing was adjourned, to reconvene at 8:30 a.m., Wednesday, November 9, 1983.)

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end 33

CERTIFICATE OF PROCEEDINGS

This is to certify that the attached proceedings before the

NRC COMMISSION

In the matter of:

Date of Proceeding: Tuesday, November 8, 1983

Place of Proceeding: Washington, D. C. 20006

were held as herein appears, and that this is the original transcript for the file of the Commission.

Sharon Filipour
Official Reporter - Typed

Sharon Filipour
Official Reporter - Signature

Tapes - 2

REACTOR SYSTEMS RESEARCH BRANCH PROGRAMS

NUCLEAR PLANT ANALYZER/DATA BANK: RES NEEDS AND PROGRAM DIRECTION

CODE DEVELOPMENT AND ASSESSMENT

2D/3D PROGRAM: FUTURE OPTIONS (CLOSED SESSION)

LOUIS M. SHOTKIN
U.S. NUCLEAR REGULATORY COMMISSION

ACRS SUBCOMMITTEE MEETING

WASHINGTON, D. C.

NOVEMBER 8-9, 1983

RSRB PROGRAMS

CODE : FACILITY MATRIX

CODE APPLICATIONS TO LWR'S	TRAC-PWR	RELAP5	TRAC-BWR	COBRA	COMPONENT CODES	OTHER CODES
PTS	CE B&W	WESTINGHOUSE B&W			CREARE	
NPA/DB	LANL	INEL				BNL
2D/3D	CCTF SCTF UPTF					
WESTINGHOUSE SAFETY ISSUES CE	LOFT [*]	SEMISCALE ROSA-IV				
B&W SAFETY ISSUES	MIST					
GE SAFETY ISSUES			FIST [*]			NUFREQ (STABILITY)
S.G.					MB-2 [*]	
BLOCKAGE --- UHI				FLECHT SEASET [*]		

[*] - OTHER U.S. AND OVERSEAS FACILITIES

NUCLEAR PLANT ANALYZER

RES NEEDS

- FAST RUNNING BWR ANALYZER (BNL)
  - USER CONVENIENCES
  - INTERACTIVE CAPABILITY
- FAST RUNNING PWR ANALYZER (LANL/INEL)
  - USER CONVENIENCES
  - INTERACTIVE CAPABILITY
- LOOP VIEWS OF INTEGRAL TEST DATA (INEL)

NUCLEAR PLANT ANALYZER

PROGRAM DIRECTION

- DEMONSTRATE BWR CAPABILITY FOR CHAPTER 15 TRANSIENTS IN FY 1984 (BNL), EXCEPT LOCA
- DEMONSTRATE PWR CAPABILITY FOR TRAC-PWR AND RELAP5 IN FY 1984 (LANL/INEL)
- CONTINUE IMPORVEMENT OF CAPABILITIES IN FY 1985 BASED ON USER REQUIREMENTS
- CONSIDER OTHER NEEDS:
  - (1) SEVERE ACCIDENT, AND
  - (2) TRAC-BWR.

NUCLEAR PLANT DATA BANK

RES NEEDS

- CENTRAL REPOSITORY FOR PLANT GEOMETRIC AND OPERATING DATA
- AUTOMATIC GENERATION OF INPUT DECKS FOR TRAC AND RELAP

PROGRAM DIRECTION

- FINISH MAJOR SOFTWARE DEVELOPMENT IN FY 1984
- INSTRUCT CODE USERS ON FORMAT OF NPDB DATA SHEETS
- ENTER PLANT DATA ALREADY IN NRC HANDS

CODE DEVELOPMENT AND ASSESSMENT

COMPUTER CODE AVAILABILITY

- CODE RELEASE ONLY THROUGH NRC
  - TRAC-PF1/MOD1
  - TRAC-BD1/MOD1
  - TRAC-BF1
  - RELAP5/MOD2
  - NUCLEAR PLANT ANALYZER AND DATA BANK
  - COBRA/TRAC
  - COBRA-TF
  - SOLA-PTS
- FOREIGN RELEASE AS PART OF BILATERAL CODE TECHNOLOGY EXCHANGE AGREEMENTS. PRIMARILY, FOREIGN INSTITUTIONS ANALYZE DATA FROM THEIR FACILITIES, OR PLANTS, WITH NRC CODES AND SHARE ASSESSMENT RESULTS WITH NRC.

CODE DEVELOPMENT AND ASSESSMENT (CONTINUED)

COMPUTER CODE AVAILABILITY (CONTINUED)

- DOMESTIC RELEASE FOR USE ONLY BY REQUESTOR; NO THIRD-PARTY RELEASE WITHOUT NRC AGREEMENT.
- USER SUPPORT IN EXCHANGE FOR ASSESSMENT STUDIES, NODING SENSITIVITY STUDIES, ETC.

CODE DEVELOPMENT AND ASSESSMENT (CONTINUED)

FUTURE SUPPORT FOR TRAC-PWR AND RELAP5

- ONE CODE WILL BE CHOSEN FOR FURTHER DEVELOPMENT, THE OTHER WILL BE MAINTAINED FOR USERS.
- EVALUATION SOLICITED FROM SEVERAL GROUPS:
  - NRC/RES
  - NRC/NRR
  - ACRS
  - UNIVERSITY EXPERTS AND ACRG MEMBERS
  - CODE EXPERTS
  - CODE ASSESSORS
  - CODE USERS
  - FOREIGN ASSESSORS/USERS

CODE DEVELOPMENT AND ASSESSMENT (CONTINUED)

FUTURE SUPPORT FOR TRAC-PWR AND RELAP5 (CONTINUED)

- BASIS FOR EVALUATION
  - CURRENT CAPABILITIES, INCLUDING RUN TIME
  - FUTURE CAPABILITIES AND USER NEEDS
  - ACCURACY AND RELIABILITY
  - ASSESSMENT RESULTS
  - FLEXIBILITY (NODING, NUMERICS)
  - EASE OF USE
- FUTURE REQUIREMENTS OF CODE DEVELOPERS AND CODE USERS WILL BE CONSIDERED
- DECISION BY MARCH 1984

2D/3D PROGRAM: FUTURE OPTIONS

- CURRENT AGREEMENT EXPIRES IN APRIL 1985
- RES DEVELOPING OPTIONS FOR NEGOTIATING A NEW AGREEMENT
- RES WILL MEET COMMITMENTS UNDER OLD AGREEMENT IN GOOD FAITH AND SUBJECT TO FUNDING LIMITATIONS
- NEW AGREEMENT WILL NOT JEOPARDIZE RELATIONS WITH PARTNERS

Tape 3

- ACRS ECCS SUBCOMMITTEE HAS EXPRESSED CONCERNS REGARDING ADEQUACY OF IST
- SUBCOMMITTEE AND CONSULTANTS APPEAR TO BE OF OPINION THAT:
  - STAFF HAS NOT CLEARLY IDENTIFIED CONCERNS OR THERMAL-HYDRAULIC BEHAVIOR ASSOCIATED WITH CONCERN
  - CURRENT UNDERSTANDING OF PARTICULAR PHENOMENA NOT DEFINED
  - CAPABILITIES OF CODES TO MODEL PHENOMENA NOT IDENTIFIED
  - ABILITY OF GERDA/OTIS/MIST U OF MD ETC TO ADDRESS (OR NOT ADDRESS) EACH ISSUE HAS NOT BEEN IDENTIFIED

- STAFF HAS IDENTIFIED CONCERNS AND THERMAL/HYDRAULIC BEHAVIOR ASSOCIATED WITH CONCERNS IN NUMEROUS DOCUMENTS

SOME EXAMPLES ARE:

- LETTER, FROM H. R. DENTON TO Wm. O. PARKER (DUKE) DATED APRIL 1, 1981
- MEETING SUMMARY OF THE EXECUTIVE REPRESENTATIVES OF THE OWNERS OF B&W OPERATING PLANTS CONCERNING EXPERIMENTAL VERIFICATION OF ACCIDENT MODELS ON OCTOBER 23, 1981, DATED NOVEMBER 10, 1981
- MEMORANDUM, DENTON TO MINOGUE, "REQUEST FOR THE CONCEPTUAL DESIGN OF A FACILITY FOR THE STUDY OF B&W AND CE INTEGRAL SYSTEM CHARACTERISTICS" DATED DECEMBER 30, 1981
- LETTER, DENTON TO J. J. MATTIMOE (SMUD) DATED NOVEMBER 16, 1982

IN ADDITION, TWO REPORTS HAVE BEEN ISSUED WHICH ADDRESS THE 4 AREAS OF CONCERN:

- EG&G 2x4 STUDY
- TEST ADVISORY GROUP (TAG) FINAL REPORT

- THE NRR STAFF BELIEVES THAT:
  - -ALL ISSUES HAVE BEEN CLEARLY IDENTIFIED, DISCUSSED, AND DOCUMENTED
  - -THE THERMAL-HYDRAULIC ISSUES HAVE BEEN IDENTIFIED
  - -THE CAPABILITIES OF THE VARIOUS FACILITIES TO PRODUCE THE DESIRED DATA, INCLUDING SCALING CONSIDERATION, HAVE BEEN EVALUATED IN MORE DETAIL THAN OTHER INTEGRAL FACILITIES.

WE BELIEVE THAT ACRS CONCERNS CAN BEST BE ADDRESSED BY THE STAFF IF THEY SPECIFICALLY REFER TO OMISSIONS OR DEFICIENCIES IN THE TAG REPORT.

NRR COMMENTS ON NUCLEAR PLANT ANALYZER/DATA BANK

-DATA BANK

-NRR GENERALLY SUPPORTS DATA BANK CONCEPT - I.E., REDUCTION IN RESOURCES NEEDED TO SET UP PLANT INPUT DECK

-NRR DOES NOT PLAN TO TAKE OVER DATA BANK MANAGEMENT. RES MUST RUN DATA BANK PROGRAM

-NRR HAS NO PLANS TO REQUIRE UTILITIES TO SUBMIT PLANT DATA SPECIFICALLY FOR DATA BANK.

-NUCLEAR PLANT ANALYZER

-PWR ANALYZERS

- OUR UNDERSTANDING IS THAT THE ANALYZER IS BEING DESIGNED TO MAKE TRAC & RELAP5 MORE USER-CONVENIENT AND TO HAVE AN INTERACTIVE CAPABILITY.
- NRR GENERALLY ENDORSES THE CONCEPT OF CODE USER CONVENIENCE
- WE DO NOT HAVE ANY SPECIFIC NEED FOR AN INTERACTIVE CAPABILITY.
- NON-UNIFORMITY OF COMPUTER HARDWARE IS POTENTIAL PROBLEM

•BWR ANALYZERS

-NRR AGREES THAT AN ANALYTICAL TOOL WHICH CAN PERFORM BWR TRANSIENT ANALYSES FAST IS DESIRABLE

-BNL PROGRAM WAS ORIGINALLY DESIGNED TO DO THIS

-OUR CURRENT ASSESSMENT IS THAT WE ARE NOT SURE IF THE BNL PROGRAM WILL BE COST-EFFECTIVE.

- PROGRAM DESIGNED FOR SPECIFIC COMPUTER ONLY AVAILABLE AT BNL
- SIGNIFICANT "HARD-WIRING OF INPUT DATA
- TRANSIENT CAPABILITY NOT COMPLETELY DEMONSTRATED
- NO ASSESSMENT
- BNL PURPOSE FOR PROGRAM INCONSISTENT WITH NRR NEEDS
- DEVELOPMENT OF TRAC BWR "ANALYZER" MAY BE MORE COST-EFFECTIVE.

Table 5-4. TAG Rating of Facilities

Phenomena	Option I	Option I'	Option II	Option II'	Option III
Natural Circulation					
Single phase	7	9	8	9	9
Two phase	5	7	6	7	8
Boiler condenser model	5	7	6	7	8
Cooldown	7	8	7	8	9
Hydraulic stability					
1. Intra loop	6	7	7	7	8
2. Inter loop	2	4	3	4	4
Interruption/restart	6	8	7	8	9
High point vents	5	7	6	7	8
Effects of noncondensibles	5	7	6	7	8
Vent valves	4	4	4	4	5
SB LOCAs					
Size	5	6	7	8	8
ECCS	4	7	7	8	8
Pump operation	1	6	6	7	8
Location	5	7	7	8	8
Break isolation	6	7	7	8	8
Vent valves	5	5	5	6	6
Feed and Bleed	6	7	6	7	7
OTSG Tube Rupture	5	6	6	7	8

Table 5-5. TAG Effective Facility Rating

Phenomena	Option I	Option I'	Option II	Option II'	Option III
Natural Circulation					
Single phase	7	9	8	9	9
Two phase	20	28	24	28	32
Boiler condenser mode	50	70	60	70	80
Cooldown	49	56	49	56	56
Hydraulic stability					
1. Intra loop	42	49	49	49	56
2. Inter loop	14	28	21	28	28
Interruption/restart	42	56	49	56	56
High point vents (Owners)	5	7	6	7	8
(NRC)	50	70	60	70	80
Effect of noncondensibles	35	49	42	49	56
Vent valves	16	16	16	16	20
SB LOCAs					
Size	20	24	28	32	32
ECCS	16	28	28	32	32
Pump operation	7	42	42	49	56
Location	5	7	7	8	8
Break isolation	42	49	49	56	56
Vent valves	35	35	35	42	42
Feed and Bleed	6	7	6	7	7
OTSG Tube Rupture	35	42	42	49	56

Tape 4

Table 3-2. TAG Evaluation of Issues

Natural Circulation	
Single-phase natural circulation	D
Two-phase natural circulation	C
Boiler condenser natural circulation	A
Steam generator-driven instabilities	B
Cold leg oscillations	B
Interruption/reestablishment	B
High point vents	A/D
Non-condensable gases	B
Reactor vessel vent valves	C
Small Break Loss-of-Coolant Accident	
Break size	C
Emergency core cooling system operation	C
Reactor coolant pump operation	B
Location of break	D
Break isolation	B
Reactor vessel vent valves	B
Feed and Bleed	D
Once-Through Steam Generator	B

11/7/83

ACRS ECCS SUBCOMMITTEE MEETING
NOVEMBER 8-9, 1983
WASHINGTON, DC

- TENTATIVE SCHEDULE OF PRESENTATIONS -

November 8, 1983

I.	INTRODUCTION	D. Ward	8:30 am
II.	NRC RES PROGRAMS		
A.	RES Reactor Systems Research Branch Programs - An Overview	L. Shotkin RES	8:45 am
B.	Integral System Test (IST) Program for B&W Reactors		
1.	NRR Comments on IST Program	B. Sheron NRR	9:15 pm
2.	Background and Overview of Program	W. Beckner RES	9:45 am
3.	Program Management Group (PMG) Report	M. Young RES	9:55 am
	° U. Md and SRI-II Companion Facilities		
	*** BREAK *** (During above presentation)		10:20 am
4.	MIST/OTIS Facility Design and Objectives	R. Carter B&W Alliance RES	11:05 am
		R. A. Turner B&W Lynchburg	
		C. D. Morgan B&W Lynchburg	
5.	MIST/OTIS Test Matrix, Analysis Plans	M. Young	12:00 pm
	*** LUNCH ***		12:30-1:30 pm
C.	Nuclear Plant Analyzer/Data Bank		
1.	NRR Needs	B. Sheron	1:30 pm
2.	RES Needs and Program Direction	L. Shotkin	2:00 pm
3.	LANL/INEL/IDC Program Details	C. Troutman RES	2:30 pm
	*** BREAK ***		3:30 pm

- TENTATIVE SCHEDULE OF PRESENTATIONS -

November 8, 1983 (Cont'd)

	4. BNL Plant Analyzer Program	F. Odar RES	3:45 pm
D.	20/30 Program		
	1. Current Status	G. Rhee RES	4:15 pm
	2. Future Options (Closed Session)	W. Beckner	4:45 pm
III.	RECESS		5:15 pm

November 9, 1983

IV.	RECONVENE	D. Ward	8:30 am
V.	NRC RES PROGRAMS (Continued)		
E.	Code Development and Assessment		
	1. NRR Comments on Development and Assessment Needs	B. Sheron	8:35 am
	2. RES Comments on Development and Assessment Needs	L. Shotkin	9:05 am
	3. Details of Code Development Effort		
	a. TRAC PWR	C. Tovmassian	9:20 am
	*** BREAK ***		:05 am
	b. TRAC BWR	F. Odar	10:20 am
	c. RELAP-5	R. Landry	11:05 am
	4. Code Assessment Effort	F. Odar	11:50 am
	*** LUNCH ***		12:20-1:20 pm
F.	Appendix K Revision Status	W. Beckner	1:20 pm

- TENTATIVE SCHEDULE OF PRESENTATIONS -

November 9, 1983 (Cont'd)

G.	ROSA Test Program		
1.	ROSA III Test Results	W. Beckner	2:00 pm
2.	ROSA IV Facility and Agreement Details	Y. Chen	2:20 pm
H.	Semiscale Program		
1.	Status and Plans	R. Landry	3:00 pm
2.	NRR Comments	B. Sheron	4:00 pm
VI.	DISCUSSION AND ADJOURN		4:30 pm

INTRODUCTION TO

INTEGRAL SYSTEM TEST PROGRAM (IST)

WILLIAM D. BECKNER
U.S. NUCLEAR REGULATORY COMMISSION

ACRS SUBCOMMITTEE MEETING
WASHINGTON, D. C.

NOVEMBER 8, 1983

BACKGROUND

- THE TEST ADVISOTY GROUP (TAG), WHICH CONSISTED OF REPRESENTATIVES FROM NRC, EPRI, B&W, AND B&W OWNER'S, WAS ESTABLISHED IN SEPTEMBER 1982 IN ORDER TO:
  - IDENTIFY EXPERIMENTAL DATA NEEDS
  - IDENTIFY OPERATING PLANT AND EXPERIMENTAL DATA AVAILABLE NOW OR IN THE NEAR FUTURE
  - EVALUATE HOW WELL THESE DATA ADDRESS THE IDENTIFIED DATA NEEDS
  - PROVIDE RECOMMENDATIONS FOR FUTURE PROGRAMS
- THE TAG PROVIDED THEIR RECOMMENDATIONS IN JUNE 1983, WHICH RESULTED IN THE IST PROGRAM.

BACKGROUND (CONTINUED)

- THE IST PROGRAM, JOINTLY FUNDED BY NRC, B&W OWNER'S, B&W, AND EPRI, CONSISTS OF THREE PHASES:
  - ONCE-THROUGH INTEGRAL SYSTEM (OTIS) PROJECT
  - MULTILOOP INTEGRAL SYSTEMS TEST (MIST) FACILITY SPECIFICATIONS
  - MIST PROJECT
- THE IST PROGRAM CONTRACT WAS SIGNED IN JULY 1983 AND IS A $31 MILLION PROGRAM FUNDED 42 PERCENT BY NRC, 27 PERCENT BY B&W OWNER'S, 27 PERCENT BY B&W, AND 4 PERCENT BY EPRI, INCLUDING BOTH CASH AND CONTRIBUTIONS IN-KIND. THE PROGRAM IS MANAGED BY A PROGRAM MANAGEMENT GROUP (PMG) CONSISTING OF A REPRESENTATIVE FROM EACH OF THE PARTIES.

IST PROGRAM ISSUES

- THE ACRS HAS REQUESTED CLARIFICATION OF NRR CONCERNS AND NEEDS AND THE THERMAL HYDRAULIC PHENOMENA ASSOCIATED WITH THESE CONCERNS.
- QUESTIONS HAVE BEEN RAISED CONCERNING THE ABILITY OF THE IST PROGRAM TO PROVIDE DATA NECESSARY TO UNDERSTAND THESE PHENOMENA.
- WE HAVE PRESENTED THE PROGRAM OBJECTIVES AND FACILITY DESIGN/SCALING ON SEVERAL OCCASSIONS TO THE ACRS AND HAVE HAD A NUMBER OF PROGRAM REVIEWS DEALING WITH THESE ISSUES. THE MOST RECENT WAS THE OCTOBER 1983 REVIEW GROUP MEETING.
- THE OVERALL ISSUES CAN BE REDUCED TO QUESTIONS CONCERNING:
  - . . DESIGN OF THE DOWNCOMER AND RVVV
  - . . DESIGN OF THE HOT LEG AND U-BEND
  - . . FULL HEIGHT SCALING

AND GIVEN THESE DESIGNS, WHAT WILL BE THE FACILITY LIMITATIONS?

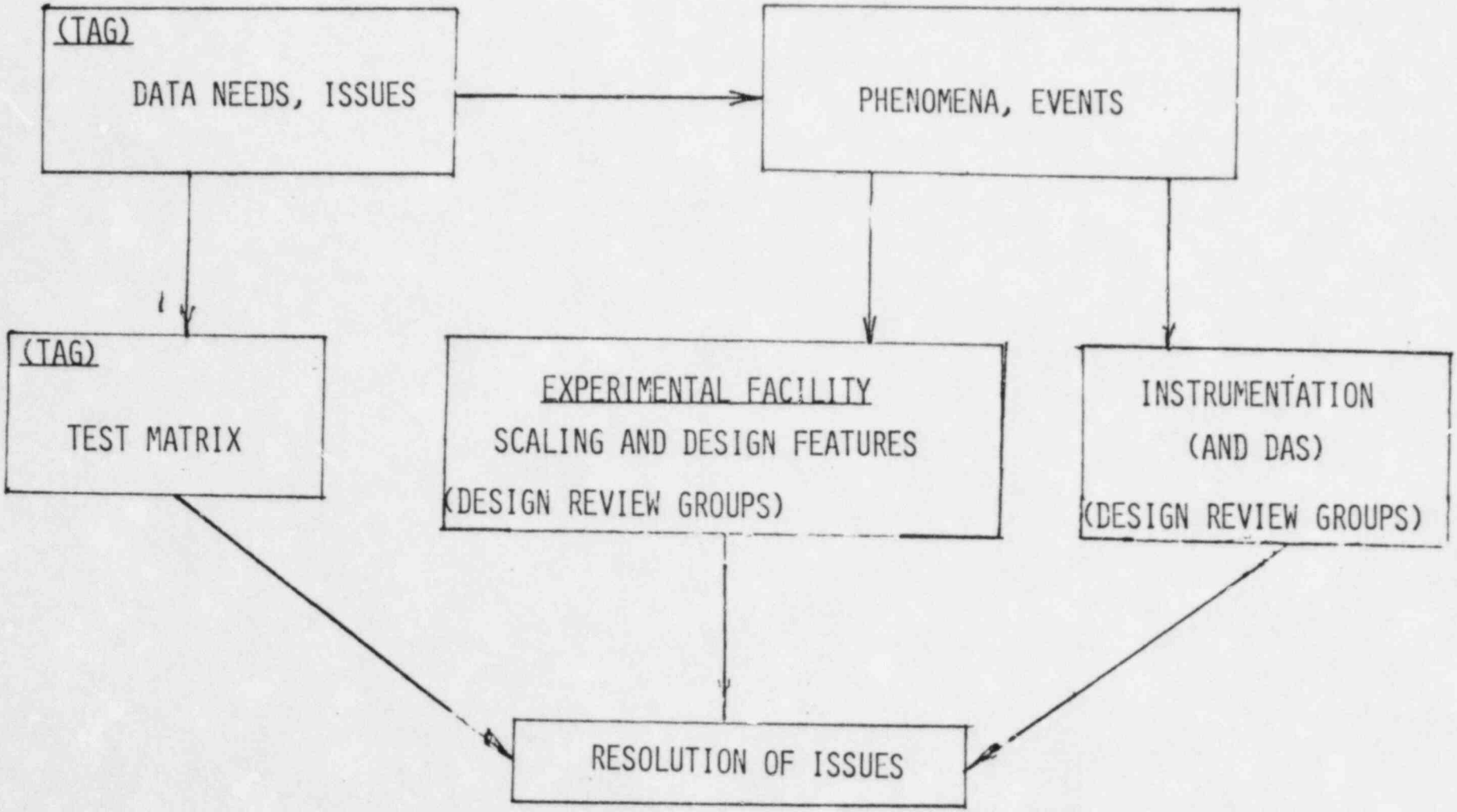
IST PROGRAM ISSUES (CONTINUED)

- WE PLAN TO INFORM THE ACRS TODAY HOW WE HAVE ADDRESSED THESE CONCERNS ABOUT THE FACILITY DESIGN.

Tape 6

IST PROGRAM DEVELOPMENT

TAG ESTABLISHED	SEPT 1982
ACRS ENDORSEMENT	FEB 1983
TAG REPORT	JUNE 1983
ACRS SUBCOMMITTEE MEETING	JULY 1983
PMG MEETINGS	
. PUMP DESIGN REQUIREMENTS, BUILDING SPECIFICATIONS	AUGUST 1983
. SCALING, TEST MATRIX, INSTRUMENTATION	OCTOBER 1983
MIST FACILITY SPECIFICATION ISSUED	OCTOBER 31, 1983
ACRS MEETING	NOVEMBER 8, 1983
FORMAL DESIGN REVIEW GROUP MEETING	NOVEMBER 16-17, 1983
FINAL CONCURRENCE ON FACILITY SPECIFICATION	NOVEMBER 30, 1983
INITIATE MAJOR PROCUREMENT ACTIVITIES	DECEMBER 1, 1983
COMPLETE MIST CONSTRUCTION	AUGUST 1985


(TAG)
DATA NEEDS, ISSUES
PHENOMENA, EVENTS
(TAG)
TEST MATRIX
EXPERIMENTAL FACILITY
SCALING AND DESIGN FEATURES
(DESIGN REVIEW GROUPS)
INSTRUMENTATION
(AND DAS)
(DESIGN REVIEW GROUPS)
RESOLUTION OF ISSUES

PRESENTATION AGENDA

- PURPOSE OF IST PROGRAM
- IST PROGRAM FORMULATION AND FOUNDATION
  - DATA NEEDS, ISSUES
  - EXPERIMENTAL FACILITY (MIST)
- FACILITY DESIGN AND EVALUATION
  - PMG MEETING NO. 2 - DECISIONS
  - SCALING SUMMARY
  - COMPONENT DESIGN REQUIREMENTS
  - INSTRUMENTATION (AND DAS) REQUIREMENTS
- TEST MATRIX
- SUPPORT PROGRAMS
- SCHEDULE

PURPOSE OF IST PROGRAM

- TO SATISFY REQUIREMENTS OF TMI-2 TASK ACTION PLAN ITEM II.K.3.30
  - REQUIRES SMALL BREAK MODEL BE COMPARED TO APPLICABLE DATA
- TO GAIN TECHNICAL INSIGHT AND TO ALLOW ASSESSMENT OF
  - B&W ABNORMAL TRANSIENT OPERATOR BUIDELINES (ATOG)
  - SBLOCA SCENARIOS
  - STEAM GENERATOR TUBE RUPTURE IN A OTSG
- TO BENCHMARK AND ASSESS NRC COMPUTER CODES TO ALLOW INDEPENDENT AUDITS TO BE PERFORMED

FORMULATION OF IST PROGRAM

- TAG ESTABLISHED IN SEPTEMBER 1982 TO ACCOMPLISH FOUR TASKS:
  - (1) IDENTIFY EXPERIMENTAL DATA NEEDS,
  - (2) IDENTIFY AVAILABLE DATA,
  - (3) EVALUATE HOW WELL DATA ADDRESS IDENTIFIED DATA NEEDS, AND
  - (4) RECOMMEND FUTURE PROGRAMS.
- MAJOR ELEMENTS RESULTING FROM TAG EFFORT
  - . . AGREEMENT ON PRIORITIZED LIST OF ISSUES
  - . . USE OF GERDA FACILITY FOR CONSTRUCTING OTIS AND MIST
  - . . TEST MATRIX FOR OTIS AND MIST
  - . . AGREEMENT ON ESSENTIAL DESIGN FEATURES OF MIST
- CONTRACT SIGNED JULY 8, 1983

. TAG DEVELOPED LIST OF TESTING NEEDS AND ALSO REVIEWED EXISTING TEST DATA.

. . DATA NEEDED TO GAIN ADDITIONAL CONFIDENCE IN UNDERSTANDING TRANSIENT THERMAL-HYDRAULIC PHENOMENA OF B&W PLANTS.

. . . UNDERSTAND SLOW CYCLIC PRESSURE CHANGES POSTULATED BY B&W TO OCCUR DURING CERTAIN SBLOCA.

. . . ASSESS THE REVISED SBLOCA MODELS.

. . . CHARACTERIZE NATURAL CIRCULATION, PARTICULARLY CONDITIONS OCCURRING IN THE HLUB REGION.

- TAG DEVELOPED A COMPOSITE LIST OF ISSUES CATEGORIZED INTO FOUR BASIC PHENOMENA.
  - NATURAL CIRCULATION
  - SBLOCA
  - FEED AND BLEED COOLING
  - OTSG TUBE RUPTURE
- NATURAL CIRCULATION
  - PREVIOUS LARGE IST FACILITIES DID NOT MODEL UNIQUE B&W HOT LEG CONFIGURATION OR OTSG. AS A RESULT, IT DID NOT SIMULATE APPROPRIATE NATURAL CIRCULATION CONDITIONS.
  - UNCERTAINTY ABOUT EFFECTS OF TWO-PHASE FLOW, NONCONDENSABLE GASES, AND THE VALIDITY OF THE BOILER-CONDENSER MODE OF HEAT REMOVAL.
  - ALSO, HYDRAULIC STABILITY, EFFECTS OF HIGH POINT VENTS, AND INTERNAL RVVV WERE OF INTEREST.

- SBLOCA
  - NATURAL CIRCULATION MODE OF HEAT REMOVAL IS A MAJOR PHENOMENA IN A SBLOCA.
  - BREAK SIZE, LOCATION, ISOLATION, SENSITIVITY TO ECCS OPERATION SHOULD BE ADDRESSED.
  - EFFECT OF RC PUMP OPERATION SHOULD BE EVALUATED.
  - EFFECTS OF RVVV'S SHOULD BE VERIFIED ON AN INTEGRAL BASIS.
- FEED AND BLEED COOLING
  - ALTHOUGH IT IS NOT A HIGH PRIORITY ISSUE, CODE CAPABILITY OF PREDICTING THIS MODE OF HEAT REMOVAL SHOULD BE ASSESSED.

- OTSG TUBE RUPTURE
  - OTSG IS DIFFERENT CONFIGURATION THAN U-TUBE S.G.
  - INTEGRAL TESTING OF TUBE RUPTURES
    - EFFECTS OF SINGLE AND MULTIPLE RUPTURES
    - RCP OPERATION
    - ASYMMETRIC LOOP EFFECTS
    - COMBINED TR AND STREAM LINE BREAK

LIST OF ISSUES

TAG - COMPOSITE LIST OF ISSUES CATEGORIZED INTO FOUR BASIC PHENOMENA:

NATURAL CIRCULATION	PRIORITY
*BOILER CONDENSER NATURAL CIRCULATION	A
HIGH POINT VENTS	A/D
*INTERRUPTION/REESTABLISHMENT	B
NONCONDENSABLE GASES	B
STEAM GENERATOR-DRIVEN INSTABILITIES	B
*(LOOP TO LOOP INTERACTIONS)	
COLD LEG OSCILLATION	B
TWO-PHASE NATURAL CIRCULATION	C
REACTOR VESSEL VENT VALVES	C
*SINGLE-PHASE NATURAL CIRCULATION	D

SMALL BREAK LOSS-OF-COOLANT ACCIDENT	
BREAK ISOLATION	B
REACTOR COOLANT PUMP OPERATION	B
REACTOR VESSEL VENT VALVES	B
BREAK SIZE	C
EMERGENCY CORE COOLING SYSTEM OPERATION	C
LOCATION OF BREAK	D
FEED AND BLEED	D
OTSG TUBE RUPTURE	B

*IDENTIFIED AS IMPORTANT ISSUES AT ACRS MEETING ON JULY 19, 1983.

SBLOCA EVENTS AND PHENOMENA

Initiation

1. Leak Flow
2. Pressurizer Draining
3. Primary Depressurization
4. Power and Flow Transient: Reactor and Reactor Coolant Pump Trips, Transfer of Steam Generator Feed
5. Single Phase Natural Circulation

Intermittent Spillover Circulation

6. Hot Leg U-Bend Saturation and Voiding
7. Reactor Vesel Upper Head Voiding
8. Reactor Vessel Vent Valve Actuation
9. Decoupling of Steam Generator, Steam Generator Depressurization
10. Primary Repressurization
11. Leak-HPI (High Pressure Injection) Cooling
12. Feed and Bleed (Primary) Cooling
13. Downcomer and Cold Leg Voiding and Condensation
14. Asymmetric Conditions Among Cold Legs

Boiler Condenser Mode

15. Steam Generator Condensation of Primary Steam
16. Primary Depressurization to CFT/LPI Pressures
17. Steam Generator Repressurization

Primary Refill

18. Compression of Primary Steam
19. Venting of Primary Fluid
20. Subcooling of Primary Components
21. Spillover Circulation (Hot Leg U-Bend Refilled)
22. "Pump Bump"

Cooldown

23. Controlled Steam Generator Depressurization and Primary Cooldown
24. Reinitiation of Natural Circulation
25. Cooling of Idled Loop

- TAG AGREED TO FORMULATION OF A 2 X 4 INTEGRAL SYSTEM TEST FACILITY BASED ON GERDA
  - FULL ELEVATION, POWER AND VOLUME SCALING HAS BEEN USED IN OTHER INTEGRAL SYSTEM TEST PROGRAMS
  - COST BENEFIT BY USING EXISTING OTSG, HOT LEG, AND INSTRUMENTATION
  - B&W OBSERVED PHENOMENA IN GERDA
    - HLUB VOIDING AND INTERRUPTION
    - BOILER-CONDENSER COOLING MODE
- IST PROGRAM COST ESTIMATE BASED ON USE OF GERDA COMPONENTS

OVERALL SYSTEM	→ FULL ELEVATION
POWER AND VOLUME	→ 815

PMG NO. 2 MEETING OBJECTIVES

(OCTOBER 11-14, 1983)

- REVIEW AND CONCUR ON SCALING APPROACH SUPPORTING THE MIST FACILITY WITH RESPECT TO THE PROGRAM OBJECTIVES.
- REVIEW OTIS AND MIST TEST MATRIX. RECEIVE COMMENTS AND RECOMMENDATIONS FROM MEETING PARTICIPANTS.
- RECOMMEND AND CONCUR ON MIST INSTRUMENTATION NEEDS BASED ON TEST OBJECTIVES. ALSO, RECOMMEND DAS REQUIREMENTS.

PMG NO. 2 DECISIONS AND AGREEMENTS

- DOWNCOMER DESIGN
- INSTRUMENTATION/DAS CHANNEL CAPACITY
- ADVANCED INSTRUMENTATION

DOWNCOMER → BAFFLE QUADRANT

(4 RVVV) WITH SEPARATE EFFECTS EXPERIMENTS TO CHARACTERIZE

- ENSURE SYMMETRIC FLOW IN DOWNCOMER
- PREVENT ATYPICAL FLOW COMMUNICATION BETWEEN COLD LEGS
- MAINTAIN B&W DESIGN FEATURES
- CODE ABILITY TO MODEL; SEPARATE EFFECTS TESTING

INSTRUMENTATION

- CODE ANALYSTS PROVIDED INPUT ON INSTRUMENTATION NEEDS
  - INITIAL BOUNDARY CONDITIONS
  - SYSTEM INVENTORIES ⟶ INFLOW AND OUTFLOW BOUNDARY CONDITIONS (BREAK FLOW, ECC INJECTION, VENT FLOWS, NONCONDENSABLE INJECTION, FEEDWATER FLOW INTO AND STEAM FLOW OUT OF OTSG)
  - EXTERNAL HEAT LOSSES FROM SYSTEM
  - POWER TO GUARD HEATERS
  - FLOW IN EACH PIPING LEG (AT LEAST VELOCITY)
  - RVVV FLOW
  - DENSITY MEASUREMENT IN EACH PIPING LEG (HOT LEG, PUMP SUCTION, COLD LEG, RVVV PIPING)
  - DENSITY IN HLUB

INSTRUMENTATION (CONTINUED)

- . . TEMPERATURE IN COLD LEGS (THERMAL STRATIFICATION)
- . . T/C RAKE IN HOT LEG
- . . DO NOT SUPPORT REDUCTION IN PROPOSED INSTRUMENTATION LIST

. PMG AGREED ON INSTRUMENTATION REQUIREMENTS AS PROPOSED BY B&W (ABOUT 700), LANL MAJOR REQUIREMENTS MET.

. PMG AGREED TO INSTALLING GAMMA DENSITOMETER PORTS (WASHERS) AND TO USE OF FIVE (5) GAMMA DENSITOMETERS PENDING THE FOLLOWING:

1. DESIGN FEASIBILITY OF WELDING WASHERS IN PIPING, AVOID FLUID LEAKAGE FROM SYSTEM, AND
2. EVALUATE CALIBRATION PROCEDURE AND IMPACT ON TESTING SCHEDULE AND COSTS.

DAS

- PMG AGREEMENT FOR 700 CHANNEL CAPACITY
- DAS REVIEW MEETING (NOVEMBER 4, 1983) FOR EXPERTS TO EVALUATE THE CRITERIA AND BASIS FOR THE PROPOSED DAS LAYOUT AND NEEDS (HARDWARE AND SOFTWARE)

IMPACT OF REVIEW GROUP

(1) INSTRUMENTATION NEEDS

- STRATIFICATION IN CL's
- GAMMA-DENSITOMETERS
- PLACEMENT OF METAL AND FLUID T/C's IN CORE

(2) TEST MATRIX

- STEADY STATE

(3) DOWNCOMER/RVVV DESIGN

- ASYMMETRIES
- SIMPLE DESIGN/NO ASYMMETRIES
- SEPARATE EFFECTS TESTING

(4) DAS

- REVIEW MEETING

BNL PLANT ANALYZER

FUAT ODAR
U.S. NUCLEAR REGULATORY COMMISSION

ACRS ECCS SUBCOMMITTEE MEETING
WASHINGTON, D. C.

NOVEMBER 8-9, 1983

PROGRAM OBJECTIVES

- SAFETY ANALYSES AND AUDIT CALCULATIONS
  - REALISTIC BEST-ESTIMATE SIMULATIONS OF OPERATIONAL AND ACCIDENTAL TRANSIENTS ((SBLOCA) TRANSIENTS, ETC.)
  - MANY SIMULATIONS, FAST, AT LOW COST:
    - PARAMETRIC STUDIES
    - RISK ASSESSMENT
    - ACCIDENT SIGNATURES
    - CONTROL SYSTEM STUDIES

PROGRAM OVERVIEW

JANUARY 1, 1982	START
MARCH 1, 1982	PDP-11/34 HOST COMPUTER OPERATING
MARCH 15, 1982	AD10 PERIPHERAL PROCESSOR OPERATING
SEPTEMBER 25, 1982	FEASIBILITY DEMONSTRATION COMPLETED (BWR HYDRAULICS)
JUNE 1, 1983	KINETICS, THERMAL CONDUCTION AND STEAM LINE DYNAMICS SIMULATED
AUGUST 31, 1983	SEVEN TRANSIENTS SIMULATED
OCTOBER 15, 1983	LOOP SIMULATED FOR BWR/4 (BROWNS FERRY) THREE MAJOR CONTROL SYSTEMS SIMULATED. ALL OPERATIONAL TRANSIENTS EXCEPT FOR SMALL BREAK LOCAS CAN BE SIMULATED.

CURRENT SIMULATION CAPABILITIES

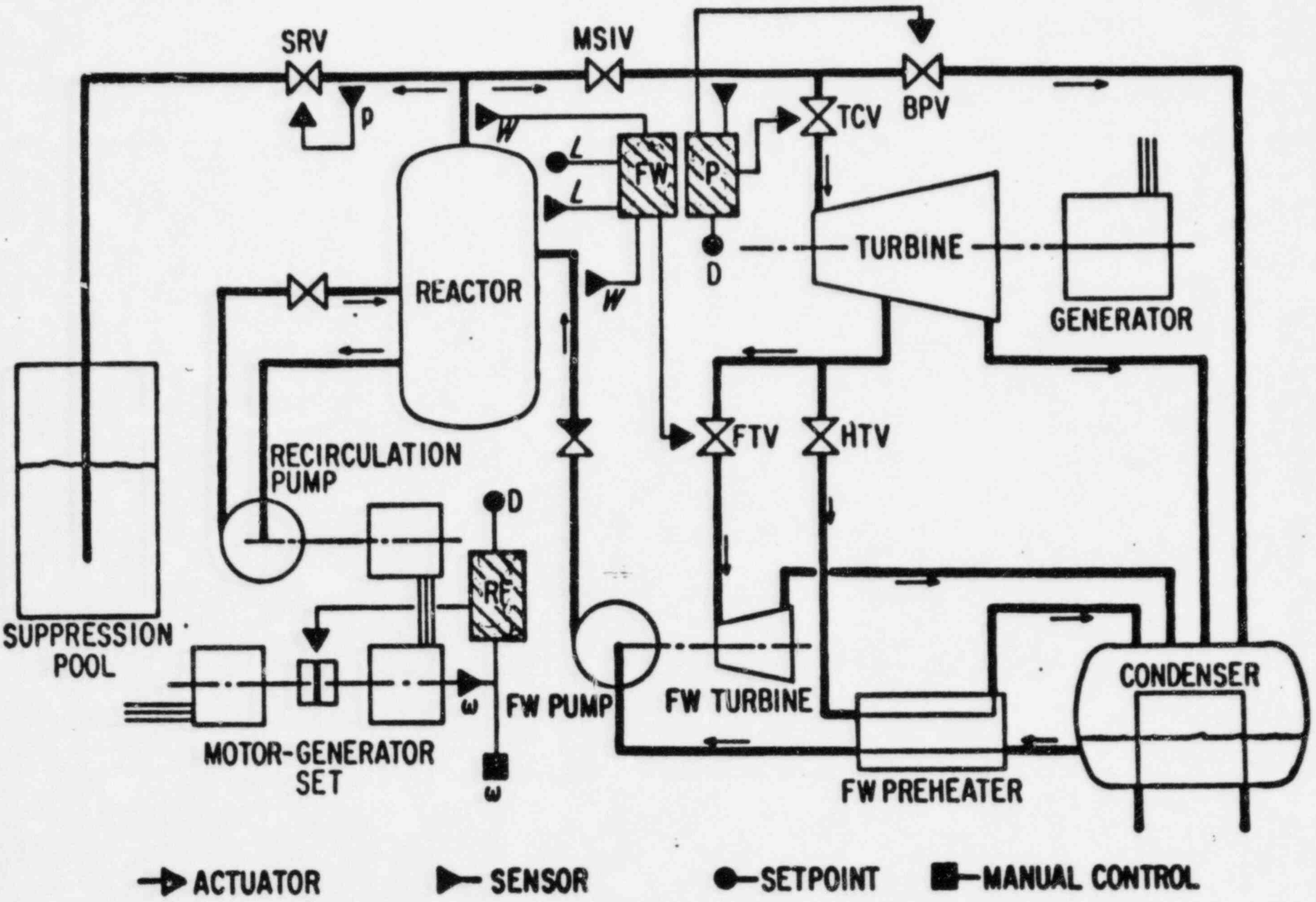
- TRANSIENTS WITH SYSTEM PRESSURE RISE
  - GENERATOR LOAD REJECTION
  - TURBINE TRIP WITHOUT BYPASS FLOW
  - TURBINE TRIP WITH BYPASS FLOW
  - CLOSURE OF MAIN STEAM ISOLATION VALVE
- TRANSIENTS WITH MODERATOR TEMPERATURE DECREASE
  - INADVERTENT FEEDWATER PUMP START-UP
  - FEEDWATER CONTROLLER FAILURE, MAXIMUM DEMAND
  - FEEDWATER HEATER LOSS
  - RHRS INADVERTENTLY STARTED
  - HPCIS AND/OR RCIS INADVERTENTLY STARTED
- TRANSIENTS WITH REACTIVITY CHANGES
  - SCRAM OR SCRAM FAILURE
  - CONTROL ROD DROP
  - CONTINUOUS CONTROL ROD REMOVAL

CURRENT SIMULATION CAPABILITIES (CONTINUED)

- TRANSIENTS WITH LOSS OF INVENTORY
  - LOSS OF FEEDWATER FLOW
  - SRV STUCK OPEN, ANY BANK OR COMBINATION OF BANKS
  - PRESSURE REGULATOR FAILURE
- TRANSIENTS WITH CHANGE IN CORE FLOW
  - RECIRCULATION PUMP CONTROL FAILURE
  - RECIRCULATION PUMP TRIP
  - INADVERTENT RCP START-UP
  - RCP SEIZURE
- ATWS

LIMITATIONS

- NO FLOW REVERSAL - SOME MULTIPLE FAILURES CANNOT BE SIMULATED
- NO POST-CHF HEAT TRANSFER - LIMITATION ON ATWS
- NO SPRAY - CANNOT ANALYZE BWR/6
- NO BORON INJECTION - LIMITATION ON ATWS MITIGATION
- FIXED NODALIZATION - SUFFICIENT FOR TRANSIENTS ABOVE.
  DOESN'T SEEM TO BE A BIG LIMITATION.
- STANDARD BOP - PROGRAM NEEDS TO BE CHANGED. NEW DEVELOPMENTAL ASSESSMENT. (PLANT SPECIFIC)
- DIFFICULT TO SIMULATE EXPERIMENTAL FACILITIES. ASSESSMENT WILL BE LIMITED TO PLANT DATA AND COMPARISONS WITH OTHER CODES.
- POTENTIALLY LIMITED FOR SMALL BREAK LOCA. NO 3-D UPPER PLENUM.


SRV
MSIV
BPV
TCV
P
W
L
L
FW
P
D
TURBINE
GENERATOR
REACTOR
W
FTV
HTV
RECIRCULATION
PUMP
D
RF
SUPPRESSION
POOL
ω
FW PUMP
FW TURBINE
CONDENSER
MOTOR-GENERATOR
SET
ω
FW PREHEATER
ACTUATOR
SENSOR
SETPOINT
MANUAL CONTROL

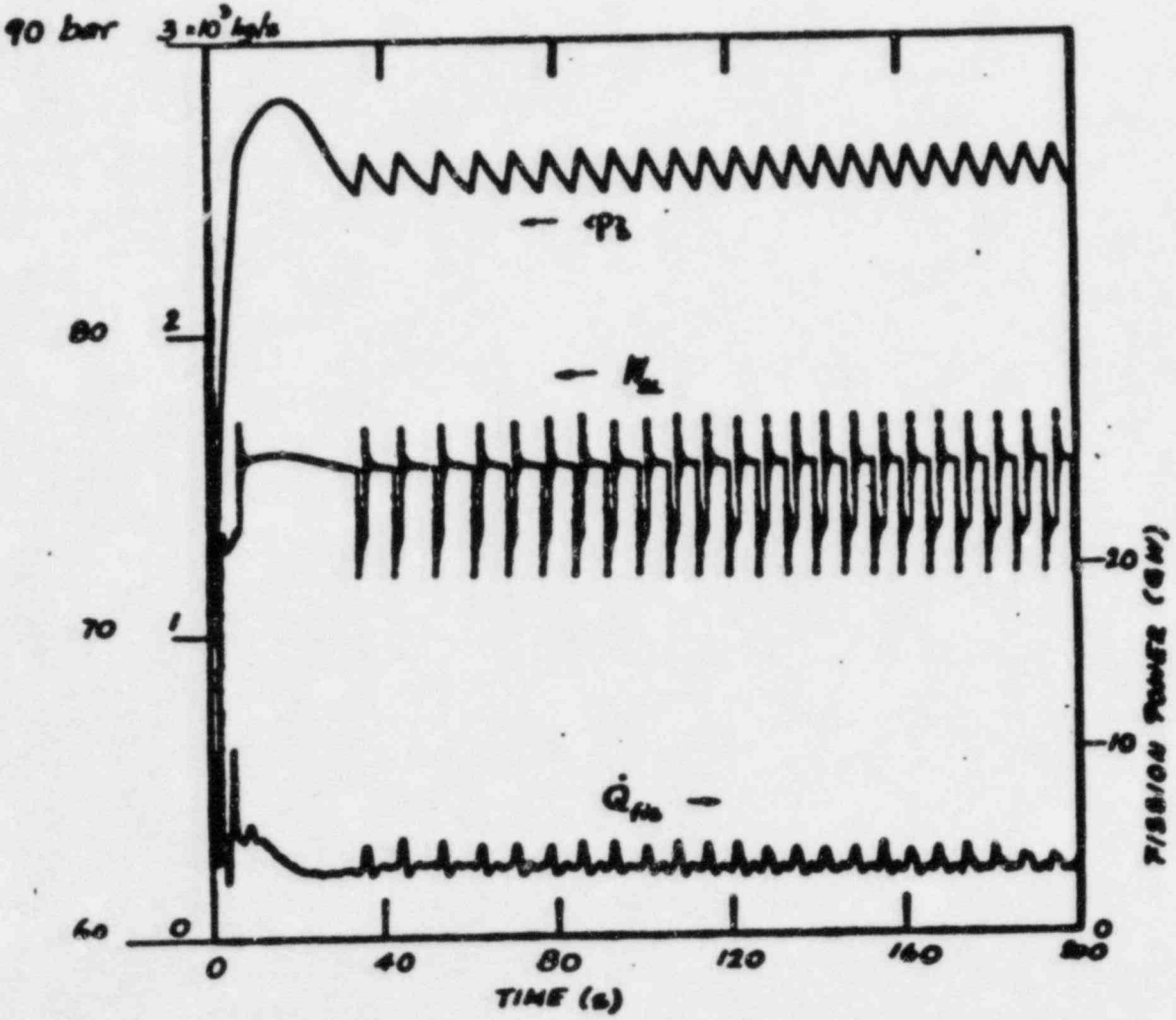
CONTROL PANEL

NON-REPRODUCABLE SLIDE

EVALUATION OF SIMULATION SPEED

- SELECTED TRANSIENT
  - TURBINE TRIP FROM FULL POWER
    - WITH SCRAM
    - WITHOUT SRV AND BYPASS
    - RCP NOT TRIPPED
- COMPUTATIONAL SCOPE: VESSEL HYDRAULICS
  - AD10 - 55 COMPUTATIONAL CELLS (HIPA-MPS10)
  - CDC-7600 - 43 COMPUTATIONAL CELLS (RAMONA-FORTRAN)
- RESULTS
  - AD10 WAS 110 TIMES FASTER THAN CDC-7600
  - AD10 WAS 10 TIMES FASTER THAN REAL-TIME

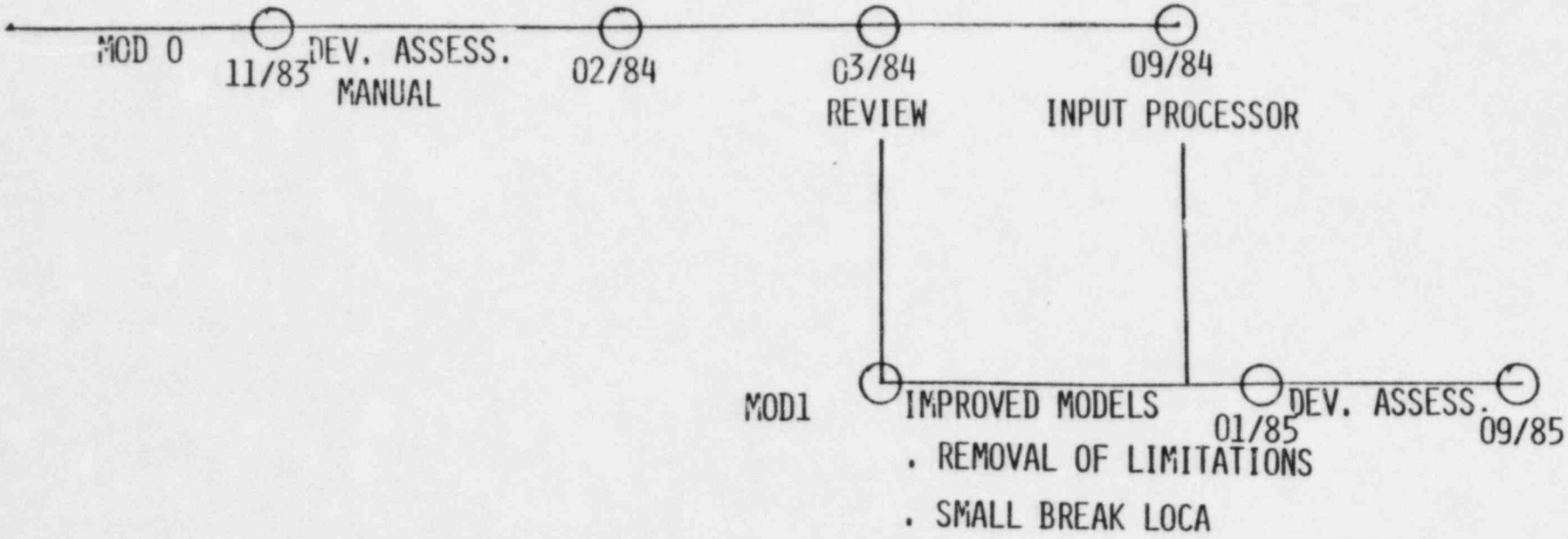
ATWS


90 bar
3·10³ kg/s
80
2
70
1
60
0
— p_2
— $\dot{M}_{in}$
$\dot{Q}_{fis}$ —
20
10
0
FISSION POWER (GW)
0
40
80
120
160
200
TIME (s)

WHERE DOES THE SPEED OF HIPA-PB2 COME FROM

SOURCE	FACTOR
. COMPUTER ARCHITECTURE	25 TO 30
. HIGH LEVEL SIMULATION LANGUAGE AND PROGRAMMING	2
. FAST TABLE LOOKUP AND INTERPOLATION OF PRECOMPUTED PROPERTIES	2

FUTURE PLANS



2D/3D PROGRAM STATUS

BY

GENE S. RHEE

PRESENTED TO

ACRS

WASH., D.C.

NOV. 8, 1983

STATUS OF 2D/3D PROGRAM

I. TEST FACILITY STATUS

II. U. S. EFFORT

III. PRELIMINARY RESULTS

IV. DATA ANALYSIS PROCEDURE

V. EXPECTED RESULTS

STATUS OF 2D/3D PROGRAM

I. TEST FACILITY STATUS

JAERI

COMPLETED CCTF I AND SCTF I TESTING

CCTF II TESTS IN PROGRESS

SCTF II CONSTRUCTION TO BE COMPLETED BY 3/84

SCTF III UNDER DESIGN

FRG BMFT/GRS/KWU

UPTF CONSTRUCTION TO BE COMPLETED BY 4/85

II. U. S. EFFORT

1. INSTRUMENTATION

- Provided Advanced Two-Phase Flow Instruments To CCTF I & II and SCTF I & II.
- Will Provide Instruments To UPTF And SCTF III.
- Tie Plate Design Change By FRG Resulted;
  - Redesign of Core/Up Interface Instruments (DB, BTD, DP)
  - FRG Taking Over Responsibility Of Developing Algorithm For Calculating Mass Flow Across Core/UP Interface
  - FRG To Complete Inst. Calibration Testing
  - Reduction of U. S. Instruments For UPTF (18 x 7 FDG, 6 Turbines, 6 BTD's)

2. TRAC ANALYSES

- Completed TRAC Calc For CCTF I.
- Performing Post-Test Predictions For SCTF I and CCTF II
- Performing TRAC Calc For UPTF Design And Operation Assistance
- Completed B.E. Calc For GPWR HL Break And US/J PWR CL Break
- Improved TRAC Modeling:
  Condensation, Deentrainment, Droplet, Cross Flow, Etc.
- Tie Plate Design Change By FRG Resulted;
  - FRG To Perform 2 GPWR And 1 BBR/B&W TRAC Calc
  - FRG Resident Engr At LANL For 1/2 Yr.

III. PRELIMINARY RESULTS

1. EFFECTIVE CORE COOLING BY TWO-PHASE FLOW IN SPITE OF SOME STEAM BINDING AND CORE NOT FULLY COVERED WITH LIQUID

2. EFFECT OF 60% FLOW BLOCKAGE NOT SIGNIFICANT

3. NON-UNIFORM RADIAL POWER DISTRIBUTION EFFECTIVELY MITIGATED BY CROSS FLOW BETWEEN BUNDLES

4. PWR B.E. TRAC CALC SHOWS A WIDE MARGIN OF CONSERVATISM IN LICENSING ASSUMPTIONS

   (E.G. MAX PCT: 800 VS 1477 ^{O}K, CORE QUENCH WITHIN 70 SEC)

IV. DATA ANALYSIS PROCEDURE

1. TEST FACILITY PERFORMS;
   QUALIFY RAW DATA

   TRANSMIT BC's AND IC's TO LANL FOR TRAC CALC

   REDUCE RAW DATA TO ENG UNITS

   TRANSMIT DATA TAPE TO LANL FOR COMPARISON WITH TRAC

   ISSUE QUICK-LOOK REPORTS

   ISSUE DATA REPORTS

   ISSUE EVALUATION REPORTS

2. LANL PERFORMS TRAC POST-TEST PREDICTIONS AND COMPARE CALC RESULTS WITH TEST RESULTS

3. NRC/LANL/MPR ANALYZE DATA FOR EACH TEST SERIES AND DRAW CONCLUSIONS,

V. EXPECTED RESULTS

	TOPICS	DATE
1.	FLOW BLOCKAGE EFFECT	1984
2.	2 DIMENSIONAL (RADIAL & AXIAL) FLOW EFFECT	1984
3.	ASSESSMENT OF TRAC IN 2 DIMENSIONAL FLOW CALC	1985
4.	EFFECTIVENESS OF ALTERNATE ECCS (CDC, LP, VENT VALVE, COMBINED HL&CL)	1986
5.	ECC BYPASS	1987
6.	3 DIMENSIONAL FLOW EFFECT	1988
7.	ASSESSMENT OF TRAC IN 3 DIMENSIONAL FLOW CALC	1988
8.	DEENTRAINMENT OF LIQUID IN UP	1988
9.	STEAM BINDING EFFECT	1988
10.	CCFL IN HL DURING SMALL BREAK LOCA	1988
11.	ASSESSMENT OF SMALL SCALE DATA AS COMPARED WITH LARGE SCALE DATA .	1988

ATTACHMENT

AI. OBJECTIVES OF TEST SERIES

CCTF	I	REFLOOD SYSTEM EFFECT
	II	REFILL
		ALTERNATE ECC (UP, DC, HL & CL, LP, VENT VALVE)
SCTF	I	FLOW BLOCKAGE
	II	2 DIMENSIONAL FLOW(GRAVITY & FORCED FEED)
	III	COUPLING WITH UPTF
UPTF		DEENTRAINMENT IN UP,
		ECC BYPASS
		CCFL IN HL

A II. TEST FACILITY STATUS

1. CCTF CORE I

- Testing Completed (total 20 tests conducted)
- All JAERI Data Reports Completed
- Data Being Analyzed By RES, MPR, LANL
- Data Analysis To Be Completed In 1984
- RIL To Be Issued In 1984

2. CCTF CORE II

- 20 Tests Conducted Including 2 UPI And 2 Refill Tests
- 9 More Tests Planned Including 2 UPI And 2 Refill Tests
- 6 JAERI Data Reports Issued
- Data Being Analyzed By JAERI, RES, MPR, LANL

3. SCTF CORE I

- Testing Completed (Total 24 Tests Conducted)
- All JAERI Quick Look Reports Issued
- JAERI Data Reports Being Issued
- Data Analysis To Be Completed In 1984

4. SCTF CORE II

- Test Facility Under Construction, To Be Completed By Jan 1984
- U. S. Instruments Installed And Checked Out
- Acceptance Tests To Start In Jan 1984
- Shakedown Tests To Start In March 1984

5. SCTF CORE III

- Core Fabrication Contract Under Negotiation
- UP Internals Design In Progress
- Procedure For Coupling With UPTF Under Discussion
- U. S. Instruments Under Fabrication

6. UPTF

- Construction Underway.
  3 1/2 Mo Delay Projected.
- Construction To Be Completed By
  4/15/1985
- 2-Yr. Testing Program To Start In Oct. 1985.
- Procedure For Coupling With SCTF III Under Discussion
- UP/Core Interface Instrument Calibration Testing
  Being Pursued.
- Core Simulator Testing Being Pursued.
- U. S. Instruments Under Fabrication.

Tape 10

MIST INSTRUMENTATION

BASIS FOR MIST INSTRUMENTATION

- GERDA INSTRUMENTATION
- GERDA EXPERIENCE
- TAG RECOMMENDATIONS
- PRIORITIZED INSTRUMENTATION
- REVIEW GROUP INPUT

METHOD FOR JUSTIFICATION & PRIORITIZATION

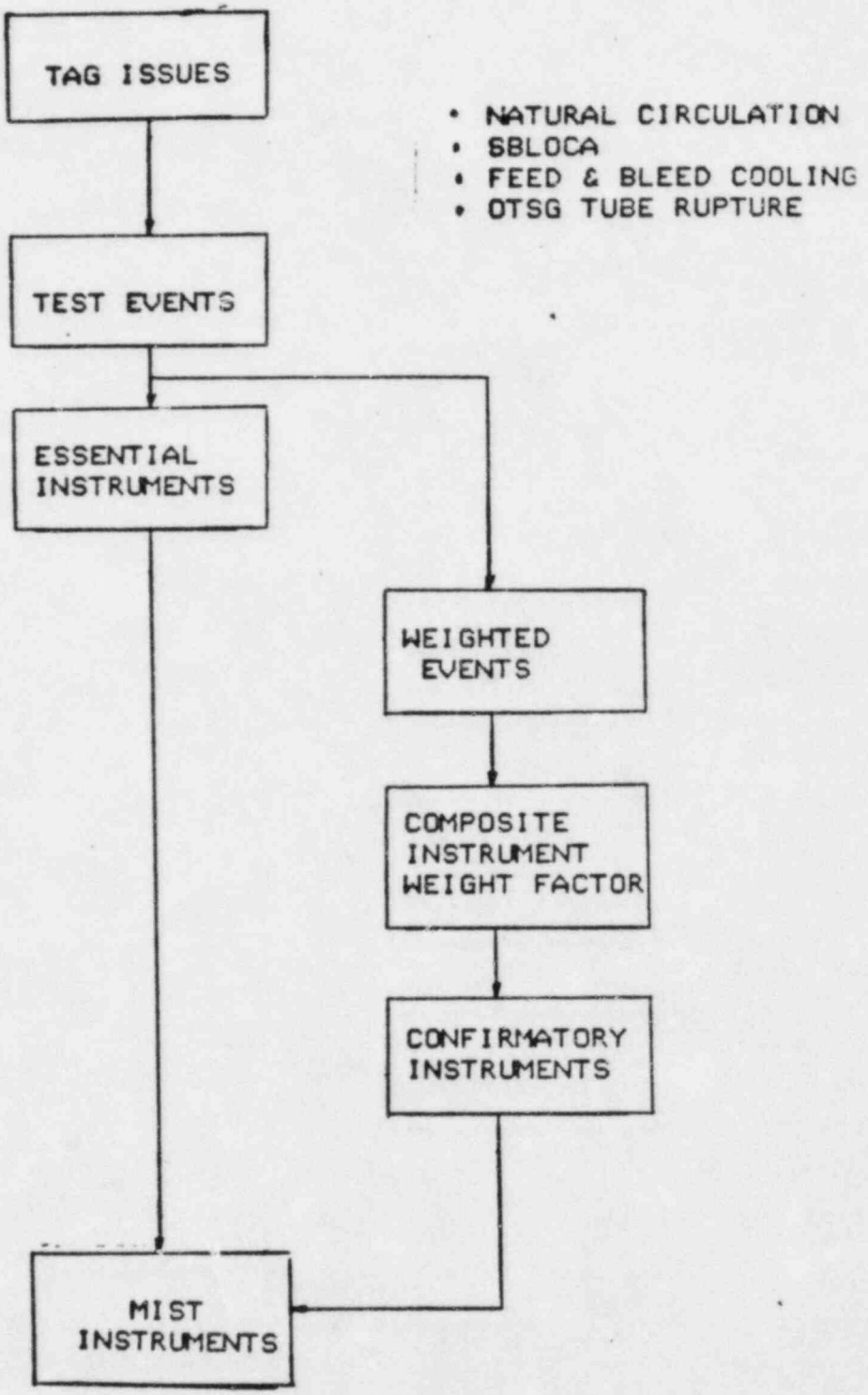


Table 6.4

RANKING OF SBLOCA TEST EVENTS

Rank	Test Event	Weight Factor
1	Hot Leg U-bend Saturation and Voiding	8
2	Reactor Vessel Vent Valve Actuation	8
3	Leak-HPI Cooling	8
4	Re-Initiate Natural Circulation	7
5	Steam Generator Condensation of Primary Steam	7
6	Downcomer and Cold Leg Voiding and Condensation	7
7	Leak Flow	7
8	Reactor Vessel Upper Head Voiding	7
9	Decoupling of Steam Generator	7
10	Spillover Circulation	6
11	Primary Repressurization	6
12	Venting of Primary Fluid	6
13	Feed and Bleed Primary Cooldown	5
14	Controlled Steam Generator Depressurization and Primary Cooldown	5
15	Compression of Primary Fluid	5
16	Asymmetric Cold Legs	5
17	Single-Phase Natural Circulation	4
18	Pump Bump	4
19	Cooling Idle Loop	4
20	Primary Depressurization	4
21	Power and Flow Transients	4
22	Primary Depressurization to Core Flood/LPI Pressures	3
23	Subcooling Primary	3
24	Steam Generator Repressurization	3
25	Pressurizer Draining	3

Table 6.5

MIST COMPONENT/LOCATIONS

1. Hot Leg "1" Upstream of Surge Line
2. Hot Leg "1" Downstream of Surge Line to Start of Hot Leg U-bend
3. Hot Leg "2" From Reactor Vessel Outlet to Start of Hot Leg U-bend
4. Hot Leg "1" and "2" - Hot Leg U-bend
5. Hot Leg "1" and "2" Downstream of Hot Leg U-bend to Steam Generator Inlet
6. Pressurizer Vessel
7. Pressurizer Surge Line
8. Pressurizer Spray Line
9. Steam Generator "1" - Primary (existing OTSG)
10. Steam Generator "2" - Primary
11. Cold Leg "1" - Broken Leg - From Steam Generator Outlet to Pump Suction
12. Cold Leg "1" - Broken Leg - From Pump Discharge to Downcomer
13. Cold Legs "2", "3", and "4" - Intact Legs - From Steam Generator Outlet to Pump Suction
14. Cold Legs "2", "3", and "4" - Intact Legs - From Pump Discharge to Downcomer
15. Reactor Coolant Pump
16. Upper Downcomer - mixing Chamber
17. Lower Downcomer to Lower Plenum Inlet
18. Reactor Vessel Vent Valve Lines
19. Lower Plenum
20. Core Region
21. Upper Plenum
22. Top Plenum
23. Steam Generator "1" - Secondary (existing OTSG)
24. Steam Generator "2" - Secondary
25. Feedwater Piping From Secondary Forced Circulation Pump to Steam Generator Inlet
26. Steam Piping From Steam Generator Outlet to Steam Condenser
27. High Pressure Injection System From Pump to Loop
28. Low Pressure Injection System From Pump to Loop
29. Core Flood Tank - Vessel and Connection to Loop
30. Single-Phase Leak System From Leak Sites to Final Collection Tank
31. Two-Phase Leak System From Leak Sites to Final Collection Tank
32. Gas Addition System
33. Gas Sampling System

MIST INSTRUMENTATION

INSTRUMENT	GERDA SCALED 2X4 LOOP	GERDA+ EXP.+ TAG	PRIORITIZED INSTRUMENTS ESS	CONF	TOTAL
FLUID TC	199	295	318	55	373
			229	104	333
METAL TC	18	110	50	61	111
			30	67	97
DIFF. TC	10	39	40	--	40
			40	--	40
RTD	15	17	14	--	14
			18	--	18
DP CELL (LEVEL)	34	76	75	--	75
			56	8	64
DP CELL (FLOW)	26	36	52	--	52
			36	--	36
PRESSURE	15	15	13	--	13
			17	--	17
CONDUCTIVTY PROBE	58	58	18	--	18
			21	16	37
OTHERS	32	43	40	8	48
			41	14	55
TOTAL	407	689	620	124	744
			488	209	697

REVIEW GROUP INPUT

INCORPORATED IN MIST

- DENSITY MEASUREMENTS
- THERMOCOUPLE RAKES
  - HOT LEGS
  - PRESSURIZER
  - COLD LEGS
- DISTRIBUTION OF METAL AND FLUID THERMOCOUPLE IN CORE

Table 6.16
MIST Instrumentation

Instrument	Downcomer	Reactor Vessel	Hot Leg	Cold Leg	Pressurizer	OTSG-Exist Primary	OTSG-New Primary	OTSG-Exist Secondary	OTSG-New Secondary	Steam	Feedwater	HPI	LPI	CFT	1-4 Venting	2-4 Venting	Gas Addition	Gas Sample	Miscellaneous	Total	% of Total
Fluid TC	13	16	37	66	10	28	48	26	50	4	4	1	1	1	3	11	4	6	8	337	46.8
Metal TC	3	22	6	12	2		20	6	5											77	11.1
Differential TC	3	4	8	12	2		6	5	5											39	5.6
DTD		1	2	4	1	2	2			2	2									16	2.3
Differential Pressure (Level)	2	8	28	14	1	2	2	3	14					1	6					83	12.0
Differential Pressure (Flow)	4			16						8	8									36	5.2
Turbine Meter												5	1							6	0.9
Accumulating Flowmeter															1	3				4	0.6
Conductivity Probes		4	20						12											36	5.2
Pitot Tubes						3	5													8	1.2
Stalled Flow	1			4																6	0.9
Absolute Pressure																1	1	6		8	1.2
Gage Pressure		1			1		1	1	1				1							7	1.0
Ammeter		1		4																5	0.7
Voltmeter		1																		1	0.1
Wattmeter				4																4	0.6
Tachometer				4																4	0.6
Weigh Tank															1	1				2	0.3
Gamma Densitometer																			10	10	1.4
Reference Voltage																			2	2	0.3
Totals	26	90	103	140	17	36	78	46	89	14	14	6	2	3	5	22	5	12	20	690	
% of Totals	3.8	8.4	14.9	20.3	2.5	5.2	11.3	6.8	12.9	2.0	2.0	0.9	0.3	0.4	0.7	3.2	0.7	1.7	2.9		

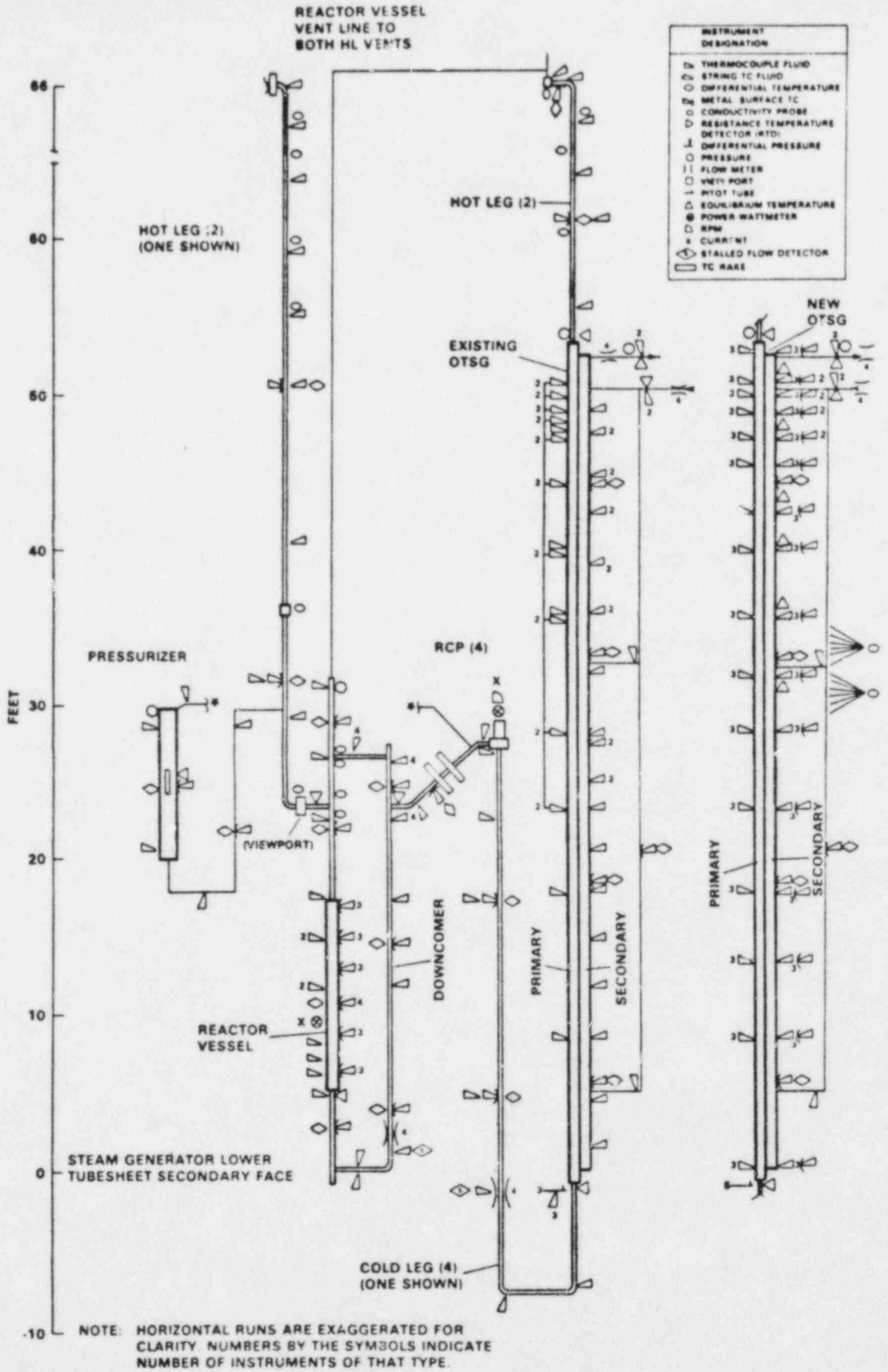


FIGURE 6.2 PRIMARY LOOP INSTRUMENTATION, LOCAL MEASUREMENTS

MIST DATA ACQUISITION SYSTEM

M I S T D A T A A C Q U I S I T I O N S Y S T E M

OBJECTIVE

- Provide operator support during instrument calibration and test set up.
- Acquisition of instrument outputs with storage to disk.
- Real-time test data display and instrument error checking.
- Post-test data analysis and data qualification.
- Data archival to magnetic tape.
- Data distribution to users outside of ARC.
- Data base rerun and maintenance.

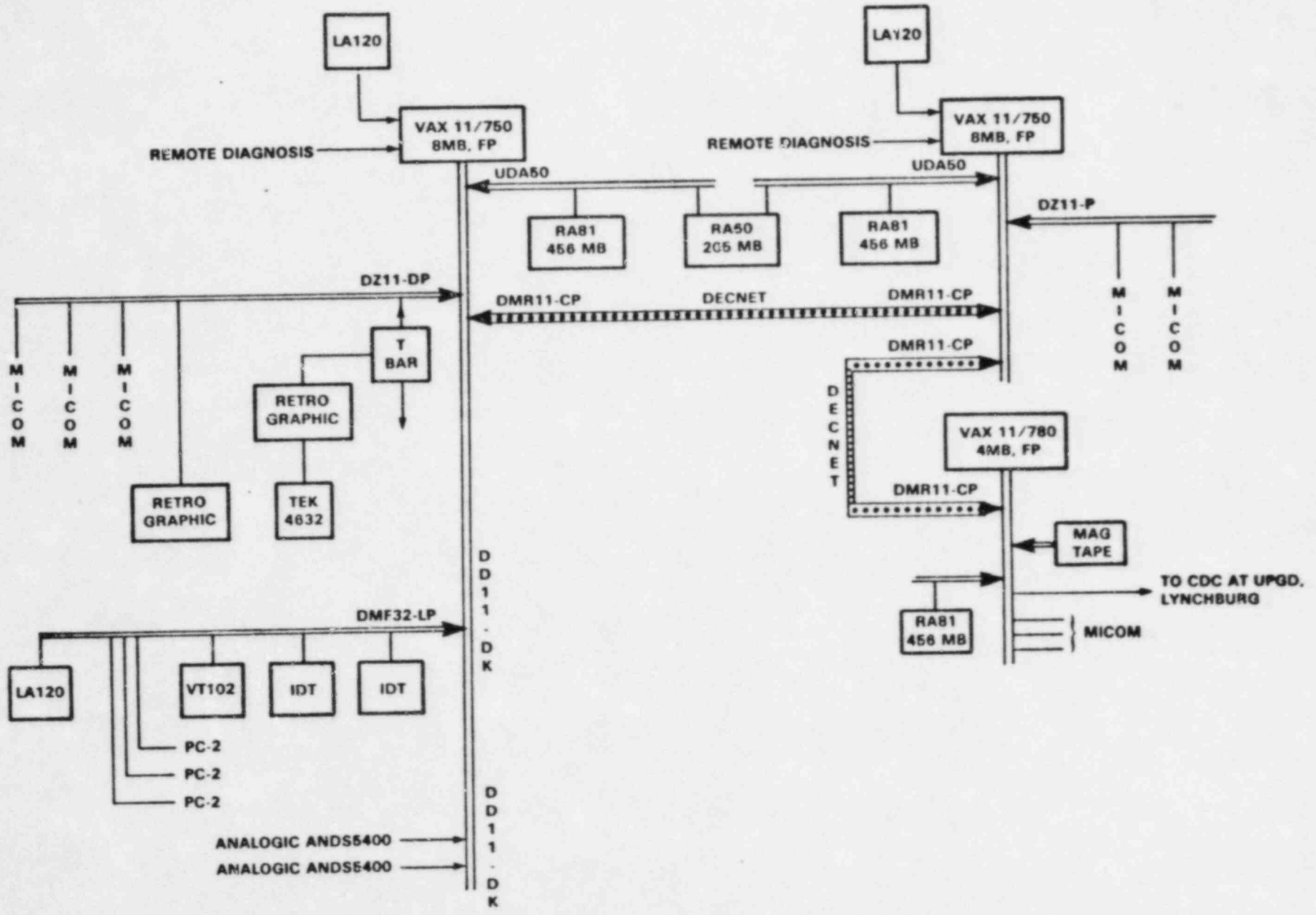


FIGURE 9.2 MIST DATA ACQUISITION SYSTEM

OTIS / MIST TEST MATRIX

TEST MATRIX FOR THE MIST PROJECT (PHASE III)

SUMMARY OF MIST COMPOSITE TESTS

Test Category	Test Series	Number of Tests
Mode Transition	1	6
SBLOCA	2	19
Tube Rupture	3	6
Feed and Bleed	4	4
Guard Heaters Off	-	1
Planned (Undefined)	-	5
		41

SBLOCA

- LEAK CONFIGURATION
- RC PUMP EFFECTS
- NCG & VENT EFFECT
- AFW EFFECT
- RVVV EFFECT

SBLOCA

. LEAK CONFIGURATION

. . DETERMINE THE EFFECT OF LEAK SIZE, LOCATION, AND ISOLATION (6 TESTS)

. . . LEAK SIZE (5, 10, 50 CM^2) LOCATED AT CL PUMP DISCHARGE (3 TESTS)

. . . BREAK LOCATION (2 TESTS), 10 CM^2 BREAK AT COLD LEG PUMP SUCTION AND AT PORV

. . . LEAK ISOLATION (1 TEST), 10 CM^2 BREAK AT CLD

SBLOCA (CONTINUED)

. RC PUMP EFFECTS

. . DETERMINE EFFECT OF RC PUMP STATUS ON SYSTEM RESPONSE DURING SBLOCA TRANSIENT (4 TESTS)

. . . RCP'S COASTDOWN COINCIDENT WITH LOCA INITIATION AND REMAIN TRIPPED DURING ENTIRE TRANSIENT

. . . SAME AS ABOVE EXCEPT RCPS ARE BUMPED WHEN NECESSARY TO PROMOTE FLOW AND NATURAL CIRCULATION

. . . RCP'S REMAIN OPERATING DURING TRANSIENT

. . . SBLOCA INITIATED WITH RCP'S OPERATING. RCP's TRIPPED WHEN MOST NEED - WHEN SYSTEM'S HIGHLY VOIDED.

SBLOCA (CONTINUED)

- NCG AND VENT EFFECT
  - CHARACTERIZED THE SYSTEM RESPONSE TO NCG AND STEAM VENTING OF PRIMARY SYSTEM (5 TESTS)
    - EFFECT OF VENT CONFIGURATION (4 TESTS) DIFFER VENT SETTINGS, USE THRESHOLD CONCENTRATIONS OF NCF
    - FIFTH TEST INCLUDES NO NCG AND WILL USE AN INDEPENDENT HP VALVE FOR VENT SETTING

SBLOCA (CONTINUED)

- AFW EFFECT
  - QUALIFY INFLUENCE OF AFW INJECTION ON SYSTEM PERFORMANCE (2 TESTS)
    - SG LEVEL CONTROLLED BY WITHIN ± 0.5 FT. BAND
    - SG LEVEL CONTROLLED BY ASYMMETRIC AFW FLOW

- RVVV EFFECTS
  - DETERMINE THE SENSITIVITY OF SYSTEM TO RVVV FLOW RESISTANCE DURING SBLOCA TRANSIENT
  - VARY RVV RESISTANCE (NOMINAL, 2X, AND VARIABLE PRESSURE DIFFERENCE)

FEED AND BLEED

- DETERMINE EFFECTIVENESS OF FEED AND BLEED MODE WITH NO LEAK AND NO AFW AVAILABLE THROUGHOUT THE TRANSIENT (4 TESTS).
  - RAMP DOWN CORE POWER, TRIP AND COAST DOWN RC PUMPS; INITIATE FULL INSTALLED HPI WHEN PORV OPENS (ABOUT 2375 PSIG). LEAVE PORV OPEN. HPI THROTTLING AND/OR PORV VENTING ARE USED TO COOLDOWN (TO 200 PSIA).
  - SIMILAR TO TEST 1 EXCEPT HPI FLOW BASED ON EVALUATION MODEL.
  - SAME AS TEST 1 EXCEPT HPI IS DELAYED 20 MINUTES AFTER THE EVENT STARTS.
  - SAME AS TEST 1 EXCEPT RC PUMPS ARE NOT TRIPPED AND WILL CONTINUE TO RUN DURING TRANSIENT.

OTSG TUBE RUPTURE

- DETERMINE EFFECT OF OTSG TUBE RUPTURE ON SYSTEM BEHAVIOR AND COOLDOWN (6 TESTS)
  - INITIATE LEAK (10 TUBES) AT TOP OF S.G. RAMP DOWN POWER; TRIP AND COAST DOWN RC PUMPS, ACTUATE FULL HPI; ISOLATE FEEDWATER TO AFFECTED SG. RAISE GOOD SG TO 95 PERCENT LEVEL.
  - SIMILAR TO TEST 1 EXCEPT LEAK AREA = 1 TUBE.
  - SAME AS TEST 1 EXCEPT RC PUMPS CONTINUE TO RUN.
  - SAME AS TEST 1 EXCEPT AFFECTED SG IS INITATIED WITH 95 PERCENT LEVEL (FULL) AND ISOLATED (NO FEEDWATER)
  - SIMILAR TO TEST 2 EXCEPT SIMULTANEOUS STEAM LINE BREAK IS ASSUMED.
  - SAME AS TEST 1 EXCEPT LEAK LOCATION OS AT BOTTOM OF SG.

MODE TRANSITION

- DETERMINE THE PRIMARY SYSTEM POST-LOCA RESPONSE TO THE TRANSITION AMONG COOLING TECHNIQUES (6 TESTS).
  - PRECEEDING TESTS HAVE EXPLORED VARIOUS MODES OF POST-LOCA COOLDOWN SUCH AS LEAK HPI COOLING, SG COOLING, AND HPI PORV COOLING. TESTS IN THIS CATEGORY INTEGRATE ALL THESE MODES OF COOLING.

SMALL BREAK LO[illegible] COOLANT ACCIDENT (SBLOCA)

	1	2	3	4	5	6	7	8	9
					Parameter				
Setting	Size cm^2	Location	ECCS	RCP	Isolation	RVVV	AFW	NCG	Vents
1	10	CLD	Best Estimate	Off	None	Nominal Resistance	Constant Level	None	None
2	50	CLS	Evaluation Model	Bump	At Stalled Flow	2X Resistance	Band	Threshold	Hot Leg U-Bend - HPV (HP)
3	5	PORV		Long Run		P Variation	Asymetric		Upper Head Reactor Vessel Vent (UH)
4				Worst Stop					HP and UH
5									Independent HP
Test									
Leak Size									
Location									
Isolation									
Effects									
1	1	1	2	1	1	1	1	1	1
2	2	1	2	1	1	1	1	1	1
3	3	1	2	1	1	1	1	1	1
4	1*	2	1	1	1	1	1	1	1
5	1*	3	1	1	1	1	1	1	1
6	1*	1	1	1	2	1	1	1	1
RCP Effects									
7	1*	1	1	1	1	1	1	1	1
8	1*	1	1	3	1	1	1	1	1
9	1*	1	1	4	1	1	1	1	1
10	1*	1	1	2	1	1	1	1	1
NCG And Vent Effects									
11	1*	1	1	1	1	1	1	2	1
12	1*	1	1	1	1	1	1	2	2
13	1*	1	1	1	1	1	1	2	3
14	1*	1	1	1	1	1	1	2	4
15	1*	1	1	1	1	1	1	1	5
AFW Effects									
16	1*	1	1	1	1	1	3	1	1
17	1*	1	1	1	1	1	2	1	1
RVVV Effects									
18	1*	1	1	1	1	2	1	1	1
19	1*	1	1	1	1	3	1	1	1

FEED AND BLEED TESTS

Parameters

Setting	1 ECCS	2 Delay	3 Reactor Coolant Pump
1	Best Estimate	PORV Lift	Off
2	Evaluation Model	20 Minutes	On
Test			
1	1	1	1
2	2	1	1
3	1	2	1
4	1	1	2

Delay to start of HPI.

STEAM GENERATOR TUBE RUPTURE TESTS

Parameters

Setting	1 Number of Tubes	2 Reactor Coolant Pumps	3 Level	4 Steam Line Break	5 Location
1	10	Off	Nominal	None	Top
2	1	On	Full, Isolated, Steam Generator	Main Steam Line	Bottom
Test					
1	1	1	1	1	1
2	2	1	1	1	1
3	1	2	1	1	1
4	1	1	2	1	1
5	2	1	1	2	1
6	1	1	1	1	2

In an affected steam generator.

MODE TRANSITION TESTS

Parameters

Settings	1 Power	2 Steam Generator Level	3 ECCS	4 Vents
1	Nominal	Balanced	Best Estimate	None
2	High	Unbalanced	Evaluation Model	Hot Leg U-Bend HPV
3		Balance Level		
Test				
1	1	1	1	1
2	2	1	1	1
3	1	2	1	1
4	1	1	2	1
5	1	1	1	2
6	1	3	1	1

Use ANS power ramp

ANS X 1.2

Steam generator levels are fed up at a prescribed rate.

Best estimate equals design capacity.

A $10cm^2$ ($0.01ft^2$) cold leg discharge leak will be used.

TAG ISSUES

NATURAL CIRCULATION	MIST TESTS
SINGLE-PHASE NATURAL CIRCULATION	1,2,3
TWO-PHASE NATURAL CIRCULATION	1,2,3
BOILER CONDENSER NATURAL CIRCULATION	1,2
STEAM GENERATOR-DRIVEN INSTABILITIES	1,3
COLD LEG OSCILLATIONS	1,2
INTERRUPTION/RE-ESTABLISHMENT	1,2,3
HIGH POINT VENTS	1,2
NON-CONDENSIBLE GASES	2
REACTOR VESSEL VENT VALVES	1,2,3,4

SMALL BREAK LOSS-OF-COOLANT ACCIDENT	
BREAK SIZE	2
EMERGENCY CORE COOLING SYSTEM OPERATION	1,2
REACTOR COOLANT PUMP OPERATION	2,3
LOCATION OF BREAK	2,3
BREAK ISOLATION	2
REACTOR VESSEL VENT VALVES	1,2,3,4

FEED AND BLEED	4
STEAM GENERATOR TUBE RUPTURE	3

OTIS TEST MATRIX

- CONSISTS OF 7 TEST SERIES AND 13 TESTS
- BENCHMARK TEST (TEST 1)
- CHARACTERIZATION OF REACTOR VESSEL HPV (TEST 2)
- LEAK CONFIGURATION AND LOCATION (TEST 3)
    - 2 BREAK SIZES
    - 1 ISOLATED BREAK
    - 3 LOCATIONS
    - TOTAL OF 5 TESTS
- SECONDARY CHARACTERISTICS (TEST 4)
    - EXAMINE EFFECT OF SG LEVEL AND LEVEL CONTROL
    - 2 TESTS
- HIGH PRESSURE INJECTION CAPACITY (TEST 5)
- HIGH PRESSURE INJECTION COOLDOWN (TEST 6)
- COMPOSITE TEST (TEST 7)
    - 2 TESTS

LEAK CONFIGURATION AND LOCATION MATRIX

VARIABLES:	1. LEAK SIZE ($CM^2 = 10^{-3} FT^2$)	2. LEAK ISOLATION	3. BREAK LOCATION
SETTINGS:			
1	15	NO ISOLATION	CLS
2	10	ISOLATION UPON PRIMARY FLOW STAGNATION	CLD
3			PZR
TESTPOINTS:			
1	1	1	1
2	2	1	1
3	1	2	1
4	1	1	2
5	1	1	3

SECONDARY CHARACTERISTICS MATRIX

VARIABLES:	1. SG LEVEL AFTER TRIP	2. SG LEVEL CONTROL
SETTINGS:		
1	25 FT (NO RATE LIMIT)	CONSTANT LEVEL
2	36 FT (@3 FT/MIN)	BAND CONTROL (± 1/2 FT)
TESTPOINTS:		
1	2	1
2	1	2

TAG ISSUES

NATURAL CIRCULATION	OTIS TESTS
SINGLE-PHASE NATURAL CIRCULATION	2, 3, 4, 5, 7
TWO-PHASE NATURAL CIRCULATION	2, 3, 4, 5, 7
BOILER CONDENSER NATURAL CIRCULATION	1, 2, 3, 4, 5, 7
STEAM GENERATOR-DRIVEN INSTABILITIES	--
COLD LEG OSCILLATIONS	1, 2, 3, 4, 5, 6, 7 (LIMITED)
INTERRUPTION/RE-ESTABLISHMENT	2, 3, 4, 5, 7
HIGH POINT VENTS	2, 3, 4, 5, 7
NON-CONDENSIBLE GASES	--
REACTOR VESSEL VENT VALVES	1, 2, 3, 4, 5, 6, 7

SMALL BREAK LOSS-OF-COOLANT ACCIDENT	
BREAK SIZE	3
EMERGENCY CORE COOLING SYSTEM OPERATION	ONLY HPI (TESTS 2-7
REACTOR COOLANT PUMP OPERATION	--
LOCATION OF BREAK	3
BREAK ISOLATION	3, 7
REACTOR VESSEL VENT VALVES	1, 2, 3, 4, 5, 6, 7

FEED AND BLEED	6, 7
STEAM GENERATOR TUBE RUPTURE	--

CONCLUSION

-TEST MATRICIES HAVE BEEN DEVELOPED WHICH:

-ADDRESSES ALL THE TAG ISSUES
-PROVIDES TIMELY INPUT TO THE FACILITY DESIGN

REVIEW GROUP COMMENTS ON DAS

- ALTERNATE HARDWARE CONFIGURATIONS
- REVIEW OF 2D/3D DAS
- SOFTWARE PACKAGES

8.6.2 Subtask 5.2 - Characterization Tests

Twenty-eight (28) characterization tests shall be performed. These tests shall include both equipment and component characterization and separate effect tests as proposed below.

TEST	NUMBER OF TESTS
• Component Volumes (as a function of elevation)	1
• Heat Loss (by component with guard heaters on)	5
• Primary Loop Leakage (with non-condensable gas at ambient temperatures and 1000 psia and water at 500°F and 2200 psia)	2
• Primary Loop Irrecoverable Pressure Loss	2
• Primary Loop Thermocouple Calibrations	5
• Valve Cycle Response Time (for leak isolation, vent, RVVV, valves)	1
• RVVV Line Loss Coefficient Characterization	4
• Steam Generator Heat Transfer Characterization	4
• Natural Circulation	2
• Boiler Condenser Mode	1
• Non-condensable Gas Threshold Test	1

Tape 21

SUPPORTING PROGRAMS

- ANALYSIS SUPPORT
  - LANL (TRAC-PF1/MOD1)
    - DOWNCOMER/RVVV DESIGN ANALYSIS
    - OTIS SCOPING STUDIES AND POST-TEST
    - MIST/PLANT COMPARISON
    - MIST/U OF MD ANALYSIS
    - GERDA DATA REVIEW
  - INEL
    - ADVANCED INSTRUMENTATION
    - ACQUISITION
    - ONSITE REPRESENTATIVE
    - OTIS/MIST/PLANT ANALYSIS (RELAP5/MOD2)
  - ANL
    - GERDA DATA REVIEW/SCALING IMPLICATIONS ON PHENOMENA
    - U OF MD DATA REVIEW/SCALING IMPLICATIONS

SUPPORTING PROGRAMS (CONTINUED)

- EXPERIMENTAL SUPPORT
  - U OF MD
    - 2 X 4 LOOP, ANNULAR DOWNCOMER (4 RVVV'S), "SHORT, BUT FAT," 300 PSI
    - SEPARATE EFFECTS HOT LEG CANDY CANE RIG, PHASE SEPARATION, FLOW INTERRUPTION
  - SRI-2
    - 2 X 4 LOOP, ANNULAR DOWNCOMER, SHORT, BUT FAT," 100 PSI

IST PROGRAM WORKSCOPE AND SCHEDULE

3 PHASES :

I. OTIS TESTING

.. Design Requirements, Test Specifications, etc.	11/30/83
.. Facility Modifications	1/31/84
.. Testing	Feb & March, 1984
.. Data Analysis & Report	10/31/84
II. MIST FACILITY SPECIFICATION REPORT	11/30/83
III. MIST TESTING	
.. Facility Construction	8/31/85
.. Testing (Debug, Characterization, Composite)	1 YR; Sept, 1986
.. Data Analysis & Reporting	March, 1987

WHY MIST?

THREE MAJOR DIFFERENCES BETWEEN
B AND W PWR AND OTHER VENDORS DESIGN

1. STEAM GENERATOR DESIGN
2. HOT LEG PIPING
3. REACTOR VESSEL VENT VALVES

NEED INTEGRAL SYSTEM DATA TO
BENCHMARK COMPUTER PROGRAMS

FULL ELEVATION SCALING HAS BEEN ADOPTED FOR TWO MAJOR REASONS:

1. MAJOR POST SBLOCA PHENOMENA ARE ELEVATION DEPENDENT.

   A) THERMAL CENTER IN OTSG AND THUS NATURAL CIRCULATION FLOW RATES DEPENDS ON:

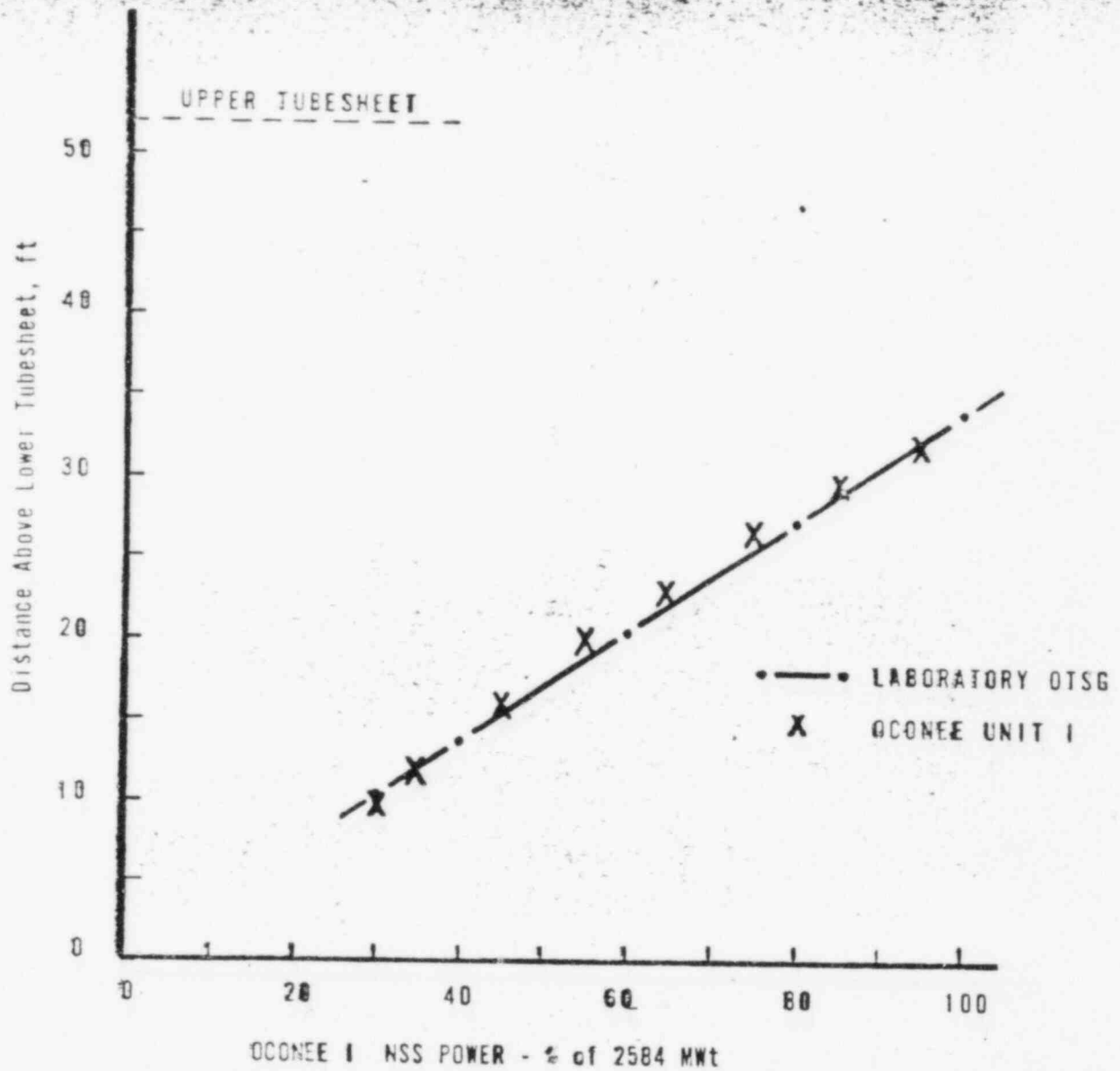
      1. AUX FEED SPRAY HEAT TRANSFER
      2. SECONDARY SIDE BOILING
      3. SENSIBLE HEAT TRANSFER IN SG SECONDARY LIQUID POOL

   B) LENGTH OF PERIOD OF NATURAL CIRCULATION AND ESTABLISHMENT OF BOILER CONDENSER MODE OF ENERGY REMOVAL.

2. FULL LENGTH MODELS AND MODEL DESIGNS EXIST.

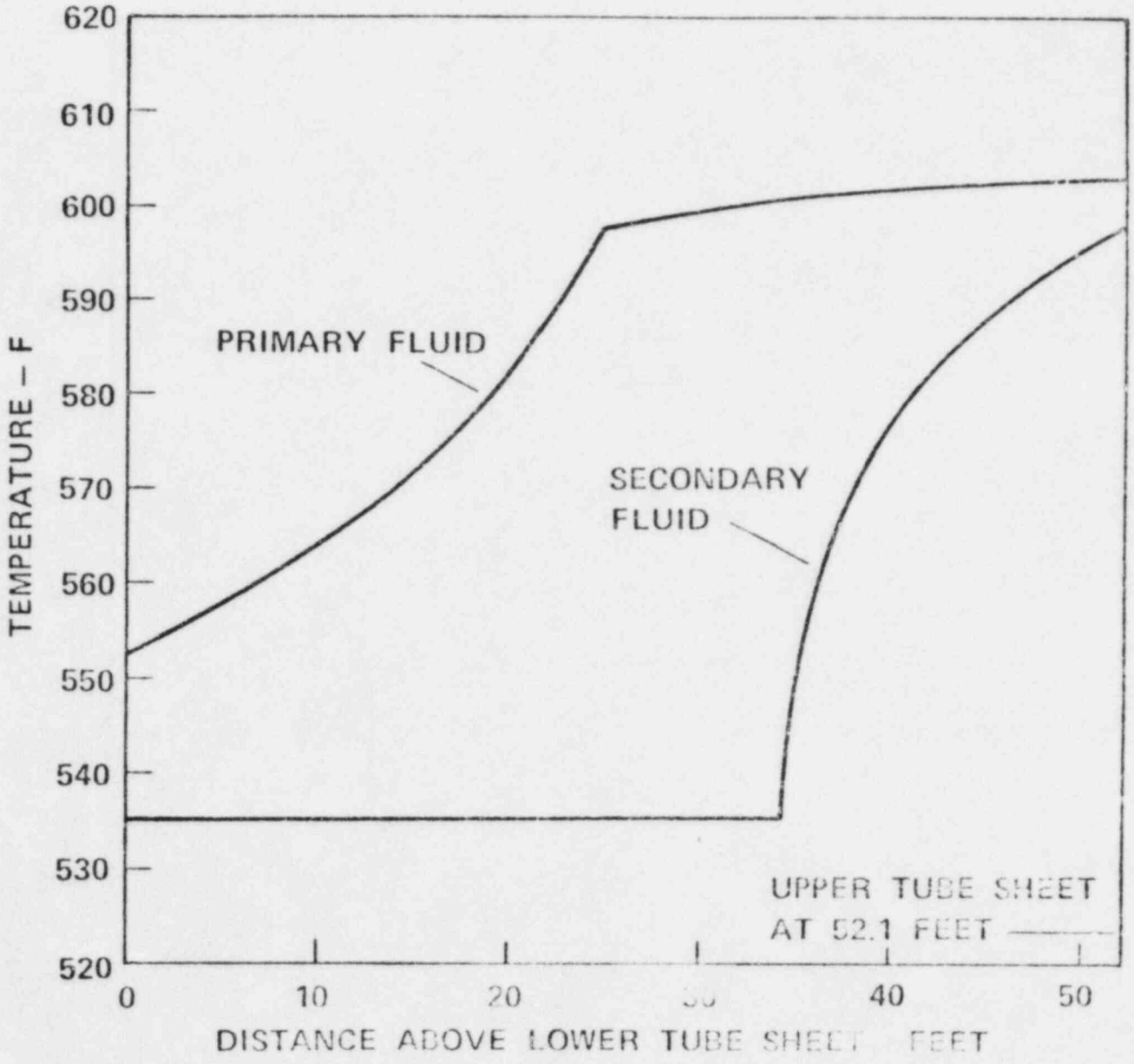
   A) FULL LENGTH MODELS EXTENSIVELY CHARACTERIZED OVER 15 YEARS OF B&W R&D. THIS PROVIDES VALUABLE INPUT TO CODE MODELERS WHICH WOULD BE ABSENT IN REDUCED SCALE MODELS.

   B) CHAPACTERIZED MODELS HAVE BEEN COMPARED TO FULL SCALE PERFORMANCE.



LENGTH REQUIRED TO PRODUCE DRY STEAM

AXIAL TEMPERATURE DISTRIBUTION AT 100% LOAD



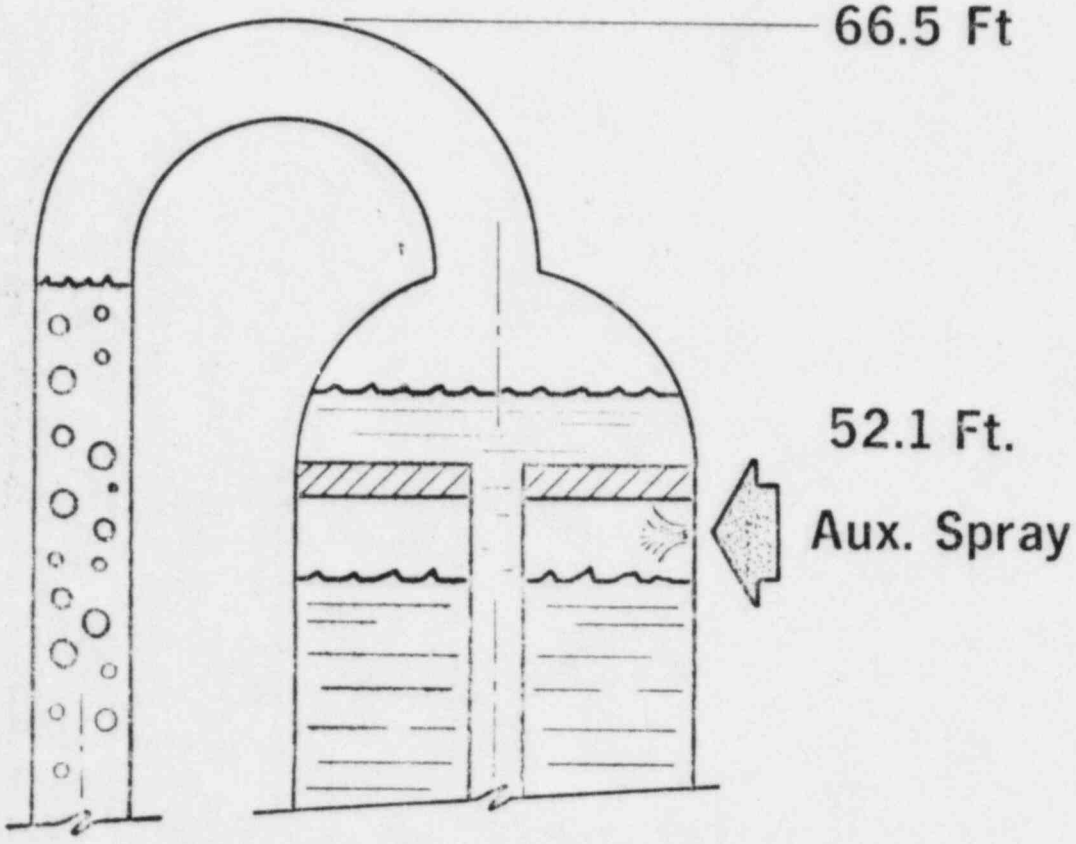
FULL LENGTH STEAM GENERATOR

- PRESERVES ALL HEAT TRANSFER PROCESSES
  - FORCED CONVECTION
  - NATURAL CONVECTION
  - PRIMARY SIDE
  - SECONDARY SIDE

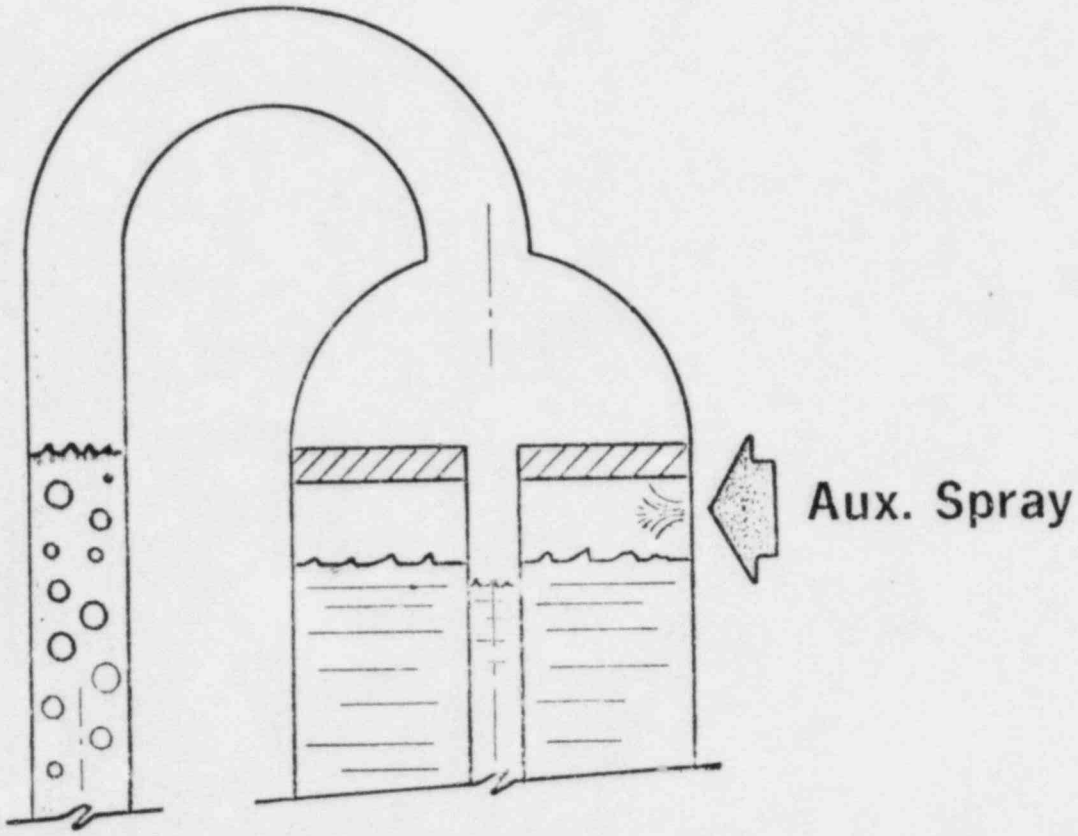
REDUCED LENGTH STEAM GENERATOR

- IMPOSSIBLE TO SCALE BOTH FORCED CONVECTION AND NATURAL CONVECTION WITH ONE DESIGN
- SECONDARY SIDE HEAT TRANSFER NOT SCALED
  - IN OTSG DESIGN THE SECONDARY SIDE HAS A LARGE INFLUENCE ON THE OVERALL HEAT TRANSFER COEFFICIENT.

Interupted Natural Circulation



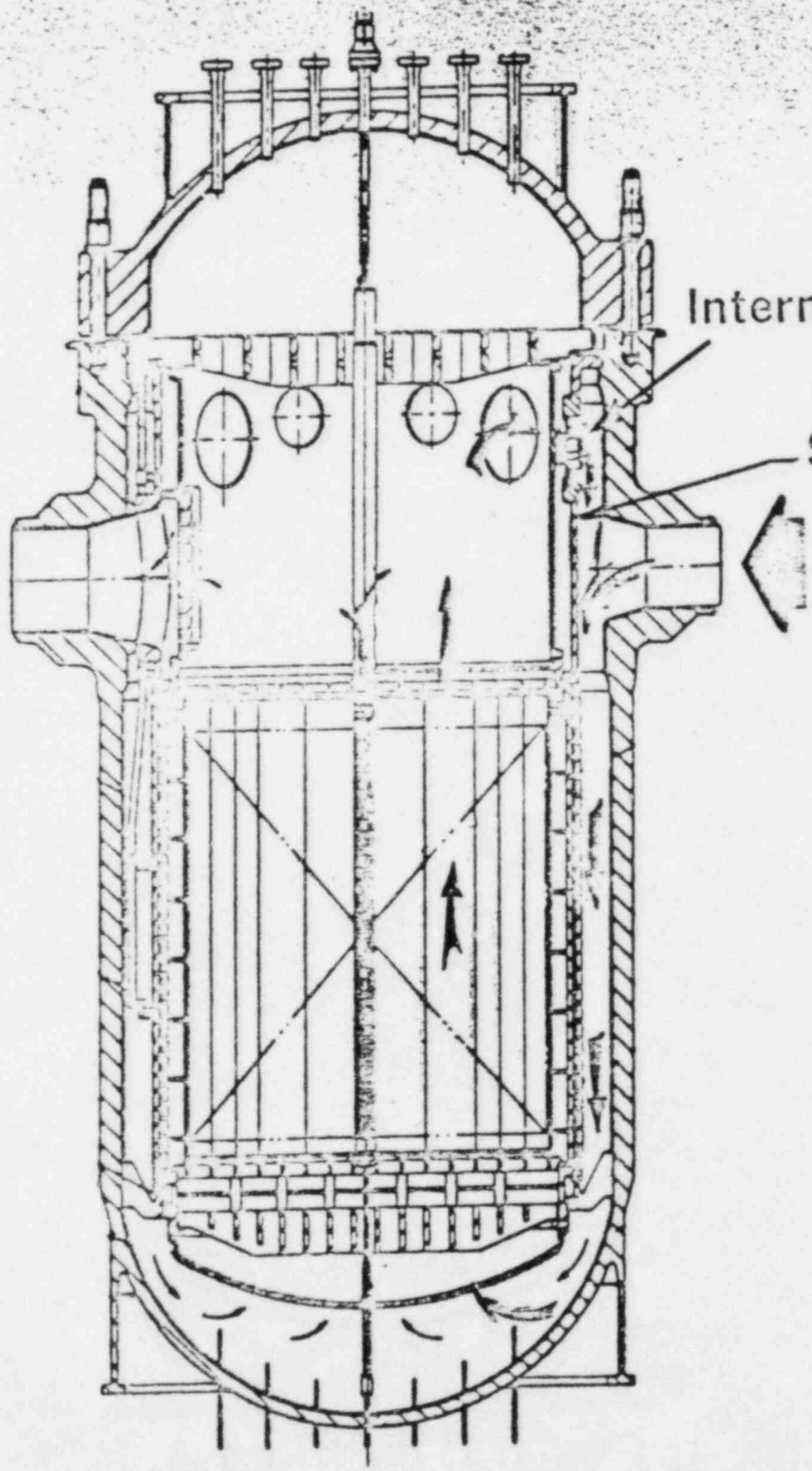
Boiler Condense Mode



VENT VALVE CONCERN

- LOCA ANALYSIS PROGRAMS (CRAFT, RELAP4, RELAP5, TRAC) ALL SHOW ENHANCED CORE COOLING DUE TO INTERNAL CIRCULATION PATH PROVIDED BY VENT VALVES.
- NRC WANTS THESE PREDICTIONS VERIFIED.
- CONCERNS ON VENT VALVE MECHANICAL OPERATION, AND FLOW BEHAVIOR HAVE BEEN ADDRESSED IN OTHER SEPARATE EFFECTS TESTING.

Internal Flow Path For Core Cooling Resulting From Open Reactor Vessel Vent Valve



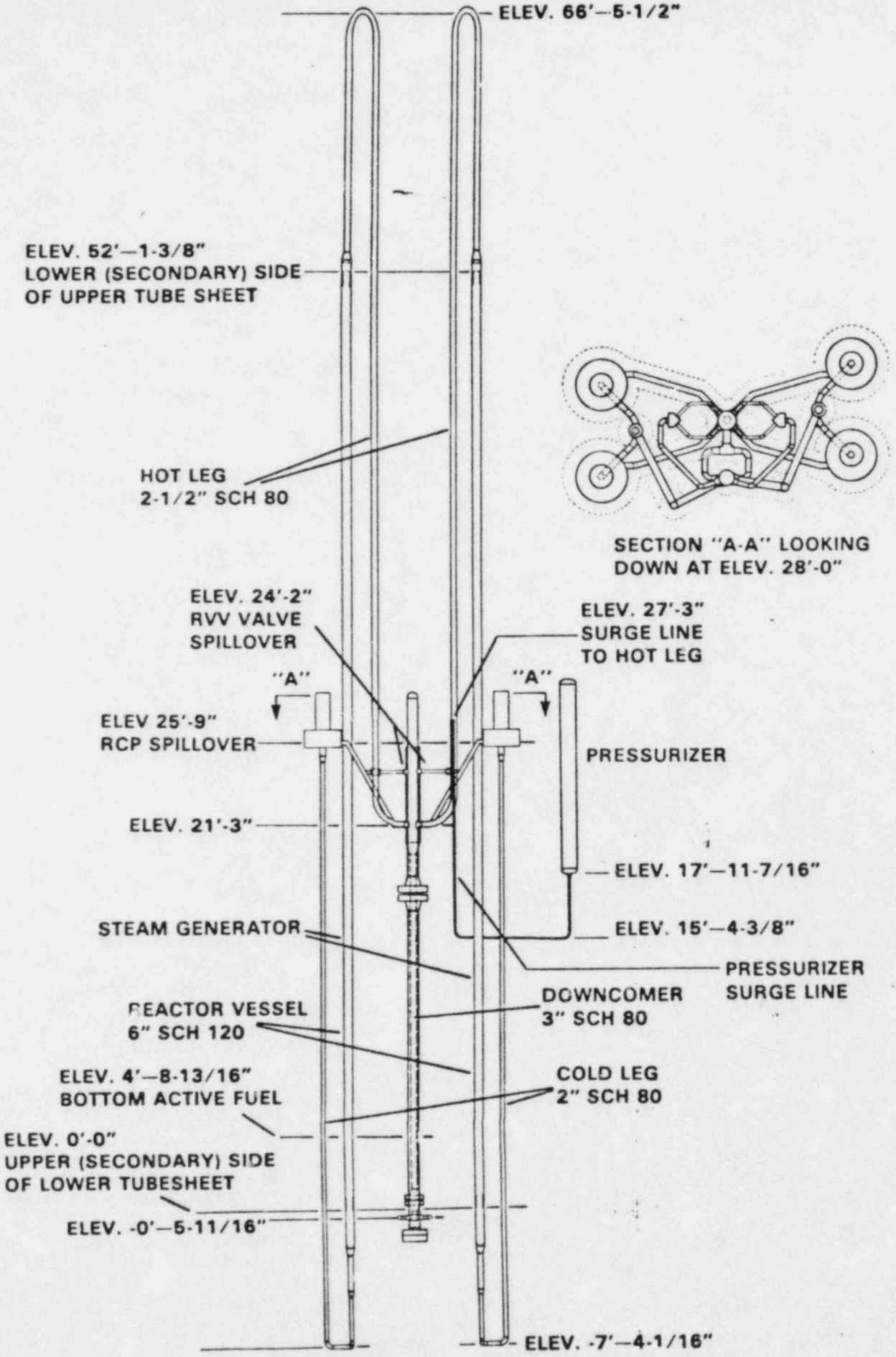


FIGURE 1.2 REACTOR COOLANT SYSTEM ARRANGEMENT

BAFFLED QUAD DOWNCOMER CROSS-SECTION THROUGH THE CENTER OF THE VENT VALVE OPENINGS

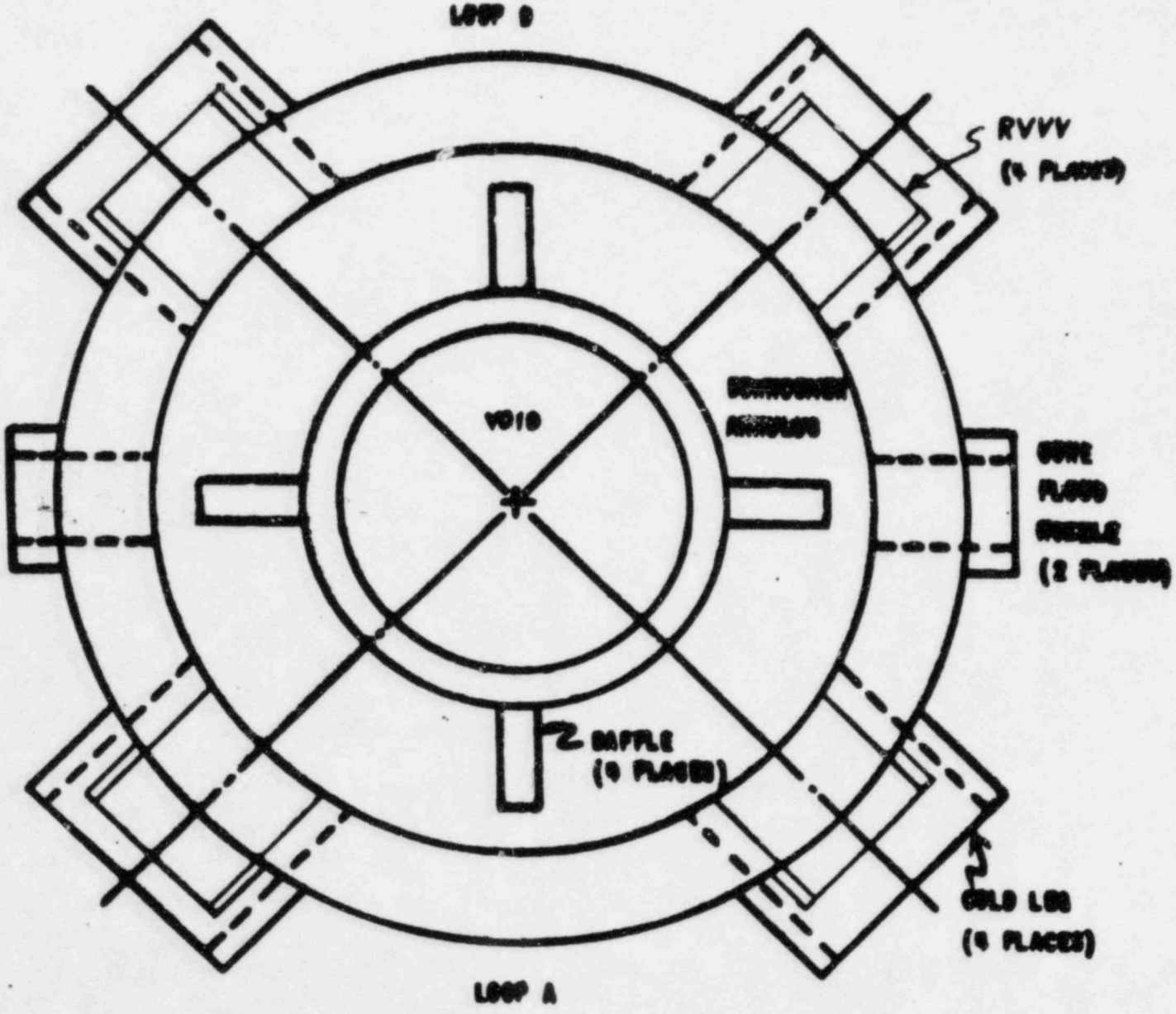
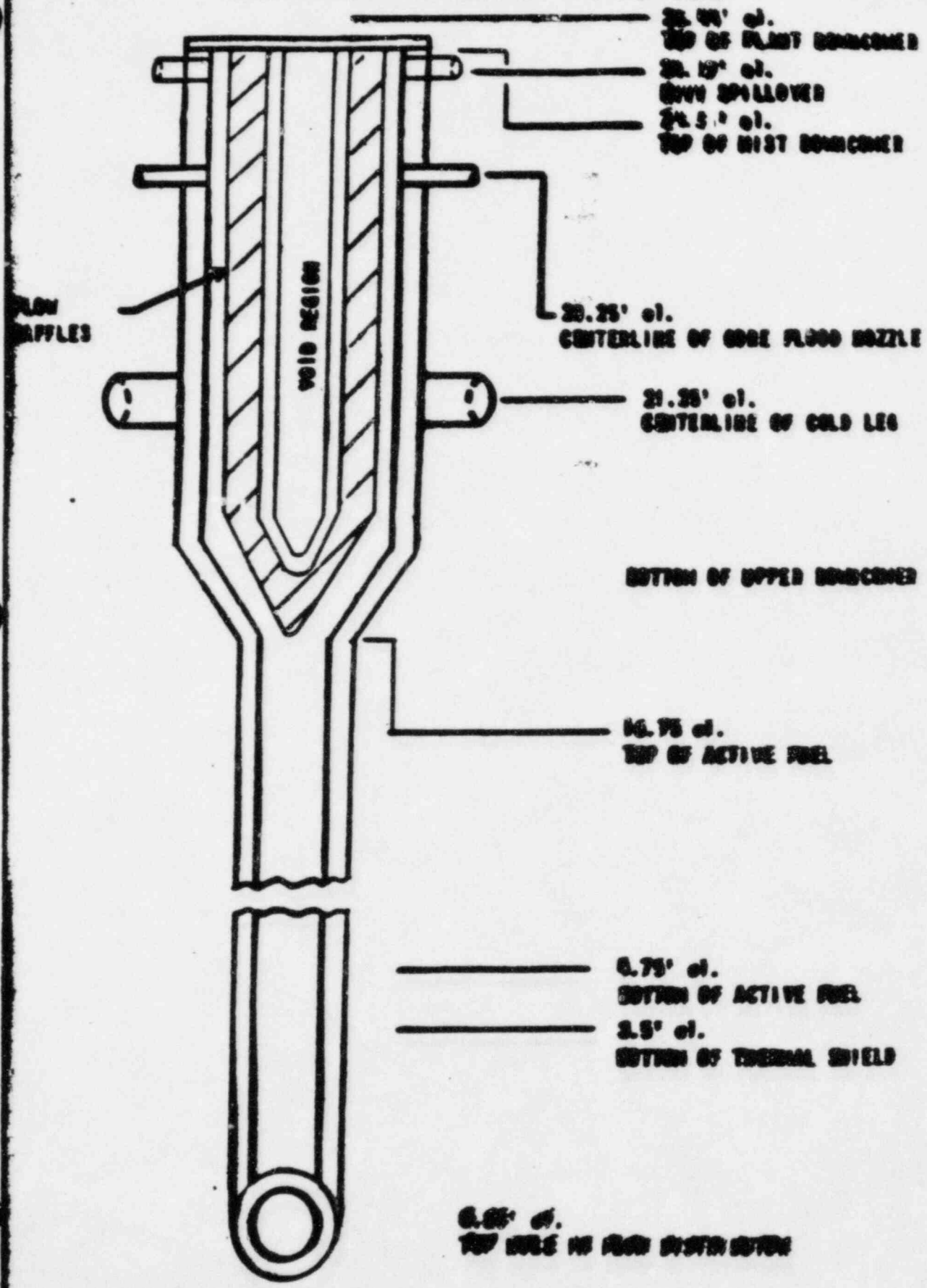


Figure 6.a

AXIAL CROSS-SECTION OF THE DOWNCOMER (BAFFLED-QUADRANT)



ADVANTAGE OF DOWNCOMER DESIGN

- ANNULUS LARGE ENOUGH TO PRECLUDE HOT WALL EFFECTS WITHOUT TOO MUCH EXCESS VOLUME.
- SYMMETRIC DESIGN BUT DOES NOT PRECLUDE ASSYMETRIC EFFECTS.

  ALL VENT VALVES CAN BE OPERATED FROM ONE SIGNAL FOR SYMMETRIC STUDIES.

  VENT VALVES CAN BE OPERATED FROM INDEPENDENT SIGNAL OR OPERATED VALVED SHUT TO STUDY ASSYMETRIC BEHAVIOR.

NOTE - SOME SEPARATE EFFECTS CHARACTERIZATION OF THE DOWNCOMER DESIGN WILL BE PERFORMED.

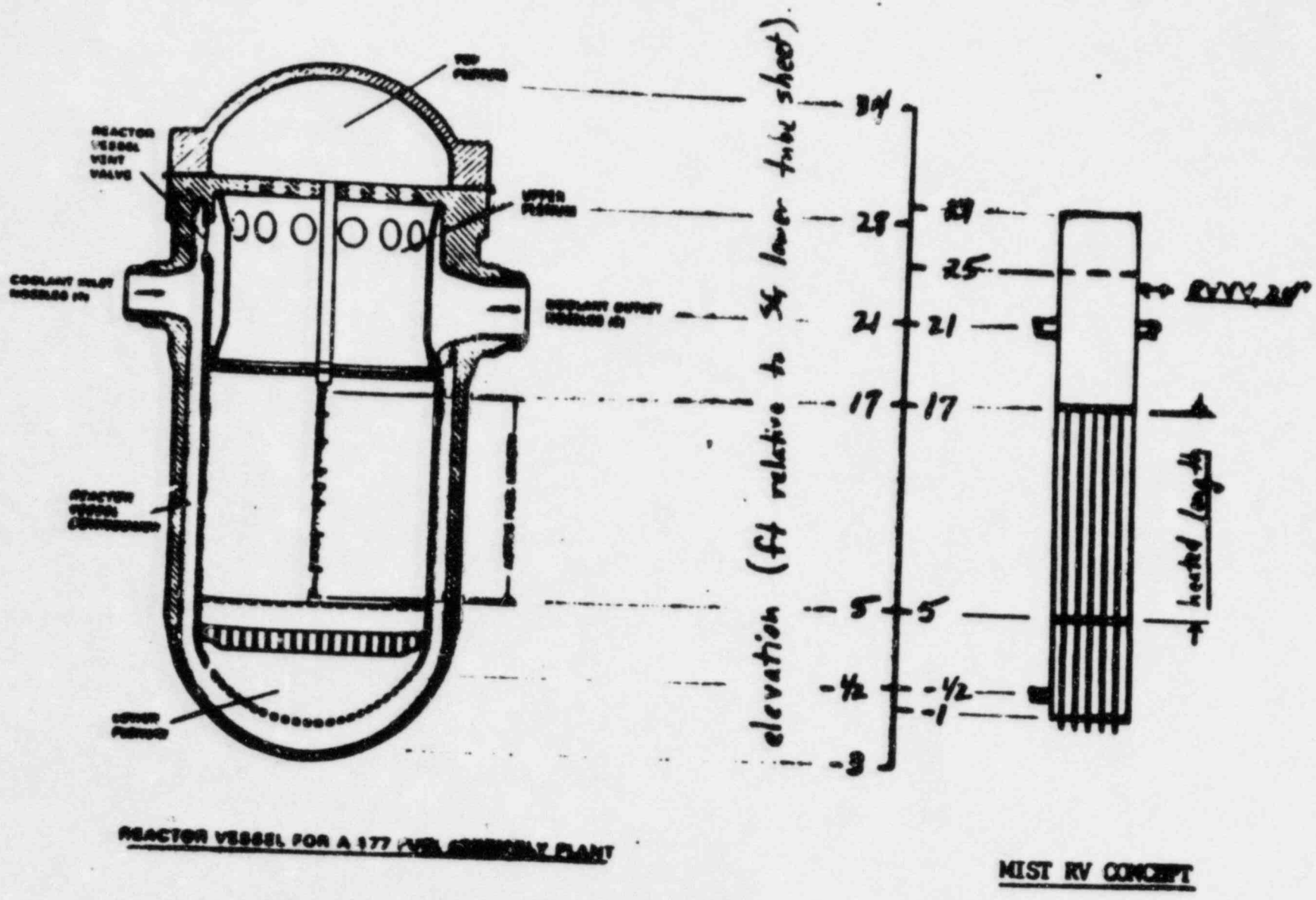


FIGURE 4.4 MIST REACTOR VESSEL CONCEPT

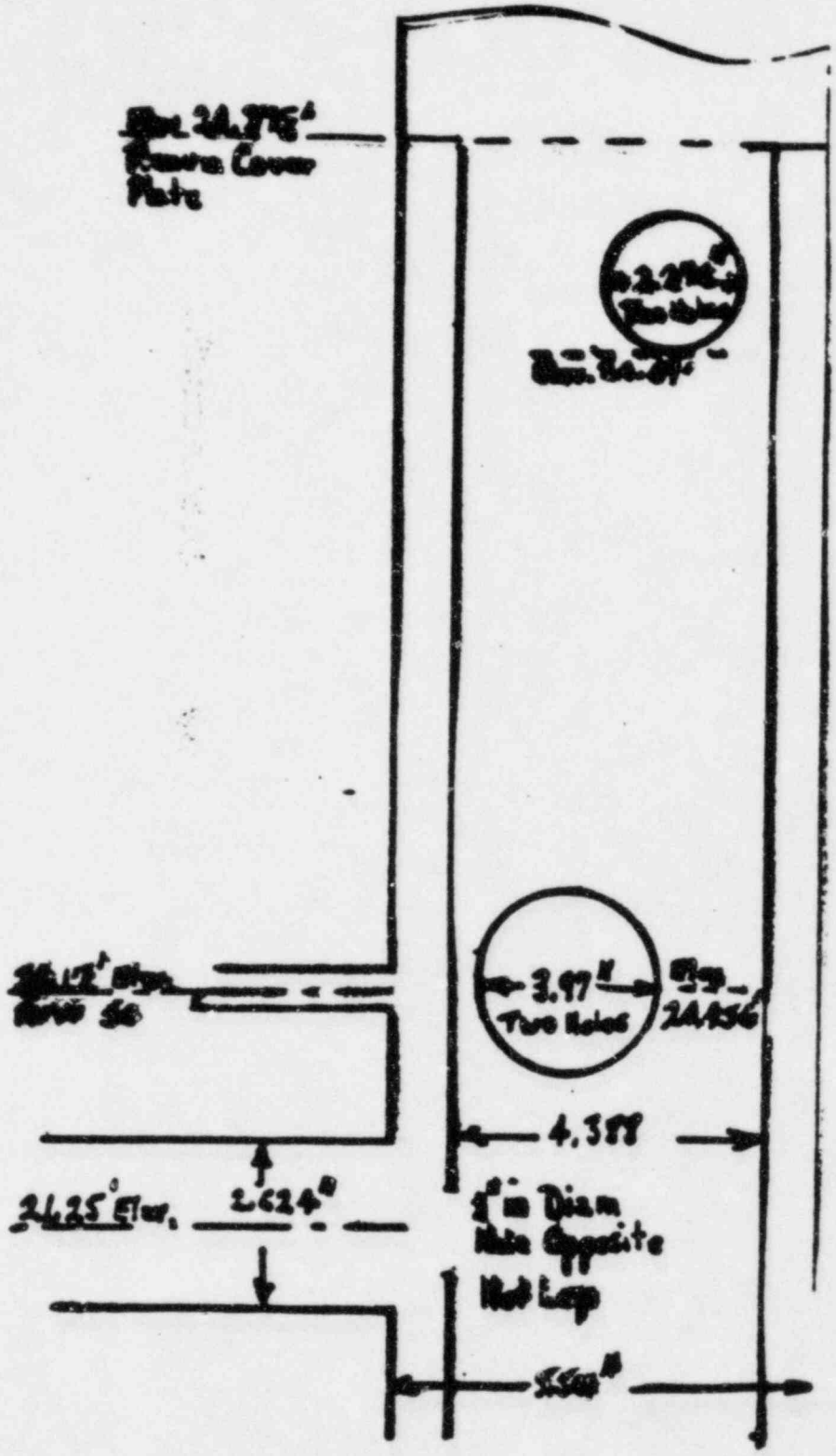


FIGURE 4.5a

RV UPPER PLENUM VERTICAL SECTION

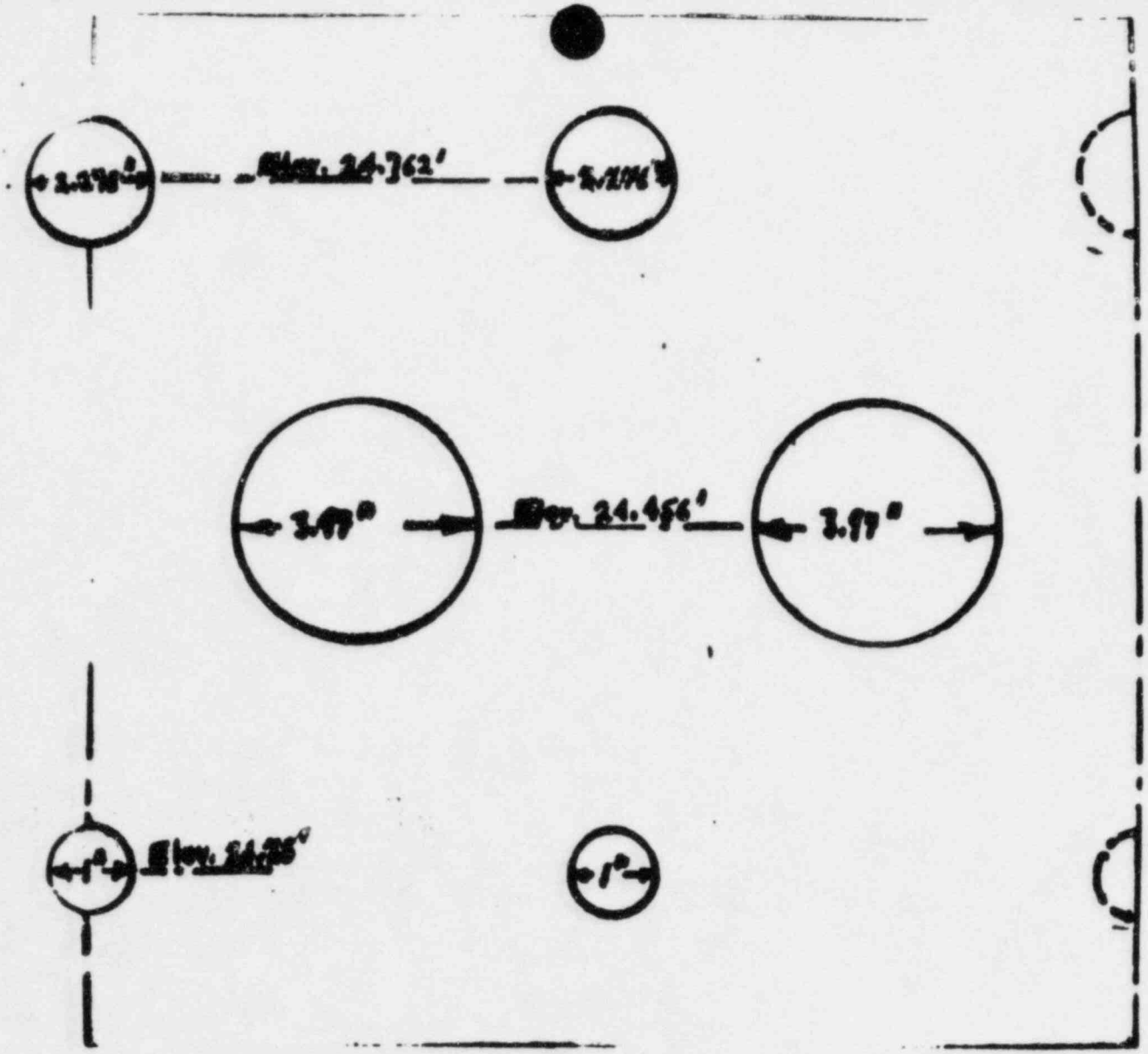


FIGURE 4.9

UPPER PLENUM CYLINDER FOLDED VIEW

HOT LEG

- 2½" SCHEDULE 80 PIPE ID= 2.32"

  SATISFIES CRITERIA THAT THE PIPE IS LARGE ENOUGH TO BE IN "LARGE PIPE REGIME".

  PRESSURE DROP IS CLOSE TO PLANT TYPICAL.

  METAL VOL/FLUID VOLUME CLOSE TO TYPICAL.

- U BEND RADIUS = 1.6 FT.

  REQUIRED TO MAKE LOOP FIT AND PRESERVE L/D OF HORIZONTAL SECTION.

  VOIDING OCCURS EARLY IN TRANSIENT IN EITHER CASE.

COLD LEG

2" SCHEDULE 80

SATISFIES "LARGE PIPE CRITERIA"

PRESSURE DROP IS CLOSE TO PLANT TYPICAL WITH ADDITION OF REQUIRED PUMP ORIFICE AND FLOW MEASUREMENT DEVICE.

PRESSURIZER

6" SCHEDULE 120 PIPE

VOLUME PRESERVED

HEIGHT 11.5 FT.

ELEVATIONS OF SURGE LINE PIPING WILL BE PRESERVED

SURGE LINE DIFFUSER MODELED

SPRAYS AND HEATERS MODELED

REACTOR COOLANT PUMPS

- 4 CANNED ROTOR PUMPS
  (ONLY PUMPS WHICH SATISFY MINIMUM HEAT AND MASS LEAKAGE REQUIREMENTS WITHOUT EXTENSIVE DEVELOPMENT)
- SCALED HEAD FLOW
- LOCKED ROTOR RESISTANCE MATCHED
- VERTICALLY INSTALLED

LIST OF ISSUES

TAG - COMPOSITE LIST OF ISSUES CATEGORIZED INTO FOUR BASIC PHENOMENA:

NATURAL CIRCULATION	PRIORITY
*BOILER CONDENSER NATURAL CIRCULATION	A
HIGH POINT VENTS	A/D
*INTERRUPTION/REESTABLISHMENT	B
NONCONDENSABLE GASES	B
STEAM GENERATOR-DRIVEN INSTABILITIES	B
*(LOOP TO LOOP INTERACTIONS)	
COLD LEG OSCILLATION	B
TWO-PHASE NATURAL CIRCULATION	C
REACTOR VESSEL VENT VALVES	C
*SINGLE-PHASE NATURAL CIRCULATION	D

SMALL BREAK LOSS-OF-COOLANT ACCIDENT	
BREAK ISOLATION	B
REACTOR COOLANT PUMP OPERATION	B
REACTOR VESSEL VENT VALVES	B
BREAK SIZE	C
EMERGENCY CORE COOLING SYSTEM OPERATION	C
LOCATION OF BREAK	D
FEED AND BLEED	D
OTSG TUBE RUPTURE	B

*IDENTIFIED AS IMPORTANT ISSUES AT ACRS MEETING ON JULY 19, 1983.