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UNITED STATES NUCLEAR REGULATORY COMMISSION

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BRIEFING ON ADVANCED REACTOR TECHNICAL ISSUES

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PUBLIC MEETING

Commission Hearing Room
11555 Rockville Pike
Rockville, Maryland

Friday, February 3, 1995

The Commission met in open session, pursuant to notice, at 2:00 p.m., Ivan Selin, Chairman, presiding.

COMMISSIONERS PRESENT:

IVAN SELIN, Chairman
KENNETH C. ROGERS, Commissioner
E. GAIL de PLANQUE, Commissioner

STAFF AND PRESENTERS SEATED AT THE COMMISSION TABLE:

JOHN HOYLE, Acting Secretary

KAREN D. CYR, General Counsel

JAMES TAYLOR, EDO

WILLIAM RUSSELL, Director, NRR

ASHOK THADANI, NRR

ALAN LEVIN, NRR

WILLIAM TRAVERS, NRR

ERIC BECKJORD, Director, RES

P R O C E E D I N G S

[2:02 p.m.]

CHAIRMAN SELIN: Good afternoon, ladies and gentlemen.

The Commission is pleased to welcome the staff to brief us on the status of the review of the two advanced reactor designs, the Westinghouse AP-600 and the General Electric small boiling water reactor advanced reactor designs. With the completion of AP-600 testing by Westinghouse in November, the staff has been reviewing the results and will continue to be doing this for the next few months. The GE design review was suspended last August at GE's request, although they are continuing their testing.

The staff has continued to review the test program and will continue to do so until GE requests reinitiation of the design review. We are all looking forward to a discussion of these reviews and the resolution of the technical issues, especially those that are unique to passive designs.

Mr. Taylor.

MR. TAYLOR: Good afternoon. With me at the table are Bill Travers, Eric Beckjord, Bill Russell, Ashok Thadani and Alan Levin.

Today we will talk on selected issues in the advanced reactor area, including important information from

some of the testing that has been going on and the briefing will be by Ashok Thadani and Alan Levin.

Ashok?

MR. THADANI: Thank you, Jim.

Good afternoon. May I have viewgraph number two, please?

[Slide.]

MR. THADANI: We briefed the Commission on December 20 regarding the status of all of the advanced reactor projects. At that time we noted that for the AP-600 for which we have issued draft safety evaluation report, that there were in fact a significant number of open issues and we indicated at the time that we were preparing a list of the more important technical issues which would require close management attention to get those issues resolved.

We have completed that activity and, in fact, have transmitted that list of issues to Westinghouse. I suspect that list might grow when Westinghouse identifies areas that they should there should be close management attention on. Nevertheless, we have completed that activity.

May I go to the next viewgraph, please.

[Slide.]

MR. THADANI: This -- this is a list of issues that we would cover today. Obviously we will not be able to go into a lot of detail on these issues. What we hope to do

today is to spend a fair amount of time on probably the most crucial issue which is the experimental program testing, where we stand on that.

Alan Levin is going to go through some of the details but before he gets into that, I would like to note that so far the results that we have seen on tests done in support of AP-600 design have been fairly positive. I am pretty upbeat about what we are seeing so far.

We have also made some program on SBWR but I think a great deal needs to be done on SBWR.

After Alan gets done with the discussion of testing programs and where we are and what we are seeing, I will come back and briefly go over some other technical issues to try to give you some sense in terms of what are other types of technical issues we are grappling with and in some cases we will tell you we have actually achieved resolution in the interim. utility I will go through some of those afterwards.

Alan.

MR. LEVIN: If I could have the next slide, please?

[Slide.]

MR. LEVIN: I will cover AP-600 vendor and confirmatory testing first and then go on to SBWR.

The AP-600 vendor test program is being conducted

to provide data for analytical model development and code validation. Westinghouse is using one major containment code called WGOTHIC and three reactor systems codes, WCOBRA track for large-break LOCA, NOTRUMP for small-break LOCA and LOFTRAN/LOFTR-2 for non-LOCA transients.

There are two major types of testing that are being conducted. Separate effects tests and integral systems tests. Major separate effects tests are core makeup tank testing, which uses a one-seventh diameter, one-half height model of the core makeup tank. Automatic depressurization system testing, which is being conducted in two stages, two phases. The first phase looked primarily at sparger behavior in a large tank of water and the second phase examined the behavior of the piping network and some real and simulated valves in the piping network for the automatic pressurization system and also had the sparger in the tank for the second phase of testing as well.

And the passive residual heat removal heat exchanger testing that was done at Westinghouse used three tubes, represented the design of the passive RHR system, passive RHR heat exchanger as it existed at that time. The design has changed somewhat since then but these three tube tests were used to try to characterize the heat transfer behavior of the tubing.

COMMISSIONER ROGERS: How well does that model

what you are -- what they are trying to find out just with three tubes? I mean, where did three come from? Why is it not two or five or 10? Where did three come from?

MR. LEVIN: The original design was for banks of just straight vertical tubes connected by headers. And it was felt, I think, originally that three tubes would give you enough interference between the tubes to simulate any effects from tube to tube interactions and the boiling going on between the tubes on the outside and would give you some indication of distribution of flow between the three tubes.

The basic heat transfer regimes, I think, are very similar but there are some questions about the applicability of the test data to the new design, which has a C-shape tube where about half the length is vertical and about half the length is in the two horizontal runs. And we have asked Westinghouse to provide us some additional justification for the use of this data in that regard and they are proceeding to do so. We have not received a full answer yet. We are expecting to get one.

I should note, though, that in the integral systems tests, the C tube shape is being used for all three, different numbers of tubes and because the vertical scales are different as well, there are different sizes. But there will be some test data to be able to play one off against the other.

The integral systems tests are the high-pressure, full-height SPES-2 tests and SIET in Piacenza, Italy. That is a one-four hundredth scale full-height, full-pressure simulation or representation of the AP-600. And the low-pressure, reduced height testing which is being performed at Oregon State University, which uses one-quarter height, about one-two hundredth volume scale model of the AP-600. Those are reactor systems tests only.

May I have the next slide?

[Slide.]

MR. LEVIN: Westinghouse is also performing containment testing. They have done a number of heat transfer tests in various facilities ranging up to a one-eighth linear scale representation of the full containment to look at the condensation heat transfer on the inside of the containment dome and of the evaporative cooling by water running down the dome and the sides on the outside of the dome.

They have also done an angular sector test for water distribution on an unheated full-size sector of the dome and they have performed scale model wind tunnel testing of the AP-600 plant layout also, since the cooling of the outside of the containment dome depends on the natural convection of air up around the water as it is evaporating and subsequently, if they run out of water, natural

convection from the air itself. The distribution of air around that dome and how it might be affected by wind currents on the outside of the plant was of interest to Westinghouse.

All of the test programs, both reactor systems and containment, focused primarily on design basis conditions. All of that testing, containment and reactor systems, was completed as of November 1994. We have begun to receive documentation from Westinghouse. We have a significant number of quick-look reports which just have the data in them from many of the test programs and additional key documentation in the form of analysis reports for this test data are scheduled to be submitted between March and September of this year.

We are currently scheduled to issue a supplement to the draft safety evaluation report, the supplement to cover testing-related review activities. Right now, we are scheduled to release that in October of this year.

Next slide, please.

[Slide.]

MR. LEVIN: We are also conducting an extensive series of confirmatory tests at two facilities. The first, the high-pressure full-height integral systems tests in the ROSA large-scale testing facility at the Japan Atomic Energy Research Institute in Toki, Japan. There are 10 tests

completed in that series so far. The facility was returned for some test activities to GERI between January and March of this year. We will start again a brief series of tests in April, concluding in June. And we have the possibility of getting back into the facility in early 1996, if we deem it advisable to do so.

CHAIRMAN SELIN: Have we had a problem? Or has it been beneficial or sort of irrelevant that the confirmatory testing has come so much earlier compared to the vendor's testing than we had expected?

MR. LEVIN: I think that we found it beneficial. It has helped us to identify specific issues to investigate, to focus on in our review of Westinghouse's test data.

CHAIRMAN SELIN: But will it also have carried out confirmatory function or will we be faced with the need to do new confirmatory testing when we finish with the Westinghouse analysis?

MR. LEVIN: It is fulfilling its confirmatory assumption. If we identify specific issues from the confirmatory test program that appear that they fall within Westinghouse's requirement to resolve them, we will put them to Westinghouse for resolution which could involve additional testing if they would choose to do so.

The -- we are looking at what kinds of testing might be included in a 1996 test series, since we will be

along the road toward a final SER at that point. But those tests would probably be focused on beyond-design-basis events to try to gain insights related to PRA and so forth.

MR. RUSSELL: We are, however, still maintaining the position that we have had throughout, which is that Westinghouse needs to perform sufficient testing to demonstrate that their codes are appropriate. What we are seeing are some differences in scaling and in think the early test results also confirmed what we saw would be some of the weaknesses in design in the facility where they were different from, particularly the loop seals and the thermal stratification which did occur in some of the early tests, which were, I think, important because it caused us to try and understand the differences and really get into not just taking test results but really trying to understand why they were different and was this due to the differences between the design of the proposed facility and the test facility.

So I believe it has been beneficial. There have been a number of dialogues back and forth and it has improved the staff's understanding. But the fundamental premise is still that Westinghouse needs to do sufficient testing to qualify the codes that they are proposing to use for the licensing basis for the AP-600.

CHAIRMAN SELIN: After they are finished with all of their testing, do we still need to do tests to spot check

their analysis?

MR. RUSSELL: At this point in time, we have not concluded that. There is work that is ongoing to look at what would be the scope of any additional testing. What we are now talking about is not the second set, which we are talking about this spring or after spring but whether there is a need for anything in '96 and that has not come through a management decision process yet. Right now we are in the developmental stages of looking at that as to whether it would be needed or not.

Generally, if we are concluding that something is needed for the licensing review to support the decision, we would pass the questions to Westinghouse, have Westinghouse develop the answers to those and then we decide what, if anything, we needed to do to independently confirm that. So I don't see a critical path issue now with completing the review.

MR. THADANI: I think that is the key. I think we have -- we set up what I thought was a fairly good program early on in terms of confirmatory research. We identified specific tests that were to be run at ROSA in two phases. We believe that was sufficient and in fact the results that we have seen so far, as I think Bill noted, have also identified how valuable this facility has turned out to be and I think Alan is going to go through an example or two of

the things we cite at ROSA and how we had to go back and look at Westinghouse information to see if they had identified similar kinds of situations.

At this stage, we really have not made any plans for additional testing as Bill said. It is still, we are still talking about it, should we do additional tests. If we do, what kinds of tests would be of some value down the road? But not for design certification. The schedule is completely inconsistent, I think, with that.

MR. RUSSELL: I think there is also an issue in deciding what confirmatory testing, if any, needs to be done. I have got to look at that along with the other requests that I have put on the Office of Research to give them some feel for what the priorities ought to be. Because there is a significant portion of their budget that is going into activities requested by NRR and so that is --

CHAIRMAN SELIN: You are solving a more complicated question than I am posing. Originally, the idea was that Westinghouse would to a whole lot of relatively small-scale tests, give us their results, we would do a very small number of relatively large-scale tests to see if the answers were in the ballpark or did we have some problems. We have done our tests before, they have done theirs. Does that leave a hole in our logic? That is basically all I am asking.

MR. THADANI: Actually, I guess, Westinghouse has basically completed their test program. It just turns out --

CHAIRMAN SELIN: But they weren't inputs to our program. We didn't have their inputs when we designed our tests. Does that leave a hole in our program?

MR. THADANI: I don't think so.

COMMISSIONER de PLANQUE: I think the answer is you hope not but you can take care of it if you need it?

MR. THADANI: Based on what we have seen so far, we don't think so. But -- but we will have to see.

MR. BECKJORD: Just a comment. It seems to me that it comes down to whether there will be surprises in later tests. And there really hasn't been that big a surprise. So if it goes that way, probably not.

MR. LEVIN: Even though the test programs were roughly contemporaneous, we did know what Westinghouse's test matrix was going to be before we tried working things up at ROSA, so we have been able to I think do what we were --

CHAIRMAN SELIN: Don't be tempted to perjure yourself in answering the question. The fact that it is sort of okay and we will see what comes out is a satisfactory answer.

MR. LEVIN: That's about it.

COMMISSIONER ROGERS: I have a question about that program. My understanding of the ROSA program was that at least one of its major reasons for being carried out was to validate computer codes in the regime -- in this new regime.

MR. LEVIN: That's correct.

COMMISSIONER ROGERS: And one of the points that I thought was going to be important in carrying out those tests was that there was an analysis done of expected results before the data was accumulated, not after the data was accumulated. And when I was there a year or so ago, they were having trouble doing that because there were changes being made at the last minute by Westinghouse in some aspects of the design that didn't allow the testing schedule to be conducted more or less as planned and actually do the computer analysis before the test was run because the initial conditions and so on and so forth were changed at the last minute.

Now, to what extent has that program been able to actually calculate the expected results of a test before the test was actually carried out? Now, I know this is not so simple. In principle, it is the right thing to do, it is not so simple apparently because in setting up the testing, some of the conditions that are plugged in for actually carrying out the test don't get determined until almost the time at which you are ready to do the test. So it is not

quite so simple as one would like.

But to what extent has this program been able to really independently calculate the results of -- expected results of a test before the data is actually run?

MR. LEVIN: I can speak from one specific personal example, personal experience. I observed one of the tests at GERI last August. It was a beyond-design-basis type test where we simulated a failure of all of the first three stages of the automatic depressurization system and just had the fourth stage available to operate. We did have a pretest prediction that was made prior to the test being run. It showed that the system would depressurize, on the basis of passive RHR cooling, that the fourth stage automatic depressurization valve would open because of a drop in core makeup tank level per the AP-600's design at about 10,500 seconds. When the test was run, the ADS four valve opened up in about 200 seconds of the prediction and the general trend of the calculation was extremely close to the results that were seen in terms of facility pressure and those kinds of responses.

So I think that despite the last minute changes that did have to be made in ROSA to accommodate the design changes that we learned about from Westinghouse and the pressure on conducting calculations before the tests were able to be done, that from what I have seen we have been

able to do that fairly successfully.

COMMISSIONER ROGERS: For remaining tests, after last summer's tests?

MR. LEVIN: Yes, yes.

MR. RUSSELL: We are using a combination of both blind tests, as you were just discussing, and testing that may result in modifications to code because that is, in fact, why you are doing some of the testing. I believe the only area that there was still a question on blind test predictions was associated with some of the containment testing as it relates to Westinghouse's scope and that this was an issue that has been pretty heavily discussed back and forth between the staff and the vendor and we have reached agreement on the processes, particularly as it relates to the parallel use of the codes for safety analysis while you are completing the code work.

So, basically, we wanted them to put the beta version of the code in a drawer, lock it up, not make changes to it, run the analysis in parallel and then if the actual final code results and blind tests and analysis of that indicates you have got to make a revision to the codes, then you are going to have to justify why that is okay.

So there was quite a substantial amount of dialogue back and forth because of this parallel path with actually using the codes to do safety analysis while they

are finishing up the code V&V work.

MR. THADANI: I think a certain amount of risk factor is still there nevertheless because we are going forward with our reviews, transient and accident analyses based on current codes, staff and Westinghouse agreed on selected tests for which pretest predictions would be made and then post-test evaluations would be made to see if, in fact, things are as they should be.

Some of that work has not been done, so that is yet to come and I think there is some risk there.

MR. LEVIN: Let's go back to slide number 6.

[Slide.]

MR. LEVIN: We have, in addition to the ROSA test program, there will be a confirmatory set of tests performed at OSU. The first test, I believe, is scheduled to be run this week and we do have a test matrix put together for that look primarily at beyond-design-basis conditions but we are also doing some testing to resolve some questions with regard to some of the Westinghouse test results and I will refer to that further on the next page.

Next slide, please.

[Slide.]

MR. LEVIN: Listed here are some significant findings and observations that have come out of our initial review of the test program and the data. The results

generally appear to indicate that the passive safety systems can accomplish their intended safety functions. We have seen some things that we didn't anticipate, which I guess is good because if you knew all the answers to start with, you wouldn't need to do the testing program anyway.

But in general, the facilities have been pretty well behaved. We have found that the passive RHR heat removal dominates the early integral test facility response. There is no way to emphasize this too strongly.

Westinghouse made a design change in terms of the actuation logic for the passive RHR system around a year ago. They have the passive RHR ready to come on right at the beginning of the safety system actuation. And the heat removal from that system now forces the facility pressure down very rapidly, removes heat extremely efficiently we found and really just overwhelms almost anything else that is going on.

The passive containment cooling system testing performance is also dominated by heat transfer and in this case by the transfer on the outside of the dome.

The observations I have relate again to the passive RHR cooling. The extremely efficient heat removal performed by this system means that very cold water comes back to the reactor cooling system. The heat rejection is to the in-containment refueling water storage tank, the

IRWST, which is sitting at atmospheric pressure in the containment, essentially room temperature. And the water coming back into the reactor cooling system is about 250 degrees Fahrenheit, something on that order, 300 degrees Fahrenheit, very much colder than when it goes in from the cold -- or from the hot leg, very much colder than it would normally be coming back into the cold leg from say the steam generator.

This causes significant thermal stratification in the cold legs, up to about 350 degrees Fahrenheit, bottom to top. In addition, this cold water comes in and because it is so much denser than what is in the reactor vessel to start with, it sinks to the bottom, kind of wells up there and pools, and when the automatic depressurization system actuates, the vales are at the top of the pressurizer and it has a tendency to pull all of the water in the reactor vessel upwards.

On the top is still some steam that is pulled in from the steam generators and also sort of resides in the upper plenum -- upper head area. When that cold water hits the steam, it has shown rapid condensation and associated water hammer. And we have referred these questions to both Westinghouse and the Division of Engineering for evaluation. We are in the process of looking at that to see what the significance is.

COMMISSIONER ROGERS: Are there any other phenomena that you have to worry about with respect to that injection of cold water? Is there a thermal shock problem?

MR. LEVIN: I checked with the Division of Engineering on that question and they believe that the thermal shock question is bounded by more severe events beyond this and that this would not be a significant issue in that respect.

COMMISSIONER ROGERS: Also, can that effect criticality?

MR. LEVIN: We don't think so at this point but we are evaluating that.

We have also seen some dynamic behavior in the long-term cooling data from Oregon State University. The Office of Research has been analyzing this data. They have provided some excellent insights into the behavior. We have requested that Westinghouse look at this. We believe that at least part of it may be due to the way the Oregon State University's facility is set up. It might if not induced by then encouraged by, let's say, the setup of the break and ADS flow measurement systems that exist in the OSU facility that are not typical of what would be an AP-600 plant. Some of our early confirmatory tests are going to look at changing some of the configurations of the BAMS, the break and accident and ADS measuring systems, components and see

if that eliminates this behavior. And we are continuing to discuss this with Westinghouse but we do want them to evaluate the behavior and let us know what the significance is.

COMMISSIONER ROGERS: Presumably there are some scaling questions involved there as well.

MR. LEVIN: Yes.

COMMISSIONER ROGERS: And how are they going to be dealt with?

MR. LEVIN: It is sort of one part of the whole. We have to understand what is the cause of and the factors that sort of encourage these oscillations to occur, this dynamic behavior to occur, and then look at the actual AP-600 design and see whether the scaling considerations involved in the Oregon State facility looked at against the AP-600 design would tend to indicate that similar types of behavior might occur in the plant. If it is strictly an artifact of the test facility, then obviously it is something that has to be known about and evaluated but it may not have any impact on the consideration for the plant.

COMMISSIONER ROGERS: Just before you leave that slide, I wonder if you could go back to this, your statement, that performance is dominated by external cooling of the PCCS. What does that mean? How serious is that?

MR. LEVIN: Well, I am not sure I can address the

specific technical details. But the inside of the containment shell is condensing the steam, which is a very efficient heat transfer process. The outside is evaporating water with the convection of air over the water film, which is also a fairly efficient heat transfer process. But there is not 100 percent uniform coverage of the dome and the striping of the dome and how that has an impact on the overall heat transfer performance on the exterior looks like it has the dominant effect.

If you are transferring through a series of resistances to heat transfer, if one of them is fluctuating a lot or one is significantly lower than others, then it will tend to be the dominant factor in calculating what the overall heat transfer resistance is. And it appears to be that case here, from what I have been able to --

COMMISSIONER ROGERS: Well, I mean, does this imply for example that in an actual reactor, weather conditions would be an important consideration?

MR. LEVIN: Possibly. But the dome is surrounded by a shield building which tends to funnel the flow of air around it and then out through the chimney. So that would wend to shield from a certain extent the fluctuations that might occur due to wind. I think the more significant aspect is trying to get the water coverage on the dome and to know how the striping of water and dry patches and so

forth would effect the heat transfer behavior on the outside.

MR. RUSSELL: There are a couple of operational types of issues that come out of some of the early testing, this excessive cooling from the passive heat removal systems. On a design basis, you assume one is not available to work and so you do your calculation. So now you've got a situation where if they both work as designed, you've got even more cooling, more stratification than you thought you had before. Also it raises questions about inadvertent actuation of these systems and issues associated with thermal stress and thermal fatigue of the components and how many cycles can it go through. So the issues do have implications for other aspects of the review and those are being looked into as well.

MR. LEVIN: We go on now to SBWR vendor test programs, the next slide.

[Slide.]

MR. LEVIN: These test programs too provide data for analytical model development and validation. In this case, there is only one code, GE's TRACG code which is originally derived from the TRAC accident evaluation code which was developed for reactor systems analysis but is being extended by GE to cover containment as well as reactor systems. So there is no separate containment code here.

We started our review of the GE test programs in 1991 and had extensive discussions with GE over a period of years about the content of the test program. GE committed earlier this year to reassess their test program and submitted their test analysis program description report, the TAPD, in August 1994 for staff review. It was a complete look at their test program in response to comments that the staff had provided over the years. It was reviewed by an external panel as well of EPRI and DOE and I believe some consultants before it was submitted to the staff. And we have reviewed that document.

In the TAPD report, T-A-P-D report, there are major separate effects programs and integral systems tests described. The separate effects tests are carried out in the PANTHERS facility which is also at SIET Laboratories in Italy. They are both heat exchanger tests, one for the passive containment cooling system heat exchanger, which is complete now, it was completed late last year, and the second for the isolation condenser heat exchanger scheduled to begin in April of this year.

The integral systems testing described in the TAPD report comprises experiments at two facilities. The PANDA loop -- we've gone for animals here for GE's test program -- PANDA is at the Paul Scher Institute in Vernling in Switzerland. It is a one twenty-fifth full-height low-

pressure facility, one twenty-fifth volume scale. The tests are scheduled to begin in about March of this year and there are additional tests planned at the GIRAFFE facility, which is a one four-hundredth scale, volume scale, full-height facility at Toshiba's nuclear engineering laboratory in Kawasaki. There were previous tests done between about 1989 and 1992 in this facility. These are further tests starting either late this month or early in March and proceeding for about a month.

Next slide.

[Slide.]

MR. LEVIN: The confirmatory testing being planned for the SBWR uses a facility being constructed at Purdue University. It is a low-pressure, reduced-height facility, one quarter height, one four-hundredth volume scale. It's called PUMA. The facility is currently under construction and testing is scheduled to begin about mid-1995.

Scope of testing in the PUMA facility includes a full range of conditions at low pressure. It assumes that blowdown has already occurred through the automatic depressurization system in the SBWR. Testing is initiated at about 150 PSI and it covers the late blowdown phase, early ECCS injection phase and then the transition to long-term cooling. And the test matrix will include both design basis and beyond design basis scenarios.

Next slide.

[Slide.]

MR. LEVIN: Our review of the test program, as I said, has extended over the last three years but the salient point, really, is what we have done with the reassessed test program since it was submitted in August 1994. we provided our evaluation of that report in November 1994 and were pleased to see that GE had addressed many of the staff's comments about the problems with the test program as we had seen it up to that point.

We feel that the basic logic structure of the program is appropriate now but we still don't have a lot of the details that we need to be able to make a final review. Based on what we have, the containment test program appears to be adequate. We still have to do a detailed review of GE's scaling analyses and there are some issues to be resolved with their test matrices.

A particular issue of concern is the treatment of mixtures of nitrogen and hydrogen. The SBWR has an inert containment, inerted with nitrogen. If hydrogen is released into the containment, the behavior of the mixture of gases as it passes through the passive containment cooling system heat exchanger, how will the noncondensible gases affect the condensation heat transfer in that heat exchanger is still an issue and how they will address it with their testing

program.

The staff review of the TAPD -- yes.

MR. THADANI: This is a very important point, the mixture of nitrogen and hydrogen, hydrogen being lighter. The concern is, in the tubes, it might collect and prevent any injection of containment atmosphere for cooling.

MR. LEVIN: The reactor systems-related testing in the TAPD we felt was still inadequate for code validation. We told GE that we believe that additional data was required in the late and early ECCS injection phases of design basis accidents. I will discuss this a little bit further in the next slide.

We don't have any real significant findings or observations yet on the test results because we don't have any of the most recent test results from PANTHERS. We expect to be receiving them shortly and will begin our review at that point.

Next slide, please.

[Slide.]

MR. LEVIN: GE received our evaluation of the TAPD in November, took a look at it for about the next month or so and then we met with GE in January to discuss the assessment of the TAPD. We raised a number of issues on the content of the TAPD in general and the details of the test program scaling analyses and so forth. GE has agreed to

address those concerns. We did clarify for them what we intended by our comments and they are currently working on addressing these concerns.

On the issue of early phase, early ECCS injection late blowdown phase of accidents, GE told us that they were exploring the possibility of additional testing at Toshiba in the GIRAFFE facility. We believe that that facility has the potential to be able to address those kinds of questions. We don't have an indication yet from GE that they have a contract with Toshiba but we have been told within the last week that they have a verbal agreement with them to conduct these tests that would be sometime in the spring of this year. We are still awaiting details of what the test program would actually comprise in terms of a proposed test matrix but we feel that is a very positive step and on that basis we think that resolution of this particular issue is feasible.

COMMISSIONER ROGERS: Without any additional facilities being constructed?

MR. LEVIN: Right, without any additional facilities being constructed.

In conjunction with GE's trip here in January, we also met with the ACRS, met with the Thermo-hydraulic Phenomena Subcommittee and with the full committee. We have just received a letter from the ACRS on this subject. The

ACRS generally agreed with the staff's assessment across the board on the TAPD and they also raised additional questions for GE to address and GE has told us and the ACRS that they will also address those specific issues as well.

That concludes the testing presentation.

COMMISSIONER ROGERS: I think we should just move ahead.

MR. THADANI: Move on? Okay.

As I indicated earlier, I will pick up and go through some selected technical issues and give you a sense of the types of issues that we still generally have open.

I guess the overall sense I would like to leave you with is that there is a lot of work to be done and there is a lot of work to be done by Westinghouse and the staff and I think we will meet the target if both sides really buckle down and devote the necessary resources to resolve these issues. And it is not just the staff. I think that's the message for Westinghouse as well, that they need to really focus attention on some of these issues, particularly the top 50 or so issues which I think will require a fair amount of effort. You will see from some of the issues I am going to go through that they are pretty important and they will require focused attention, I think.

The first issue. May I have viewgraph number 12, please?

[Slide.]

MR. THADANI: First issue is ITAAC and on ITAAC there are three issues, subissues on ITAAC. The first issue is -- it is not yet clear that this is a real issue but we are concerned that it might be and that we understand that Westinghouse is considering an approach to ITAAC that might be significantly different than the approach that was used on ABWR and System 80-Plus. I can't give you the details because I don't know what those details are. It is what we understand the case may be.

The reason I am bringing it up is we went through and the gentleman to my left went through tremendous level of activity during the development of ITAACs for ABWR and System 80-Plus. It was a painstaking iterative process and if we changed the process in any significant manner, I think that could cause us some difficulties down the road. It is not an issue yet but it could become one down the road and that is why I am bringing it up.

A second issue relates to digital I&C ITAAC.

COMMISSIONER ROGERS: Just on that ITAAC, you know, I would hope that if that looks as if we are going to have to get into a change in how we define ITAAC and so on and so forth, that would come to the Commission.

MR. THADANI: Yes, it would.

COMMISSIONER ROGERS: And we would hear about it

because I quite agree that we went through a very arduous process there and two other vendors went through it and we worked it out and to try to tinker with that strikes me as potentially very troublesome from many different points of view.

MR. THADANI: Yes, Commissioner Rogers. That is the only reason I decided to add this issue to this list, even though it is not a so-called open issue. It could become a significant issue down the road and I thought it was important to bring it up.

COMMISSIONER de PLANQUE: Is your sense of it that this is more a matter of detail or is it more of a matter of substance?

MR. RUSSELL: I have had discussion with some of the industry side in addition to limited discussion with Westinghouse and there are differences in approach where they feel there could be an advantage to an alternative approach that may give them some competitive advantage through marketing aspects or other things. And the issue of how you handle some of the difficult issues such as the equipment qualification and other things which were handled in a generic way with relatively detailed drawings of equipment to be considered in how configuration walkdowns were being done, how environmental qualification was handled, those issues absent a substantive reason which is

proposed, which is design specific, the staff position is that that has been resolved before and we will do it the same way and we don't see a need at this point to go back into a major iteration on a process that has number well defined at this point.

COMMISSIONER ROGERS: And it took a lot of work on everybody's part, including detailed considerations by the Commission on ITAAC. ITAAC didn't exist in the early days and that was something that had to evolve. I, for one, would be very, very cautious about reopening how we define ITAAC because we really did it from a policy point of view. It was not just individual tailored decisions to each vendor. They were really dealt with, pretty much, on a policy basis at the Commission level and I think that is a very serious issue.

MR. THADANI: Yes. We believe so and that is why we raised it, even though we have not received Westinghouse's submittal.

The second ITAAC related issue has to do with digital I&C design. If you recall, there were really two key elements to digital I&C issue. The first was at the functional level, you had to provide redundancy and diversity, the so-called four step position. There is no problem in terms of functional diversity and redundancy. But the difficulty comes in since we recognized early on

that the technology was evolving and we did not have to tie down all the design details, what we developed was an approach that we call the phased ITAAC approach.

The idea behind that was to ensure that whenever the system is put together that the quality of this design would in fact be of very high standards. And the quality was to be achieved through this phased ITAAC concept. Phased ITAAC had eight elements to it and at this stage Westinghouse has not yet agreed to follow that phased ITAAC and so discussions are ongoing in that regard.

MR. RUSSELL: These phases generally address the hardware/software integration process and it follows the I&C-880 standard. We felt that basically what we were doing was licensing a process rather than licensing particular hardware. We think that is still appropriate because the hardware can change over time. We are looking at certifications which would be good for 15 years, renewable for an additional 15 for a plant that could conceivably operate for 60 and we just don't believe at this time that an approach of reviewing a particular hardware solution is sufficient, particularly in the I&C area and also in the human factors interface area, from a control room design standpoint.

So these are issues that we think we are going to be spending some time on in a senior management dialogue

back and forth with the applicant.

MR. THADANI: And I am deliberately going through these fairly in a very brief manner just so you get a sense there are -- I tried to cover different types of issues so -- in this presentation.

The third issue is kind of unique to passive designs. Natural circulation is the key to these designs and ITAAC aspired to fuel load conditions, testing done prior to loading fuel. And it is difficult to do some natural circulation tests unless you have the right heat source in there.

What we think we can do is at least we can do limited natural circulation tests using reactor coolant pump heat. We probably have to pool information base to come to a conclusion and the pooling would have to be probably look at the data that comes out of scale facilities, take a look at partial natural circulation tests that can be done prior to loading fuel and taken a look at what would be done during startup of a plant to arrive at some conclusion. These issues we are taking a look at now to see how we should proceed because of these unique aspects of the design.

COMMISSIONER ROGERS: Are there any other systems that really can't be tested prior to fuel loading? I would think there would be, but --

MR. RUSSELL: This will likely result in a more extensive test program post fuel load, which the regulations do cover, the integrated test program. And it really is an issue that our experience with Reg Guide 168 which defines the scope of a test program for an evolutionary plant is not sufficiently comprehensive to address some of these. So we may find that we have to spend some more time in the test program area and that would be controlled both by regulation and by license condition but is not controlled by ITAAC. And we are just identifying that, in this case, some fairly significant testing would likely have to be performed after fuel load.

CHAIRMAN SELIN: I need to excuse myself. I was told by the airlines that if I plan to leave, I shouldn't try to leave tomorrow night, I should leave tonight. I am not quite ready, so --

[Laughter.]

MR. RUSSELL: Have a safe trip.

MR. THADANI: May I have the next viewgraph, please?

[Slide.]

MR. THADANI: I am pleased to say this issue is actually basically resolved. It has to do with emergency response guidelines. These guidelines are needed, both in terms of control room design purposes as well as trying to

understand the necessary actions that the operators would have to carry out in the event of certain accidents and so on.

Initially, Westinghouse had proposed to use somewhat of a qualitative approach taking today's response guidelines and qualitatively saying what the differences are in today's plants versus passive design and we didn't find that to be appropriate. And I am glad to say that, as I understand, there was a meeting I believe yesterday or the day before and resolution has been achieved and the documentation would be provided in a matter of months.

Next viewgraph, please.

[Slide.]

MR. THADANI: In the area of source term, we are making a lot of progress. We are going forward, as we indicated to the Commission, that we would apply NUREG 1465 source term and that is what we are doing. However, there are some issues when you get down to details that have come up and require focus, both on our part as well as on Westinghouse's part. The first one has to do with timing of release. If you recall, the old way when we used TID source term, it was instantaneous release and Westinghouse has indicated that the releases would not begin until about an hour into the accident. However, they have not provided supporting information so that is the issue here.

I am pretty confident that they can give us the information. We may not agree to one hour, but nevertheless we do need to see the bases.

Now, the second issue I think is very important. What is the ability of this containment to hold source term? In the earlier designs, we had containment sprays which actually were very, very effective for a number -- in a number of ways, one of which was in terms of source term and decontamination and so on.

AP-600 currently does not have a containment spray system and one has to rely basically on plate-out diffusions and so on kind of mechanisms to reduce the source term. Well, how do you do that? In order to do that well, you really have to understand the containment conditions.

Just knowing pressure and temperature in a global way is not enough. You really have to understand gradients and local temperatures and what certain things can diffuse to and so on. At present, Westinghouse has not provided analyses to be able to say how would they -- they have made certain assumptions and we know what assumptions they have made but they haven't really given us again analyses to support that is in fact what would happen. I think this is going to be a difficult issue. These calculations are not going to be easy to do. So I think Westinghouse -- there is a fair amount of work to be done here I suspect.

The third issue relates to pH control. It is very important to maintain pH above 7 to minimize elemental iodine production. In fact, EPRI also requires that pH be maintained above 7. Westinghouse is now looking, actually, at what kind of chemical additions would be needed and how mixing might take place and this is under evaluation by Westinghouse.

A separate, but not so separate, actually, issue relates to the exclusion area boundary. If you recall, we propose in the revised Part 50, Part 100 rule that we discussed with the Commission that instead of using the first two hours to determine goodness of the design, engineered safety features in particular, we were going to use a sliding window two hours. Now that if you say there is no instantaneous release and, for example, if you say it at least doesn't occur for the first two hours, then using the first two hours to assess goodness doesn't really have relevance then.

We have indicated that we will use a sliding two-hour window. Westinghouse has not agreed with us on that approach and there are meetings going on now to try and some to some understanding.

MR. RUSSELL: I am not sure if it is Westinghouse or it is some of those who are involved with the EPRI, advanced reactor requirements, when they want us to use the

strict past practice because they see it gives them some relief. This issue is one that doesn't make sense technically and there is a major fundamental difference in the passive designs from the prior designs and that is this containment is going to stay at pressure for a long period of time.

So if you have, through whatever mechanism you postulate, some leakage out of containment, whether it is an assumed leakage for an accident analysis or you end up with some small penetration open, that leakage will continue and you do not have a mechanism basically for knocking the pressure down. I mean, the concepts that we had before even with the subatmospheric containments or some of the large containments was after a period of time, the leakage is in, not out. That is not the case with this design.

So whether you need something in the context of accident management longer term that may not be safety related or gold plated, the issue is that the design that is being proposed is one that would maintain pressure for a long time. So that containment function at pressure, you have to put an awful lot of confidence in the passive boundary to ensure that the containment function works, not just the heat removal function. So they have focused on the heat removal function but not the internal issues.

We see this as potentially a technical issue and

one that we have already come to the Commission and proposed by way of rulemaking. We have other policy guides. We don't see new issues yet but this may be one that we will come back to you this summer on.

We are proposing, and I was going to conclude on this later but now is probably just as good a time, we are going to come back to you with a paper so that you don't have to search through all the prior SECY papers we have sent and all of the SRMs to understand what you have already approved and what is yet pending. Plus we will summarize where we are on the technical issues and if there are any that need additional policy guidance, we will identify them at that time.

So w are proposing this kind of as a wrapup of all the issues, recognizing we may have some new members of the Commission, that this would be useful as a vehicle for getting everyone up to speed on the policy and technical issues for the passive designs.

MR. THADANI: This may turn out to be a policy issue down the road. I think if you can put two and two together, you can see what the real issues are and there are different ways to resolve them. But there may be an easier way to resolve these issues rather than going on extensive long-term analyses and so on.

One issue that Bill just mentioned, this

containment says at pressure for a long time. I indicated it is going to be difficult to try to calculate plate-out deposition and so on for this containment. The third issue is -- I guess now maybe I am getting into why I think this may be a policy issue, is should a passive design have some capability in the event of some accident, capability to be able to control pressure in the containment and how can one do that.

And there may be ways, and this is what I think Bill was referring to when he said accident management, there are things one can do it seems to us that not only can you deal with that issue but you can deal with these issues as well. But we will wait and see how it proceeds. But this could become a policy issue.

May I have -- yes, excuse me.

COMMISSIONER de PLANQUE: In the practical sense, though, is the problem with this, which two-hour interval you use, one of the difficulties in the calculation?

MR. THADANI: Yes. This is the -- well, I think what is going to -- what may well happen, depending on how much credit you are able to take, what happens in the containment, it may lead to having to make a change in the design.

MR. RUSSELL: We did some work for the activities that research did in support of the Part 100 paper and

earlier work that we were doing on large release and we think that the maximum two-hour period is likely to be sometime early in the first 24 hours. After that, you've got enough radioactive decay from the short-term isotopes that the natural decay reduces the source term significantly. So it is probably not from time zero, because we realize that these conditions, if you look at them realistically, that you don't start getting significant releases at zero. But probably sometime between one and eight hours, you will reach a maximum two-hour dose and the process by which you evaluate that is what we are proposing to use as a figure of merit to make judgments about the adequacy of the design. That is generally the approach we are taking.

MR. THADANI: May I have viewgraph number 15, please?

[Slide.]

MR. THADANI: This is a very quick issue. It is more an issue of completeness than anything else.

Westinghouse has taken a look at some pieces of what the risk might be during shutdown of this design but they haven't really taken a systematic look to say, what have we learned from operating experience, what challenges for this unique design one may experience, and then taking that information and trying to cast it in terms of, well,

how important is it as far as AP-600 design is concerned. And since the AP-600 design is supposed to include a PRA and the scope of the PRA needs to include shutdown conditions, to put it in terms of that, understand what the risks would be and then to see if anything needs to be done. So that is all this issue is about.

Next viewgraph, please.

[Slide.]

MR. THADANI: This is an issue that we have discussed with you in the past but I will try and quickly summarize what the issue is and what the real tough part is as we go forward.

The objective, of course, is to understand the importance of active systems and to decide on what type of regulatory oversight should be applied to these systems. The key in understanding the importance of active nonsafety systems is the role of the PRA. PRA is, in fact, used to -- even when you get the PRA, the boundary conditions or the process that we agreed to with EPRI early on was that we would look at core damage frequency, we would look at containment performance and then there were other issues such as potential for adverse systems interactions.

There are two key things. In order to get there, one needs to be able to estimate reliability of passive systems. That is a complex issue and I will come to that in

a minute. As far as the adverse systems interactions are concerned, I think -- I believe we have made a lot of progress. There are three types of interactions that we would traditionally worry about. One would be functional interactions, support systems connected to front line systems if a failure propagates and so on. When you do a good PRA, generally you should be able to capture those kinds of interactions.

Another kind of interaction you worry about is special interactions. But since most of the systems here are really separated, again I think the potential for those problems is clearly minimized. The only area that needs careful look and we are doing that is when you get human-induced interactions. And we are looking at -- we are utilizing analyses and the tests that are being run at facilities to try and get better understanding of how that might happen. That issue still needs some work, at least on our part, I know.

COMMISSIONER ROGERS: That's a tough one.

MR. THADANI: That's a tough one, yes.

MR. RUSSELL: We believe there is significant incentive on the part of the operators not to allow the passive systems to actuate because if you were to actuate fourth stage blowdown, it might be a long time before you operate the facility again. So there is going to be

incentive to use the nonsafety systems to handle most casualties and so the entry condition into the casualties when the passive systems actuate may be different than what you are assuming. So those kinds of interactions and what is the role of the operator are very significant.

MR. THADANI: May I have viewgraph number 17, please?

[Slide.]

MR. THADANI: As I said, I think it is very difficult to estimate reliability of passive systems. Traditionally, when you conduct reliability analyses, you have a fair amount of data and you are looking at things like pumps, valves, relays and so on. They either work or they don't work, they don't have multiple conditions that could get into and that is why you find general go/no-go type of approach in risk analyses.

Here, that is not the issue. The issue is since you have to rely on natural circulation and they are very low driving heads and you have at least four parallel paths, you have the steam generator core makeup tank, passive RHR and then containment refueling water storage tank, it becomes very, very important and the idea is to make sure that the water is actually going to the reactor core and not ending up someplace else.

So it becomes obviously very important to know

thermal hydraulic conditions, temperatures, void fractions, frictional forces and things like that which would influence where the flow is going.

We are conducting -- Westinghouse is conducting a number of tests that leads to acceptable models but you cannot run literally hundreds, probably thousands of tests. So the next question that comes up is how do you -- how do you know that you couldn't have tremendous fouling and your heat transfer is radically changed and what does it do or now I can make it even more difficult. Say I have two parameters that are changing conditions, I have corrosion products or something else. I am impacting two parameters at the same time. How should we deal with those?

The normal past practices have been when you get into situations like that, you get the expert -- you do a lot of analyses and then you do expert elicitation techniques and try to come up with some probabilities. They are largely subjective.

But here we are talking about a tremendous amount of effort if we had to do that. We believe there are alternate ways to get there and this may not be the best way. And I will tell you briefly how are we are going to try that.

Next viewgraph, please.

[Slide.]

MR. THADANI: This is again trying to pare away, to get down to what I would call a really minimum set that we should work on. So that is why we are calling it a margins type of approach.

The steps that we will go through would be as follows. First we would identify the uncertainties in thermo-hydraulic performance, what are those uncertainties in terms of passive systems. We would conduct a set of sensitivity analyses for those parameters. We would then, after doing sensitivity analyses, we would see what margins there are to undesired end condition, whether it is core damage or something else. In this case, pretty much would be core damage. And then if we find the margin is substantial and subjective judgment says that you really wouldn't get there, we would use that judgment to say that -- eliminate what I would call probably unnecessary analyses and so on.

If margin is not sufficient that we are not comfortable at that point, then one can do a number of things. At that point, we could activate the concept of regulatory treatment of nonsafety systems. We might decide and Westinghouse might decide actually instead of doing a lot more analysis, we will just take credit for an active system and let's agree on some oversight of that active system instead of going forward in this direction.

We would like to use the option of expert elicitation to actually quantification of these passive systems and their reliabilities as the last element, really. If other things don't work, we don't come to agreement on, that then would be the ultimate use. That is the general approach we are planning to use. And there is agreement between Westinghouse and the staff to go forward that way and we actually have taken a sample system that we are trying to work through to see how it will work actually.

COMMISSIONER ROGERS: I am trying to relate this to the concept of defense in depth. And they are related here.

MR. THADANI: Yes.

COMMISSIONER ROGERS: Is it really in essence the same thing?

MR. RUSSELL: The alternate that Ashok has identified, that is, some credit for safety systems, is more a defense in depth concept. The alternate approach is put all your eggs in a passive system basket and don't have defense in depth but then you have got to have very high confidence in the quality of that basket.

MR. THADANI: I am also trying to find a way to minimize a lot of refinements and a lot of, I suspect, various new points. I can give you an example.

If I put three experts on an issue and ask them

their views, two of them say one thing and one says something else. And if I use probablistic arguments, it doesn't help me.

COMMISSIONER de PLANQUE: We know about that.

MR. THADANI: I think that is the concern is that we could turn this into a nonsolvable issue so to speak.

COMMISSIONER ROGERS: Yes. Right.

MR. THADANI: So that is the concern.

May I have the next viewgraph, please?

[Slide.]

MR. THADANI: I am definitely not going to go through all of these issues here on this chart. By the way, I don't see anything surprising here. These are some of the open issues on the PRA. They are not that unusual. Obviously, there are differences in the passive design versus our operating experience and one has to be sure the data would be applicable to the case in hand. And then there are issues relating to common cause failures and human reliability models.

We have had a number of meetings with Westinghouse and, as a matter of fact, I am told that yesterday or day before, Westinghouse's has mailed the revised PRA to the staff. It does not include everything we had asked for but we expect to get the remainder of the information in about three to four weeks. So I see that as a big step forward.

But this gives you a sense of the types of issues that still we are grappling with.

Next viewgraph, please.

[Slide.]

MR. THADANI: And now a couple of examples of different types of issues that deserve close attention.

Staff conducted an audit of AP-600 and identified some errors and some anomalies in the calculations. for example, the basemat -- when I said errors, they found errors in some equations, actually. But for example basemat for AP-600 is six feet thick. If you look at today's designs, the basemat is generally over 10 feet thick. And that has raised an obvious question.

Westinghouse recognizes the issues that we have raised. They have gone back and they are relooking at their model and they have also, I believe, contracted an independent review of the foundation mat design to see if in fact something needs to be done if there is a real issue or not. As a result of this, Westinghouse and the staff have put together a critical list of milestones and actions on both sides because this could, otherwise, become a long lead issue and I expect a large number of meetings will take place on this issue alone.

MR. RUSSELL: Let me characterize, though, this is not unique to Westinghouse at this stage. We went through

three different iterations on structural design issues and audits on the ABWR. There was a lot of interaction back and forth on the structural issues and we keep telling the vendors that we are interested in a complete design and that includes the architect/engineer's scope, not just the reactor's system scope. So this has been a learning process, I think, for each of the three vendors.

All we are identifying here -- this is not an insolvable problem. This is relatively straightforward to handle; it just requires focus on management's part on both sides to bring it to closure.

COMMISSIONER ROGERS: The question I had is, our finding this error in an equation raises questions about the vendor's design control program and was that a kind of -- it seems to me that is something that should have been caught, an error in an equation. You know, putting numbers into the equation, sometimes that is a different matter. But that looks like the model itself wasn't looked at very carefully from which the equation was used to, you know, carry out a calculation.

What is your comment there on their design control program?

MR. THADANI: That is an issue I can't answer today but that is an issue that we have raised and we are pursuing that issue. I can't tell you how it is going to

come out.

MR. RUSSELL: These have been, however, in-process audits, they are not -- I mean, these are being done almost in parallel and real time so these are not calculations that have been completely through quality assurance review to check off, sign off, et cetera.

COMMISSIONER ROGERS: Well, that's good to know. All right.

MR. RUSSELL: So these are really issues that we are trying to interact early to identify the problems early so we can get agreement. We do expect the normal full QA that is required and we do audit that separately.

Not audit, we actually inspect it through the vendor branch to make sure that not only Westinghouse but Westinghouse's subcontractors are following appropriate QA to control calculations and design records. But these were more in-process audits.

COMMISSIONER ROGERS: Thank you. That is important.

MR. THADANI: May I have viewgraph number 21, please?

[Slide.]

MR. THADANI: The alternate piping design criteria issues basically goes back many years. As you well know, there have been concerns about excessive requirements,

particularly in terms of supports and so on from earlier years. As a result of a number of concerns that were raised from the '70s design criteria into '80s, in fact, in early '80s the EDO set up a piping review group to take a look the to see how conservative we were and if, in fact, we couldn't be relaxing some of the requirements. In fact, that led, in the mid-'80s a report was put out that led to a number of relaxations in what was previously required, leak-before-break for example and higher damping factors and there were several other areas where relaxations were provided.

Recently, however, there has been an addendum to ASME code that would allow significantly higher stresses. In fact, they are proposing to increase stress limits by I believe in fact 50 percent. The staff has consistently disagreed with that view. Staff has identified certain concerns with such a drastic change. The concerns basically relate to if you get substantial displacement, you could certainly impact other piping and could lead to certain failures. Nevertheless, the real key concern the staff had was there was insufficient data for the committee to have come to this conclusion and that more work really needed to be done before one could adopt this change.

Consequently, Office of Research has actually put together a peer review group to evaluate all the technical information before we move in this direction to determine

if, in fact, there is adequate basis for such a significant change.

Now, the reason -- and my understanding is it is probably optimistic to say that we would come to technical resolution through peer review group process by the end of the year because apparently there are significant issues involved here. But as far as AP-600 is concerned, there are other requirements, functionality and so on, leak-before-break application, that we don't really see when we took a look, went back to see if AP-600 had adopted this criterion what sort of benefit would there be to this design and we couldn't come up with much because of other requirements.

So we have indicated to Westinghouse that we disagree with this approach and that if this approach is to be pursued, resolution is not likely to be achieved until sometime next year and if we were to proceed, then we would have to apply some other considerations and yet be able to issue our safety evaluation report on schedule.

Other considerations, well, what would those be? Could be this could become a COL action item but that is walking away from some key elements in terms of design --

MR. RUSSELL: We have resolved this issue. In fact, we came to the Commission on a policy issue as it related to seismic design of the facility and we proposed that the operating bases, earthquake and all the analyses

associated with that, was not required, that we basically do a safe shutdown earthquake only. We spent a significant amount of effort back and forth with the ABWR review and the CE review and we provided substantial relief using the current ASME code and design processes such that we believe there had been substantial conservatism taken out with that revised process.

So we have, in fact, approved and would through the rulemaking design certification in fact approve relaxations from what is in the current ASME code but that approach is based upon a concept of controlling pipe stress in the piping systems. The new approach is essentially one of looking at fatigue and it does result in large displacements.

Eric and I have written jointly to the Nuclear Board. I have had dialogue with some of the representatives of the Board and have encouraged a meeting to discuss the technical areas of concern that we have and we have indicated at this point in time that we are not prepared to propose endorsing this by rulemaking because of the concerns the staff has. So you have got the issue of a rulemaking which would relate to whether the NRC does or does not endorse this particular version of the codes and the timing of that vis-a-vis the AP-600 review.

In the audits that we did, we found that there was

not much savings from this approach and, in fact, in a public meeting we had with the Advanced Reactor Corporation to discuss this that was opened that was widely covered by the press and others, they could not identify any substantive cost savings associated with applying this.

And so the issue is one that there appears to be some communications problems probably on both sides as to how this has been handled over time and we just don't have a good understanding as to why this is being pursued given the relief that we have already given on the two evolutionary designs and why should AP-600 be different from a piping design review standpoint than the other and is this another one of those slight competitive advantage issues or not. We don't know the answer to that but there is a big difference in how one designs a total system if you are looking at large displacements with valves with eccentrics, small lines off large lines and lines that can move fairly large distances, potential for impact. You get into spacial issues and some of the concerns about the total piping design process and that significant change have not yet been addressed to the staff's satisfaction.

I have agreed to meet, myself, with those members. We are trying to set up a technical dialogue to identify what the issues are. We have significant work going on and research to try and address it as well.

COMMISSIONER ROGERS: Have you had any opinions from ACRS?

MR. RUSSELL: Not yet. We suspect we will and we will be identifying it.

The ACRS did review the approach that we took on the AP-6 -- or on the ABWR and we made presentations to them on that.

COMMISSIONER ROGERS: Well, it would be interesting to hear their view on this. Maybe a little late, since Mr. Piping has gone off the ACRS --

[Laughter.]

COMMISSIONER ROGERS: But I think it still could be very helpful.

MR. RUSSELL: At this point, I think the staff needs to complete and work on the activities that are going on in research with our own peer review and interact with on the technical issues of concern with those on the co-committees to try and resolve it through that process.

We will certainly keep the ACRS informed as to what we are doing, but this issue was an open item in the draft report. To the extent we are able to close it, we would identify what it is or, if there is a dispute, we would certainly identify that both to the Commission and to the ACRS.

MR. THADANI: This was a brief list of some

selected issues and I hope it gives you a sense of the type of issues that are still open and I think a lot of work needs to be done still.

MR. RUSSELL: That concludes the presentations.

COMMISSIONER de PLANQUE: I have no further questions, thank you.

COMMISSIONER ROGERS: I would hate to see the long list.

[Laughter.]

COMMISSIONER ROGERS: I think this was very helpful. I do think that it is important that some of these matters which certainly start to look like they are policy issues really get flagged as such and get back to us so we have a chance to cogitate on them but some of them, particularly the ITAAC issue, is extremely important and maybe some of the others as well from a policy point of view and we really would urge you to think about them from that point of view.

And perhaps -- I think from time to time, the Commission has asked the staff to give us a list of items that you think are really policy issues as we are reviewing design, progress and design reviews, and I think that is important to do here as well.

MR. RUSSELL: As I mentioned, we will do that. At this point in time, we are not proposing to allow

significant change in past hard-fought policy issues like ITAAC, et cetera. But we will come to you with a paper in the June time frame that will identify the complete set of prior decisions and how they relate to the AP-600, what are some of the technical issues that are open that may have policy implications.

At this point, other than the ones we listed on source term and containment, we don't see there are new policy issues we would be coming to seek guidance. So we are integrating back and forth with the vendor and trying to hold the line on the existing policy decisions.

COMMISSIONER ROGERS: Just on that time frame, is there any possibility you could do that in the May time frame?

[Laughter.]

COMMISSIONER de PLANQUE: Like everything else.

COMMISSIONER ROGERS: I think it might be helpful.

MR. TAYLOR: Can we take a look at that?

MR. RUSSELL: We have just now sent 46 issues to Westinghouse. We have a significant management meeting planned with them in February and we wanted to have an opportunity to interact so that we could boil down the issues and see if we could make some of them become resolved. The sooner we do it, the longer the list would likely be. So there is a tradeoff on these two.

We are also, as you are aware, working hard on getting some other papers up to you related to the evolutionary designs and how we are going to handle COL issues. So we will re-look at it. We are really trying to target to the mid-June time frame rather than mid-May.

My friend to my left has given me quite a number of deadlines for May 15 already.

MR. TAYLOR: You didn't have to say that.

[Laughter.]

MR. TAYLOR: We will look at it but there are --

COMMISSIONER ROGERS: If it can be done before then, I think we would all appreciate it, if that was possible.

Thank you very much for a very enlightening briefing.

[Whereupon, at 3:34 p.m., the meeting was concluded.]

CERTIFICATE

This is to certify that the attached description of a meeting of the U.S. Nuclear Regulatory Commission entitled:

TITLE OF MEETING: BRIEFING ON ADVANCED REACTOR TECHNICAL ISSUES - PUBLIC MEETING

PLACE OF MEETING: Rockville, Maryland

DATE OF MEETING: Friday, February 3, 1995

was held as herein appears, is a true and accurate record of the meeting, and that this is the original transcript thereof taken stenographically by me, thereafter reduced to typewriting by me or under the direction of the court reporting company

Transcriber: Christopher Cutchall

Reporter: Barbara Whitlock

UNITED STATES NUCLEAR REGULATORY COMMISSION

ADVANCED REACTOR

TECHNICAL ISSUES

February 3, 1995

Ashok C. Thadani

Alan Levin

BACKGROUND

- Project Status Brief December 20, 1994
- Significant Number of Open Issues
- Selected Technical Issues

SELECTED TECHNICAL ISSUES

- AP-600 and SBWR Testing
- Selected AP-600 Issues
  - ITAAC
  - ERGs
  - Source Term
  - Shutdown and Low Power Operation
  - RTNSS, Passive System Reliability, PRA
  - Design of Seismic Category I Structures
  - Alternate Piping Design Criteria

AP-600 VENDOR TESTING

- Test Programs Provide Data for Analytical Model Development and Validation (1 Containment, 3 Reactor Systems Codes)
- Separate Effects Tests
  - Core Makeup Tank
  - Automatic Depressurization System (Sparger, Stage 1-3 Network)
  - Passive RHR Heat Exchanger (3 Tubes)
- Integral Systems Tests
  - High-Pressure Full-Height (SPES-2 at SIET/Italy)
  - Low-Pressure Reduced Height (OSU)

AP-600 VENDOR TESTING (CONT'D)

- Containment Tests
  - Heat Transfer Testing up to 1/8 Linear Scale Representation of Full Containment
  - Water Distribution on Full-Size Unheated Angular Sector
  - Scale Model Wind Tunnel Testing
- Test Programs Focused Primarily on Design-Basis Conditions
- All Testing Completed as of November 1994
  - Key Documentation to be Submitted between March and September 1995
- Supplemental DSER Scheduled to be Issued in October 1995

NRC CONFIRMATORY TESTING

- High-Pressure Full-Height Integral Systems Tests at ROSA, in Progress (10 Tests Completed)

- Additional Confirmatory Tests at OSU to Start Early CY 1995

- Tests Cover Range of Design-Basis and Beyond-Design-Basis Conditions

AP-600 SIGNIFICANT TEST RESULTS

- Findings
  - Results Appear to Indicate Passive Safety Systems Will Accomplish Intended Safety Functions
  - PRHR Heat Removal Dominates Early Integral Facility Response
  - PCCS Performance Dominated by External Cooling
- Notable Observations
  - Early PRHR Initiation Results in Cold Water Returning to RCS
    - Significant Thermal Stratification in Cold Legs
    - OSU and ROSA Show Water Hammer when ADS Actuates
  - Dynamic Behavior Seen in Long-Term Cooling Data from OSU, Westinghouse Evaluation Requested

SBWR VENDOR TESTING

- Test Programs Provide Data for Analytical Model Development and Validation (TRACG)
- GE Test/Analysis Program Reassessment (TAPD) Submitted August 1994
- Separate Effects Tests in PANTHERS Facility (SIET/Italy)
  - PCCS Heat Exchanger (Complete)
  - IC Heat Exchanger (Begins April 1995)
- Integral Systems Tests
  - Planned Testing is Containment Related (Long-Term Cooling)
    - Tests at PANDA (PSI) Scheduled to Begin March 1995
    - Additional GIRAFFE (Toshiba) Tests Planned (Feb. 1995)

NRC CONFIRMATORY TESTING

- Tests in Low-Pressure, Reduced-Height Integral Systems Loop (PUMA—Purdue University) Scheduled to Begin About Mid-1995
- Scope Includes Full Range of Conditions at Low Pressure
  - Late Blowdown, ECCS Injection, Transition to Long-Term Cooling
- Test Matrix Includes Both Design-Basis and Beyond-Design-Basis Events

TEST PROGRAM REVIEW

- Staff Provided Evaluation of TAPD in November 1994
  - Basic Logic Structure of Program is Appropriate, But Many Details Still Missing
  - Containment Testing Appears Adequate, Pending Review of Scaling Analyses and Test Matrices
    - Treatment of N2/H2 Mixtures is of Concern
  - Staff Believe Reactor-Systems-Related Testing is Inadequate for Code Validation
    - Additional Data Required in Late Blowdown/Early ECCS Injection Phases of Design Basis Accidents
- No Significant Findings or Observations as Yet on Test Results
  - Review Will Proceed as Data Becomes Available from GE

TEST PROGRAM REVIEW (CONT'D)

- Staff Met with GE in January to Discuss Staff's Assessment
  - GE Agreed to Address All Staff's Concerns
  - GE Exploring Possibility of 4-6 Tests at Toshiba on Late Blowdown/Early ECCS Behavior
  - Resolution of Reactor-Systems-Related Integral Testing Issue Appears Feasible
- Staff/GE Met with ACRS in January
  - ACRS Generally Agreed with Staff's Assessment
  - Committee Raised Additional Questions that GE Will Address

AP-600 ITAAC

- AP-600 Approach vs Evolutionary Design Approach
- Phased ITAAC on Digital I&C Design Process
- Passive Systems cannot be fully tested prior to fuel loading
- Staff plans to hold a number of ITAAC meetings with Westinghouse

AP-600 EMERGENCY RESPONSE GUIDELINES

- AP-600 ERGs not submitted as part of design certification.
- AP-600 ERGs required as part of DC because:
  - Passive system transient mitigation philosophy is novel
  - ERGs developed with supporting analyses of transients and accidents
  - ERGs needed for task analyses to support control room design
  - ERGs relied upon to resolve issues where operator actions play key roles in accident scenarios, e.g., SGTR.
- Westinghouse agreed to submit AP-600 ERGs in May 1995

AP-600 SOURCE TERM

- Westinghouse uses new physically based source term
- Open issues
  - Timing of release
  - Containment aerosol removal rates
  - pH control in containment
- EAB dose
  - Westinghouse calculates for the first 2-hrs of DBA
  - NRR disagrees; calculates for worst 2-hr period

AP-600 SHUTDOWN AND LOW POWER OPERATIONS

- A systematic evaluation of AP-600 design against shutdown risk issues identified in NUREG-1449 is needed

- Use of PRA to determine importance of shutdown risk issues

REGULATORY TREATMENT OF NON-SAFETY SYSTEMS

- AP-600 relies on passive systems to perform safety functions
- RTNSS Objectives:
  - Identify important active systems needed to meet beyond design basis deterministic requirements and safety goal guidelines
  - Develop appropriate regulatory oversights for these important active systems
- Important issues:
  - Acceptability of baseline PRA
  - Resolution of passive system T/H reliability
  - Evaluation of adverse systems interactions

AP-600 PASSIVE SYSTEM T/H RELIABILITY

- Passive safety systems rely on natural forces, such as gravity and stored energy, to perform their functions
- Such forces are relatively small compared to pumped systems; their magnitude vary from one scenario to another and they are subject to large uncertainties
- This requires assessment of the passive system T/H performance reliability
- Quantification of passive system T/H performance reliability is very difficult and complex

AP-600 PASSIVE SYSTEM T/H RELIABILITY

- Staff considering a risk-based "margins" analysis to eliminate the need to quantify T/H performance reliability

- Insights from testing are being sought in identifying phenomenology and range of parameters affecting passive system performance

AP-600 MAJOR DSER PRA ISSUES

- Applicability of generic failure data
- Common-cause failure (CCF) probabilities
  - Several risk important CCF probabilities may have been underestimated by underestimating the common cause failure multipliers (e.g., the CCF probability of IRWST injection check valves)
- Human Reliability Analysis (HRA)
  - No proper HRA modeling techniques and procedures were followed (e.g., in modifying failure rates to account for dependency, stress level and recovery)
  - Westinghouse is revising the HRA
- Justification of I&C failure data

AP-600 DESIGN OF SEISMIC CATEGORY I STRUCTURES

- Design of seismic Category I building structures requires substantial amount of work to be completed
- Audits identified errors in design calculations that might impact basemat and wall thicknesses
- Staff is continuing its audits of structural design calculations and meetings with Westinghouse.

AP-600 ALTERNATE PIPING DESIGN CRITERIA

- Westinghouse proposes to use revised piping design criteria
  - Recently approved by the ASME Boiler & Pressure Vessel Code
  - Portions not acceptable to the staff
- Proposed criteria have potential to reduce safety margin
  - Impact on AP-600 piping systems needs to be assessed
- RES is evaluating new piping criteria
  - Agency-wide position is expected by the end of 1995
- AP-600 Impact
  - Because little benefit is seen for AP-600, staff rejected its use at this time