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DISCUSSION OF REACTOR VESSEL WATER LEVEL INDICATOR PROGRAM

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

DISCUSSION OF REACTOR VESSEL WATER LEVEL INDICATOR PROGRAM

PUBLIC MEETING

Room 1130
1717 H Street, N.W.
Washington, D.C.

Thursday, October 14, 1982

The Commission convened on the above-entitled matter, pursuant to notice, at 10:02 a.m.

BEFORE:

NUNZIO PALLADINO, Chairman
VICTOR GILLINSKY, Commissioner
JOHN AHEARNE, Commissioner
THOMAS ROBERTS, Commissioner
JOHN ASSELSTINE, Commission

STAFF PRESENTERS SEATED AT COMMISSION TABLE:

JOHN E. ZERBE, OPE
HAROLD DENTON, NRR
ROGER MATTSON, NRR
LARRY PHILLIPS, NRR
CARL MICHELSON

P R O C E E D I N G S

CHAIRMAN PALLADINO: Good morning, ladies and gentlemen.

This morning's meetings is on the subject of additional instrumentation for detection of inadequate core cooling. We last met with the staff on this matter in Januery of this year. At that time, we also heard from reactor vessel level instrument vendors, and members of the ACRS.

We have recently received a paper from the staff, which addresses the issue that remained after the January meeting. The paper requests Commission approval of the staff's final recommendation in regard to this matter.

The purpose of this morning's meeting is to allow the staff to discuss the resolution of the open items from the last meeting and to answer any further questions that the Commissioners may have.

Do any of my fellow Commissioners have any opening remarks that they would like to make?

(No response.)

CHAIRMAN PALLADINO: Then I think, at this time, I will turn the meeting over to Mr. Denton.

MR. DENTON: Thank you, Mr. Chairman.

We think we have resolved the questions that

were brought up in previous meetings. We have made a lot of progress since those times. We have met with industry. We had several meetings of the committee to review requirements. We met with ACRS. We think we have resolved the technical issues that were outstanding.

We have done a lot of work on the cost/benefit issues. We are prepared today to make a recommendation that instrumentation for detection of inadequate core cooling be installed in all facilities.

Roger Mattson will describe where we have come out on this issue and the results of the studies I have mentioned.

COMMISSIONER AHEARNE: Could I ask Roger to be a little clearer than the paper is on where you come out on B&W.

MR. MATTSON: Yes.

COMMISSIONER AHEARNE: It is not all that clear.

MR. MATTSON: We will come to that as we get through this. We will probably want to discuss it at length.

With me today is Larry Phillips, the Section Leader for the Thermal Hydraulic Section for the Core Performance Branch. It was under Larry's direction that

work by the staff to review the vendors proposals and to develop generically applicable criteria, and to monitor the work of the contractor at Oakridge National Laboratory that was involved with this. All that occurred under Larry's direction.

(Commissioner Gilinsky joined the meeting.)

If I could have the first slide.

(Slide.)

This is just an introductory slide to put something on the screen while I refresh our collective memories of how we got here.

Shortly after the accident, it was fairly clear to everybody in this business -- regulators and regulated alike -- that there needed to be more direct indication of what was happening with core cooling than the operators at TMI had. The level indicator in the pressurizer had not worked to anybody's satisfaction. It was susceptible to failure for a range of accidents that we now realized had a higher probability than we appreciated before.

There were instruments, however, in this system, core exit thermal couples, that had we appreciated the value, we would have prepared operators for using them better. So it was easy to move in the short term to improving our reliance, and the ability to

rely on those core exit thermal couples. So that is hwere the concentration was for the first year or so.

COMMISSIONER GILINSKY: Could I interrupt you for a minute.

In the Lessons Learned Report, you said that in retrospect the instrumentation was adequate to detect core voiding. Is that what you had in mind, core exit thermal couples?

MR. MATTSON: Your memory is better than mine, Commissioners.

It was possible to tell from the core exit thermal couples at TMI that there was voiding and inadequate core cooling, yes, and that is essentially what I am saying here today, too.

COMMISSIONER GILINSKY: In fact, I wondered if that was a misprint. But it did say in the report that in retrospect the instrumentation was sufficient to detect inadequate cooling. Then you go on to say that it would be useful to have more direct reading, and so on.

MR. MATTSON: Let me talk for a couple more minutes, because I think I am going to come to that point.

The short term response was to use what was there better. That is, make better use of the core exit

thermal couples, because we realized, just as you said, that there was sufficient information for the operators to know, if they had appreciated it, that the cooling was inadequate and that damage would be occurring to the core, and more had to be done to cool the core.

What we were uncertain of at the time we issued requirements to improve the ability of the core exit thermal couples and to install the sub-cooling margin monitor in PWRs, back in the short-term after TMI, was whether we needed more instrumentation to detect the approach to inadequate core cooling, to give more advance warning, and then, also to aid in the recovery from inadequate core cooling, the reestablishment of inventory or level in the primary cooling system.

COMMISSIONER AHEARNE: Roger, don't you also, though, need something which might not necessarily come from the core thermal couples, and that is that at the stages when the operators are taking action, you need something to let them know their actions are helping or harming.

MR. MATTSON: That is right.

See a year ago, if I could turn to the next slide.

(Slide.)

A year ago, when the controversy was boiling between the ACRS, the staff, and the reactor vendors, the controversy, I think today, flowed mostly from what is the function we are trying to get this instrumentation to serve. Exactly what kinds of accidents, what periods in those accidents are we trying to cover with this instrumentration. There were differences of opinion as to what we were trying to achieve, and as a result there was controversy over ambiguity.

We kept insisting that we were after a level indicator. We wanted to know the level in the primary cooling system.

COMMISSIONER AHEARNE: But, in fact, there had been some words about unambiguous.

MR. MATTSON: Yes, and we were saying that we were going to make the world's best level indicator. We were going to make it unambiguous.

Then somebody said, "Wait a minute! What is going to happen when the pumps are running, the reactor coolant pumps. It isn't really level that you are measuring any more, at least not below the upper core support plant. It is some kind of inventory that you are monitoring." "Well, yes," we said, "it is some kind of inventory. It is level." "Why do you call it a

level indicator; won't that be ambiguous to the operator?"

It was in that controversy that you all were thrown last December and January, and had reactor vendors sitting here at the table, and the ACRS sitting here at the table, and a lot of confusion. You sent us off to try to address this question of ambiguity, to try to sharpen up exactly what is it that this instrument is providing that the other instruments don't already provide. And what are some of the costs and benefits, and some of the other questions that go along with that. But primarily it was this question of ambiguity and sharpening the definition of the function that the instrumentation was trying to provide.

We set forth an action plan for resolving that controversy. That plan led to a number of meetings, and they are shown on the third page of the package of viewgraphs that you have.

The first step was to meet with the industry and try to see if the misunderstanding among the various parties was as great among the technologists as it had seemed to be up here at the Commission table when the various vendors --

COMMISSIONER GILINSKY: Let me go back a little further, so that we start at the beginning.

We did ask all the companies to examine the question and evaluate some means of arriving at an indicator of water level. Did they all supply us with an evaluation?

MR. DENTON: No, they differ considerably, and Roger will come to, in a slide or two, where they stand in terms of responsiveness.

COMMISSIONER GILINSKY: But this is way back in 1980 that I am talking about.

MR. DENTON: They still differ today.

COMMISSIONER GILINSKY: I understand that. This is 1982, isn't it.

MR. MATTSON: Let me refresh my memory for a minute to make sure I don't misremember.

(Pause.)

MR. MATTSON: I think it is fair to simplify the response back in the 1979-1980 period to say that Westinghouse and Combustion, and their owners, responded more positively to the question of: Is there a need for additional instrumentation? The B&W owners and B&W responded more negatively, that is, saying they didn't think there was.

COMMISSIONER AHEARNE: This is somewhat euphemistically described. The B&W gentleman sat here and said that it wasn't needed and also was not

possible.

MR. MATTSON: I think that is too hard. There are two B&W owners who have proposed specific systems.

COMMISSIONER AHEARNE: But Vic was going back historically, and historically --

MR. MATTSON: But you are talking about a meeting that occurred a year ago at which time two B&W owners, at least, had proposed specific designs that we had under review. They didn't have the design details. They didn't have the engineering support. They didn't have the integration from their supplier that Westinghouse and Combustion had supplied for their systems, but it is unfair to say that they were in total opposition to this. There were at least two that said, "Here is a system, what do you think of it."

MR. DENTON: It appears that it is going to take orders to get B&W to install the kind of instrumentation that we like, and we then intend later in the presentation to show how we would accomplish that.

COMMISSIONER GILINSKY: Do we get submissions from each of the licensees agreeing or disagreeing with us, perhaps, but --

MR. MATTSON: Yes. They were required to submit us their views on what additional instrumentation

they thought was needed to complete an inadequate core cooling package.

COMMISSIONER GILINSKY: As I understand it, our view, or the view of the technical staff, was that this sort of instrumentation was more important in the case B&W reactors than in the case of the other PWRs.

MR. MATTSON: That is correct, yes.

CHAIRMAN PALLADINO: Are you going to take some time to over again why you think the B&W proposal is unworkable?

MR. MATTSON: Yes, we will come to that.

MR. DENTON: The status of the three suppliers is a part of the talk, and it is just a slide or two from where Roger is. If we could allow him, he will get there.

MR. MATTSON: Or we could move there now. He just wants to go over history.

COMMISSIONER GILINSKY: I guess the reason I bring this up is because we seem in a way to have gotten diverted.

The concern arose in the case of the B&W reactor. That is where, as I understood it, it was most important. B&W hung back on this for a number of reasons, so we concentrated on the ones that were more cooperative, but where the problem was not as severe.

It seemed to be more workable there.

MR. MATTSON: There is --

COMMISSIONER GILINSKY: They got caught up because of our tendency not to make invidious comparisons between reactors. We operate on a broad front.

MR. DENTON: B&W has had, I think more than the others, a "show me" attitude. They apparently are not convinced that it is of value, and except for the two efforts that Roger talked about, they have not been as forthcoming.

COMMISSIONER AHEARNE: This may be an unfair characterization because all I have is what I read in the material that has been sent up, but I would say that it is a lot more than a "show me" attitude, it is "I am not going to do it unless you order it."

MR. DENTON: I would prefer to have them characterize it in those words.

COMMISSIONER GILINSKY: However you characterize it, Westinghouse and C-E got caught up in this concern which really was initially brought up by B&W.

MR. MATTSON: Caught up is not the right way to say it. They believe this instrumentation should be added to their machines.

COMMISSIONER GILINSKY: I believe that to be, too, but the concern was greater in the case of the B&W reactors.

MR. MATTSON: There is need for this instrumentation in the other reactors, too. Sensitivity of the B&W machine, the pulling of voids in the primary coolant system is a more likely occurrence there, and for that reason it is fair for you to say that the need is probably greater in the B&W machines.

MR. DENTON: I think we are on the side that says, we think that B&W plants need it, too. I don't want to have any posture other than that.

COMMISSIONER AHEARNE: You said, you think they need it, too.

MR. DENTON: I think they all three need it.

COMMISSIONER AHEARNE: Roger just said, probably greater.

I know Vic and I have reached the conclusion that it is greater and do need it and would need it first. Do you disagree that the need is greater for them?

MR. DENTON: No, I think so, too.

MR. MATTSON: We agree. The first will be difficult since some Westinghouse plants already have it installed and calibrated. The first is past already.

CHAIRMAN PALLADINO: You speak of need, but you do use words, at least in the March 12 letter than transmissed the report from the staff, that says: "This report does not establish that reactor vessel level measurement systems are necessary to plant safety." And there are a couple of places where it says that it is very highly desirable. Do you believe this statement, or don't you believe it?

I gather, even though you speak of need, you haven't established in your own mind that there is a need, at least this important.

MR. DENTON: It depends on whether you are talking about a legalistic need and are all the plants in the U.S. deficient today because they don't have it. I look at it in the sense that we have phased implementation of improvements after TMI, and this is one of the improvements that needs to be put in. But I didn't want to get in the posture of saying that Plant A out there that doesn't have it today, can't operate safely without it, when we have stressed things like thermal couples and procedures. But I am advocating today that you approve a requirement that they put in and installed in all PWRs.

COMMISSIONER GILINSKY: This is the difficulty we face in the backfit rule.

MR. DENTON: It is that semantic use of that word.

COMMISSIONER GILINSKY: I don't think it is inconsistent to say that they are aided and it has to be there for safety, but we don't have it today, we have lived with it, and we will continue to live with it for some time.

CHAIRMAN PALLADINO: Other places you say, there is a benefit of unknown magnitude, or words to that effect.

MR. MATTSON: They are a known benefit. Where you are reading is, can you quantify that benefit the way you quantify benefits with probabilistic risk assessments and a lot of other ways. That is very difficult to do, because the instrument, what it really does is improve the operator reliability in responding to fairly frequent events that can cause voiding in the primary coolant system. If you improve his reliability in responding to those events, he doesn't make mistakes that lead to more failures, more compounding errors, and turn them into core damaging events.

How do you quantify that with probabilistic risk assessment? Stand back a minute, PRA only deals with a melted core or an unmelted core. This slicing of the bologna in a slightly degrade core versus an

undegraded core versus an arrested core melt, the PRA assessments by which you quantify risk are not capable of getting down to that level of detail.

So in the discussion in the paper that is the point that we are trying to make, it's that it is difficult to quantify. We know that it is a benefit to increasing the reliability of the operator in responding to frequent events of the steam generator tube rupture, pump seal, too fast a cool down, those kinds of events that occur with a frequency of one in ten, one in 100 years, that if there are compounding errors, or compounding equipment failures, can turn into very challenging events, and the operator reliability has to be high.

This device significantly improves the operator's reliability for those kinds of slow moving events that pull voids in the primary coolant system, give him assurance and reliability in dealing with those voids, so that they don't confuse him and lead him to make errors that we have seen or that there would be a tendency for with those slow moving events.

CHAIRMAN PALLADINO: Why don't we let you go on a little farther because eventually I do want to ask some other questions that are not related to need.

MR. DENTON: We do have a slide on which we

have attempted to list all the uses of vessel inventory information, and it is about a dozen of them that we have identified. It is the very last slide, the rear-end.

COMMISSIONER AHEARNE: Page 6.

MR. DENTON: The last page in the handout lists the types of use that we think this instrumentation --

CHAIRMAN PALLADINO: Why don't we let you go on. I was not questioning the potential value of such a system, but rather your words.

MR. DENTON: Really, our recommendation is that you require the installation of these.

MR. MATTSON: If I could just then quickly dash through this third page.

We met with the industry. We met with the CRGR twice. We met with the ACRS in one tough meeting back in April, at the subcommittee and committee level. We rebriefed the ACRS this month to tell them where we were and how the CRGR had come out.

Let me say what happened in the course of those meetings. I think the bottom-line is that we drew a consensus from that community of interest in inadequate core cooling instrumentation. We had long discussions of the events for which this instrumentation

would be useful. We had long discussions and concerns with the problem of ambiguity.

We had good operator feedback, for example, at the industry meeting. If I could characterize that in a few lines it would to the effect of the operator saying, "You gave us a pressurizer level indicator once that we thought we could reply on. Obviously you lied, we couldn't rely on it. Don't give us another instrument like that. Before you give it to us and make us rely on it, assure yourselves as engineers, regulators, designers, that the thing works and that it won't give us misleading information."

COMMISSIONER CILINSKY: When you say operators, do you mean licensed operators?

MR. MATTSON: Licensed operators and station superintendents that were brought in by the owners groups that we had invited to the two-day meeting in February.

Another thing we learned, however, was that if you do a good engineering job on this inventory trending system, this thing that we used to call a "level indicator," and you integrate it with procedures, you integrate it with training, you integrate it with the indicators on the panel in the control room. If you spend some money and work hard at it, as Westinghouse

and Combustion-Engineering have done. If you provide data to underpin the correlations that are used for pressure drop calculation. If you provide tests and facilities at Combustion Engineering, or in LOFT or in SEMISCALE, or these systems, like have been conducted in the course of the last two years. The ambiguity questions that have been raised can be answered, and they can be answered to the engineering and to the operational people's satisfaction.

COMMISSIONER AHEARNE: To me, at least, you very carefully excluded B&W from your list.

MR. MATTSON: B&W throughout this period has done no new work. They came to the meeting in February, both as an owners group and as a vendor, saying, "Here are some conceptual proposals for how we could do it if you insist on it. But we think it could be ambiguous, and we think that it is very difficult to do right." "Show me," as Harold has said, was more their attitude, rather than --

COMMISSIONER GILINSKY: Is it tied to their lawsuit?

MR. MATTSON: I haven't any idea.

CHAIRMAN PALLADINO: Didn't ACRS say some of the same thing; at least some of the individual members did.

MR. MATTSON: A year ago, yes. Now in the meeting that occurred in April, in subcommittee and committee, long discussions of the work that we had done in the February meeting with industry, the first report that we had written for the ACRS and for the CRGR, and the CRGR review. Long discussions of the same issues -- ambiguity; failure modes and effects; how do you train operators; how do you itegrate it in the control room.

The ACRS agreed that the conditions that we were placing upon the installation and training of the operators for the Westinghouse and Combustion-Engineering systems sounded good to them. They said that we were on the right track, if I can paraphrase their letter. I represent to you today that the ACRS is in agreement with where we have come and the recommendations that we are making to you.

CHAIRMAN PALLADINO: Does that include the two people that took exception earlier?

MR. MATTSON: One of the two people spoke up at the ACRS briefing that I gave last week, Mike Bender. He said, "You will have to show me." That was the state of his dissatisfaction at this point, he didn't go on at length. I took that to mean that he still is unconvinced that it can be done unambiguously, but the committee has written a letter supporting what

we were doing and giving their endorsement.

COMMISSIONER ROBERTS: What about Harold Lewis?

MR. MATTSON: Lewis was at the meeting, but he didn't speak.

COMMISSIONER GILINSKY: Bender's view is that we ought to fix the reactors rather than supply more instrumentation, which is not an unreasonable view in the long run at any rate.

MR. MATTSON: I share that.

CHAIRMAN PALLADINO: I think some of the questions he raised, I would like to have time to address this morning, because I still don't have quite the confidence in the one system, the Westinghouse system, that it is unambiguous and that you can feel confident about the information you get. I would like to be assured, and maybe we could do it this morning.

MR. MATTSON: Let me finish this slide and move to the next, and I suspect that it will lead us to those questions.

The focusing that needed to occur on what is the function of this instrumentation, really occurred in the process of these meetings, in preparing for CRGR and ACRS, and in listening to the industry feedback.

If I could say what the function is in two

simple statements. First and foremost, it is to provide coverage, provide information in a time period of interest for slow moving events that lead to voiding in the primary coolant system, where the coverage provided by the sub-cooling margin monitor and the core exit thermal couples is not complete.

That is, during a period that can be as long as hours, three or four hours, for a thing like a reactor coolant pump seal failure, a stuck open PORV, a steam generator tube rupture, which we know can happen, where you have lost sub-cooling and the sub-cooling margin monitor says zero, there is saturation at the top of the core, yet there is no heat up in the core yet. The core exit thermal couples have not begun to rise in temperature.

That dead span, if you will, in current instrumentation, can be several hours long. During that period, the operator is going to be taking actions. His procedures don't say that you have to do this or that, but he is in an event where the containment pressure is rising, the radiation signals are showing, or there is water flowing from the primary into the secondary through a broken steam generator.

He is going to be making manipulations with the emergency core cooling system. He is going to be

manipulating the secondary system to raise or lower pressure, depending on what his procedures tell him. He won't know whether that voiding that is occurring in the primary coolant system is getting worse or getting better.

Remember the Ginna steam generator tube rupture. The operators, because of really a crude level indicating system in Ginna, some thermal couples distributed in the upper-head, knew they had a void up there. They used those thermal couples to help assure them that the actions they were taking, although they were slow and deliberate, weren't causing that bubble to get bigger in a way that it could begin to interfere with the operation and the cooling of the plant. It is the same thing here. You need to know during that dead span whether the actions you are taking are aiding or hurting the recovery of the plant.

Some operators will argue, "Wait a minute! The procedures say, put all the water you can in there." The procedures say, put all the water you can in there and cool the core, yet real human beings in real situations see contrary indications. Things fail that you don't think are failing. Maybe a generator didn't start. Maybe a pump didn't flow. Maybe a valve didn't open. Maybe it was two steam

generator tubes instead of one. Maybe it was a leaking steam generator on one hand, and another broken steam generator. Maybe it was a stuck open safety in the secondary, in addition to the steam generator tube leak.

Those things are happening in plants. They become confounding to the operator, and you can't really sit at a table like this or at a design table and anticipate all of them. So what you are trying to do is increase the information during that dead span between loss of sub-cooling and onset of super-heat. The instruments that Westinghouse and Combustion have designed in detail, and B&W has proposed in concept, will significantly aid the operation of the plant.

There is a second place that the instrumentation is useful and that we have focused its design on. It is not quite as important as this one, but it is an interesting one anyhow.

Remember at Three Mile Island, when we recovered the core, when the level had been reestablished and things were stabilized and cooling was good, some thermal couples indicated super-heat and some thermal couples indicated sub-cooling in the core.

At TMI that wasn't difficult to interpret because the level had been restored in the pressurizer.

It is not hard to think of events where you might not restore level in the pressurizer. The level indicators might fail because of high radiation or flooding, they are not safety grade indicators after all. The break might have been in the pressurizer surge line, so you would not refill the pressurizer.

For an event where you think you have recovered the core, yet some thermal couple indicate high and some thermal couples indicate low, that is a completely unambiguous indication of core recovery, as the designers say, and this level indicator would help you -- this inventory indicator turned level indicator with the pumps off would help you interpret and understand that domain.

It is those domains principally that this inventory trending system is now targeted at and that there is general agreement on. The first one I should mention includes both operation with reactor coolant pumps running, and operation with the reactor coolant pumps off.

We are convinced now we can do that. The systems have been tested and analyzed and proven for those conditions, and we are convinced that the B&W system can be improved and designed in detail to satisfy those functions.

CHAIRMAN PALLADINO: You talk of tests, and that is one of the things I wanted to ask you about. Maybe you would rather go on and I will ask them later. Were the tests dynamic in nature? Did they have change of phase? Did they have voiding?

MR. MATTSON: Yes. I think if we turn to slide four, you will see I have just summarized that plant.

(Slide.)

While that is in front of you to prod your memory is there are questions you want to ask on the summary I just gave, while don't I ask Larry to summarize the kinds of tests that Combustion did in their two-phase facility in Connecticut, and Westinghouse did in the LOFT and SEMISCALE facilities in Idaho.

CHAIRMAN PALLADINO: While slide is this?

MR. MATTSON: You won't see it described on this slide, but this may prompt your thinking about some of the conditions for which the testing needs to be applicable. There isn't a slide that goes to the testing directly.

MR. PHILLIPS: For Combustion Engineering, we had them install -- I am sorry, I meant to start with Westinghouse. We had them install their level probe on

the SEMI-SCALE test facility, and piggyback on some small break LOCA experiments that were being run there. The system, of course, was well instrumented by other instruments, including the DP systems that were there for the SEMI-SCALE test instrumentation.

The tests were thoroughly analyzed and performed essentially as predicted, at least with the error band predicted.

MR. MATTSON: Wasn't there in one of the tests some error in the design of the system that showed up, and they went back and corrected for the test?

MR. PHILLIPS: Yes. The error was in the design of the test, and it had to do with a pressure drop between the core region and the upper-head region where the tap was. It was non-characteristic of the situation in the reactor, and the test was rerun with the reactor more closely simulated. It was concluded that the initial analysis of the reason for the problem was correct, and that the system was behaving properly.

CHAIRMAN PALLADINO: It is the Westinghouse system that gives me the most difficulty at the moment. Is there a delta P that they can get that will unambiguously give you some indication of the amount of voids, or can you get that same delta P from a variety of situations?

MR. PHILLIPS: No.

CHAIRMAN PALLADINO: No voiding and pumps running, or voiding --

MR. MATTSON: The Westinghouse delta P system uses different pressure taps depending on whether the reactor coolant pumps are running or are off. The system itself will detect whether the pumps are on or off, and then the operator will be told which scale to rely on.

With the pumps running, the differential pressure that being measure is the pressure drop across the reactor coolant pump --

CHAIRMAN PALLADINO: Across the reactor coolant pump.

MR. MATTSON: -- across the reactor coolant pump. How much pressure rise is provided by the pump running and pumping the fluid. That differential pressure is correlated to the amount of void in the fluid that the pump is pumping. The correlation was derived from testing by testing by Westinghouse in France, using I believe a full-scale Westinghouse pump.

CHAIRMAN PALLADINO: How does that give you any indication as to whether or not you have got voids in the core? You may hav voids elsewhere in the system.

MR. MATTSON: But if the pumps are running, then the void is being mixed throughout the system, and what you are measuring is the average void content of the reactor coolant system. There may be slightly higher voids in the core, but because of the circulation it is being mixed by the pumping action.

CHAIRMAN PALLADINO: You can have a delta P across some generator --

MR. MATTSON: But the delta P is a function, Mr. Chairman, of the amount of void. As the void changes, the delta P changes, and it is the change of delta P that gives an indication of the trending of the voids. As the delta P goes up, the voids are getting higher. As the delta P goes down, the voids are getting lower.

It is the correlation of the change in pressure drop with the change in void that has been measured in experimental facility for that pump, that is input to the design of the system. It is all in the electronics, that correlation is all built-in, and as the sensed difference in pressure across the pump changes, the instrument tells the operator that the void content is either increasing or decreasing, depending upon how the signal across the pump is changing.

COMMISSIONER AHEARNE: How much time lag is

there between the void coefficient and the actual void in the system --

CHAIRMAN PALLADINO: I am sorry, I want to hear the question.

MR. MATTSON: I am not sure.

COMMISSIONER AHEARNE: I wondered what kind of a time lag there was between the void coefficient measurement and the actual void in the system.

MR. MATTSON: Essentially none. There is no power changing characteristic of the core other than a slow decay in the shutdown mode, although there may be a slightly higher void content in the core. In some regions of the core, there is a power distribution within the core.

In the outlet of the core, the voids are all mixed uniformly and flow over through the pump, and that indication is rapid -- seconds is the transit time of the primary coolant system -- so it is a fairly rapid picture of the current condition of the core. The current void content of the reactor coolant system, it is an instantaneous measurement.

COMMISSIONER AHEARNE: I guess you are talking there about a mixture of voids through the core. What in the case of a bubble above the core, which is now forcing down.

MR. MATTSON: That bubble would be up in the upper-head and would be out of the way of the flow. If it is now out of the way of the flow, the water impinges upon the bubble. It sweeps away steam, mixing it up with the water, changes the void content, and that is instantaneously recorded by the real time pressure differential measurement across the pump and indicated on the inventory trending system in the control room.

CHAIRMAN PALLADINO: I guess I would feel better if I saw the tests.

COMMISSIONER GILINSKY: It sounds to me like it wouldn't hurt to have a detailed briefing on this subject.

MR. PHILLIPS: If I can clarify. The testing that was done on the degraded part in the facility in France was a pressure drop around the system. The void distribution is rather uniform when the pumps are running. The pressure measurement on the Westinghouse system is from the bottom of the vessel to the top of the vessel. So it is really the pressure drop across the core that is being continuously monitored.

CHAIRMAN PALLADINO: Wait, what is the Westinghouse going to be? You mentioned across the pump in the test, and now you are mentioning delta P across the core in the system.

MR. MATTSON: Mr. Chairman, there is some disconnect in our communication because this is the way flow is measured in flowing systems in all engineering system. There is nothing mysterious about about this system.

CHAIRMAN PALLADINO: But it is not. My experience has been very sad on two-phase system, that is why I keep wondering about it.

There was some disconnect also in what you are proposing. You mentioned the delta P across the pump. Is that what Westinghouse is proposing?

MR. PHILLIPS: No, it is across the reactor vessel.

CHAIRMAN PALLADINO: That is what I thought, and then you had two, in a sense.

MR. PHILLIPS: Which is a good fraction of the delta P through the system.

CHAIRMAN PALLADINO: Was that tested under dynamic conditions with voiding in process?

MR. PHILLIPS: No.

MR. MATTSON: The tests in SEMI-SCALE are dynamic tests. Small break LOCA with voiding in the system.

CHAIRMAN PALLADINO: And they got unambiguous correlation on the system as proposed?

MR. PHILLIPS: The tests were done on small break LOCA conditions.

MR. MATTSON: But this was with the pumps off.

MR. PHILLIPS: This was with the pumps off, right.

MR. MATTSON: I thought you were concerned with the pumps on.

CHAIRMAN PALLADINO: I am concerned with any time you are voiding.

MR. PHILLIPS: The pumps on data comes from the French tests at the French facility. I think you are referring probaby to the problems with two-phase multipliers, and so forth. Actually what we are talking about here is a decrease in mass flow through the system, which is predominant. As your mass flow decreases, your pressure drop will drop also. It goes in the opposite direction if you are two-phase multiplier, and it is a function of the mass and clearly related to the degraded pump tests in France.

CHAIRMAN PALLADINO: My concern is that whatever we measure is not going to mislead the operator. I think this idea of having a good indication is in concept the right one, but I somehow don't have the same kind of feeling about this kind of a DP system

as perhaps I would with a hot junction thermal couple.

However, in that one, we are measuring something different than we are in this one, and that is another question I don't understand. We are not measuring the same thing in the CE system as we are in the Westinghouse system.

MR. MATTSON: We use a different method of measuring inventory.

CHAIRMAN PALLADINO: You not only use a different method of measuring, you come up with an answer to a different question.

MR. MATTSON: I don't believe so. Not with the pumps running you don't for sure.

CHAIRMAN PALLADINO: With the CE system, it will tell you if it has voids above the core, and that is it. With the Westinghouse system, it will tell you whether you have voids in the core, perhaps.

MR. MATTSON: That part of the Westinghouse system, we have said, we wouldn't require. It is there, but we wouldn't require it. In fact, if you look at what we say we would require of the B&W system, the detection of level below the top of the core as provided by the Westinghouse system, we say is unnecessary.

We would want them to be able to provide level in the upper-head and level up and down the candycane.

CHAIRMAN PALLADINO: Does the Westinghouse system tell you whether you have got void in the upper-head?

MR. PHILLIPS: Yes.

MR. MATTSON: Yes, because it has a pressure tap at the upper-head.

CHAIRMAN PALLADINO: You mean between the top of the core and the top of the head?

MR. MATTSON: Yes.

MR. PHILLIPS: Right. There is also one to the hotleg, which gives a more precise reading.

COMMISSIONER GILINSKY: That would tell you about a void whether or not the pump is running?

MR. PHILLIPS: The only delta P used for the pumps running condition is what we call a wide range, and it is between the top of the head and the bottom of the vessel. Under dynamic conditions, of course, it is about triple the pressure drop as when it is static.

CHAIRMAN PALLADINO: It is what?

MR. PHILLIPS: The delta P difference is about three times the static DP difference.

CHAIRMAN PALLADINO: I am sorry, I lost you. I thought you said you were going to rely on the pressure drop between the top of the head and the top of the core. Now you are saying they are really relying

between the bottom of the vessel to the top of the vessel?

MR. PHILLIPS: The bottom of the vessel to the top of the vessel --

COMMISSIONER AHEARNE: Could we ask Roger to just sketch.

MR. MATTSON: I don't have the slides today, but I can show you where the pressure taps are and try to straighten this out. I don't know how to bring you back out of these details to tell you that we have covered these details, but we are not prepared to do it today.

COMMISSIONER AHEARNE: Two basic descriptions. We are talking about Westinghouse. In the case of the pumps on, what are you measuring? In the case of the pumps off, what are you measuring?

MR. PHILLIPS: In the case of the pumps on, we are measuring between the taps at the bottom of the vessel and the top of the vessel, and there is a wide range transmitter between those two and there is a narrow range transmitter. The wide range transmitter is used for the case of pumps on.

In the case of pumps off, we use the narrow range transmitter there, which is full range for quite a lot less delta P, plus we use a tap from the top of the

head to each hotleg, two more pressure drops. All three readings should be valid.

COMMISSIONER GILINSKY: How did we get into this discussion of the pressure drop across the pump?

MR. MATTSON: I think the Chairman was concerned over whether you can correlate pressure drop with --

CHAIRMAN PALLADINO: Some indication of void.

MR. MATTSON: Void in a flowing system and in a non-flowing system. For today's briefing, I thought it would suffice to say that we have analyzed that thoroughly, Westinhouse has analyzed it thoroughly. Tests have been conducted of pumps for the Westinghouse system in France. Tests have been conducted for the Westinghouse system in SEMI-SCALE. All of the tests involved voiding. Some of the tests involved pressure ramps like blowdowns, small break LOCAs in SEMI-SCALE. The system has been proven to be accurate for trending the void in the primary under all of those conditions to our satisfaction, to their owner's satisfaction, to Oakridge National Laboratory's satisfaction, and to the ACRS's satisfaction.

(General laughter.)

We have had pressure drop correlations on the table. We have had, how great can the uncertainty be.

We have been through it, Mr. Chairman, many times. We can go through it again for you, but we aren't prepared to do it today.

CHAIRMAN PALLADINO: But have you examined various kinds of circumstances because I could see where you are having significant voiding in the core.

MR. MATTSON: Yes, sir. We have looked at variable break sizes, break locations, pumps on, pumps off. We have looked at those conditions with failures in the instrumentation system. What if one tap failes and the other tap works?

What if there is conflicting information within the pressure monitoring system itself? We required Westinghouse to do a failure modes and effects analysis of that, worrying about ambiguous information to the operator. It has been thoroughly scrubbed.

MR. DENTON: We honestly aren't prepared to display that information today. Perhaps we should reschedule it if you want to go through that.

CHAIRMAN PALLADINO: That depends on the interest of the other Commissioners. I might want to just get a little more detail of that because that is the one system that concerned me.

MR. MATTSON: I appreciate the background you are coming from. The measurement of two-phase level in

steam generators down through the years, using differential pressure, has been a sticky problem. We believe --

CHAIRMAN PALLADINO: This is a different problem, though.

MR. MATTSON: Because it is transient, and because there are different modes of operation that we are worried about for the primary system.

CHAIRMAN PALLADINO: It is a more complicated situation than just measuring the level and the steam drum, for example.

MR. MATTSON: That is right.

CHAIRMAN PALLADINO: Because you have high flow.

MR. MATTSON: That is why all the work that we have done for the last two years testing these systems and analyzing these systems, and understanding how they really perform, that is why we have done it.

CHAIRMAN PALLADINO: You did clear up something else that concerned me. I thought you were measuring two different things. In the CE system, you were measuring voids above the core, and I thought you were using the Westinghouse system to measure voids in the core. I was wondering if one approach is as good as the other.

You are saying now that you are going to not rely on the Westinghouse to tell you whether there are voids in the core, but rather whether there are voids above the core.

MR. MATTSON: No. The Westinghouse system will tell you about voiding down into the core and even beneath the core. It will give you a level with the pumps off all the way down to the bottom of the vessel, if you will. The CE system won't do that.

CHAIRMAN PALLADINO: That is right.

MR. MATTSON: We don't think that it is necessary to do that.

CHAIRMAN PALLADINO: I guess that is what I was thinking.

MR. MATTSON: The core exit thermal couples are sufficient by themselves to tell you the core isn't being cooled. By how far it isn't being cooled is immaterial, we think, at that point.

CHAIRMAN PALLADINO: I thought that what you wanted to know.

MR. MATTSON: It is the approach to and recovery from a condition where the core exit thermal couples are reading high. We want to know that it is coming and confirm that it has ended.

COMMISSIONER ZILINSKY: That is the way you

have set the thing up, but why wouldn't you want to know the level below the top of the core?

MR. DENTON: Ideally, the level is what you would like to know, because that is what the operator can most directly influence by pumping more water in and out. And it is these difficulties that have taken so long to prove out the instrumentation that has been proposed.

COMMISSIONER GILINSKY: It is just too messy to get below there.

MR. MATTSON: With the CE system you can't, in all likelihood, take the heated junction thermal couple down into the core. It is too more of a difficulty to design the system for the heat and the radiation environment directly in the core.

CHAIRMAN PALLADINO: Are there any circumstances under which either system could possibly cause the operator to take a "wrong action"?

MR. MATTSON: We don't think so. You can never make a completeness argument with 100 percent. It is like saying that you have considered all accidents, you can't do it.

CHAIRMAN PALLADINO: No.

MR. MATTSON: But we have tested a variety of conditions that can lead to unusual two-phase

circumstances in the core, let me give you an example. If the heated junction thermal couple has a guard tube, which it does, it becomes a little pressurizer vessel inside the reactor pressure vessel. What happens if we have a large break, we asked, if this system is designed for small breaks, and it depressurizes at the same rate as the reactor coolant system?

What if there is a large break, and the level indicator is slow in tracking the reactor pressure vessel level; could that give the operator unwarranted confidence that his system was full of water when, in fact, it wasn't?

We looked at the ratio of the depressurization rates for the small guard pipe on the heated junction thermal couple system versus the reactor pressure vessel for intermediate and large break LOCAs. We found out that the difference in time was on a scale of seconds. So the misleading that would occur would occur during a time when so much else was changing, it was unlikely anybody would even notice it, and it would quickly correct itself and come back to a stable indicator of a low level, which you would expect for those breaks.

Another interesting one was the question of frothing. When you open a coke bottle at the top, after you have shaken, and frothing occurs throughout the coke

bottle, what is the level that you see in the system. It is very difficult to see, stuff is pouring out the top.

The same kind of thing can happen to a reactor pressure vessel. What if a control rod guide tube fails and there is penetration in the upper-head, and there is a rapid discharge of fluid out the upper-head. The heated junction thermal couple comes through one of those devices. How does the internals of the guard tube or the shield tube on the heated junction thermal couple assembly -- how does it behave? Does it just see a frothing in there, so that there is no valid indication of coolant inventory? Or, is there some separation of the bubble from the level, so that the indication that is given is valid.

That was one where there was enough controversy among the theorists that it had to be tested. Some proprietary design changes were made to the separator tube to assure the separation of bubbles from fluid, so that you had a true indication of inventory by this system even for breaks in the upper-head.

Those kinds of tests were made to the system, along with failure modes and effects assessments, and questions of how does it behave under these various

circumstances, as many as we could think of, as many as CRGR could think of, and ACRS, and the operators, and the utility design groups, and the vendor design groups.

To the extent that we have thought of everything we can think of, we are convinced that the indication is valid and not ambiguous.

CHAIRMAN PALLADINO: You give me a little more confidence based on your more extensive description of the tests.

Can I ask another question. In all of these now, you are assuming the instrument is working. Can it presumably not work and thereby give you a false indication? For example, you may think you have voids when you don't have voids, and therefore you turn on the ECCS and get thermal shock problems.

MR. MATTSON: That was one of the things we got into when we got to discussing whether it was cost beneficial to require that the single failure criterion be applied to these systems. On the one hand, you could save quite a lot of money if you said, let's only have one set, instead of making it redundant. Why do we have to have these things be safety grade, after all they are not needed in order to justify plant operation. They are just highly desirable to make the plant operation

more reliable.

On the trouble, if you remove redundancy, is you lose the ability to auction one against the other. If the one fails, then the likelihood is the other one will still be working. If an operator sees that one is giving one signal and the other one is giving another signal, then his procedures can tell him how to resolve the controversy. Or the instrument itself under some conditions can have built-in auctioning principles that choose one indication over the other. Choose the prudent one rather than the unprudent one, for example.

There is another reason for making redundant and that is, what happens if it is inoperative. Do you require the plant to shut down and fix it? How long do you allow it to operate before they can shut down and fix it.

A number of operators expressed the view that rather than face that question, if we have got to put this thing on and we think that it is good for us to put it on, let's put two of them on so we don't have to worry about what happens if one of them is down.

CHAIRMAN PALLADINO: Even though you may say that it is not absolutely necessary, once you put it in, you rely on it.

MR. MATTSON: That is right.

CHAIRMAN PALLADINO: Then it is important.

COMMISSIONER GILINSKY: They are saying that it is absolutely necessary. Once they are all in, they will be absolutely necessary.

CHAIRMAN PALLADINO: That is true.

COMMISSIONER GILINSKY: They are not absolutely necessary today. That is the way I understand what they are saying.

COMMISSIONER AHEARNE: Roger, you have described in a summary fashion all the tests that you have done, all the analyses that you have done, which have led you to have the confidence. Is it correct to say that those are tests and analyses and reviews of CEs and Westinghouse?

MR. MATTSON: Yes. In principle, the B&W system ought to work much like the Westinghouse system.

COMMISSIONER AHEARNE: But you have just finished telling us about all these tests and analysis. You thought about all these things.

MR. MATTSON: None of that has been done on the B&W system, either by them, by their owners, or by us. There is a significant amount of work to do. I don't want to kid you that that can be done overnight. It has taken us two years to get to this point of unanimity on Westinghouse and CE, and you can still see

there are residual questions today apparently.

CHAIRMAN PALLADINO: Roger, you asked level indicator vendors what specific actions might be taken by operators because of the level measurement that would not otherwise be taken. I was wondering what their response was, or what your response is, or both.

MR. MATTSON: I really gave an answer to that question a few minutes ago when I described this window between the loss of sub-cooling margin and the onset of super-heat.

You can't say that an operator would do anything specifically different. He wouldn't turn this pump on or that pump off with or without the instrumentation. All we can say is, whatever actions he was taking suited to that situation would be inherently more reliable if he knew they were helping or hurting the situation he was in.

That situation can be changed by a number of assumptions that I can make for you sitting here about the performance of equipment, the performance of the operator, or the situation that got him into the voiding in the primary coolant system in the first place.

So the answer to the question is, a significant increase in the reliability of operator actions in that period of time.

CHAIRMAN PALLADINO: At least he will have more confidence that what he is doing is done right.

MR. MATTSON: It might be time. Harold points to this last sheet of the package of slides, which is kind of a backup slide.

(Slide.)

It lists the kinds of things that you can use inventory trending information for.

With the pumps running, you understand, there is today in PWRs no real indication of voiding in the primary coolant system. There are people who argue that if you ran tests, you could do it on flow instrumentation in the primary coolant system, and primarily that is B&W. They may propose -- If we issue orders and they have to supply this equipment, they may propose, in fact, a correlation of flow measurement with the pumps on to indicate inventory in the primary coolant system.

COMMISSIONER AHEARNE: Isn't that were you people came out in your recommendations to the CRGR?

MR. MATTSON: Yes.

MR. PHILLIPS: There was test in LOFT which showed --

COMMISSIONER AHEARNE: I was just a little confused.

MR. MATTSON: The difference is -- The reason I hesitate is we said pump current, and that is what the LOFT tests go to. B&W, in some discussions with me, may in fact propose something other than pump current. They may propose the flow instrument, which is a pressure drop instrument.

In any event, today, in operating PWRs, there is no indication of reactor coolant system void changes with the reactor coolant pumps running. So this is not only a unique indication, the one provided by the CE system and the one provided by the Westinghouse system, and be the only system, and we think that is important.

COMMISSIONER GILINSKY: Let's see, the saturation meter doesn't work under those conditions?

MR. MATTSON: No. You are highly sub-cooled. You are just pumping fluid that is increasing in void content. It is getting more and more bubble. They form in the core. They collapse as they are circulated around the system and cooled in the steam generator, but the mixed mean void content of the reactor coolant system, for some reason or another, is continuing to increase and the pumps are still running. That can happen.

The pressure of the system may be coming down very slowly, insuffient to get to the criterion for

tripping the reactor coolant pumps, and still you are losing void. That something that would be nice to know about the performance of the reactor coolant system. So the first bullet here is an indication of reactor coolant system liquid inventory, and clearly with the pumps running.

CHAIRMAN PALLADINO: Does it matter whether it is accumulating at the top of the core, or mixing in the stream?

MR. MATTSON: As long as the pumps are on, it is going to be mixing. It won't accumulate at the top of the core. It could be accumulating in the upper-head.

CHAIRMAN PALLADINO: That is what I meant, the upper-head.

MR. MATTSON: With the pumps running -- Larry watch me now -- if a void is collecting in the upper-head, it won't be hurting anything. It will just be collecting up there with the pumps running.

In the case of the CE system, the way you measure the inventory increasing in the primary system is by leakage flow into the upper-head where this fluid is essentially stagnent. It is a one percent leakage flow, and you detect a separated steam/liquid system in that upper-head, and you can actually see the bubble

growing. You use the rate at which that bubble is growing to tell the operator that down below the plate -- What is the plate call up there?

MR. PHILLIPS: The guide tube support plate.

MR. MATTSON: Below that plate, where the pump is mixing things, the inventory is trendend upwards because this bypass flow that then becomes stagnent in the upper-head allow the steam to separate from the liquid, and that bypass flow is telling the instrument that the void is increasing, and that is a picture that a 1 percent bypass flow rate of what is really going on in the reactor coolant system.

In the case of the Westinghoue system --

CHAIRMAN PALLADINO: What do you do about that, then? You have the pumps running, do you lower the power?

MR. MATTSON: The procedures would tell the operator whatever the procedures tell him to do for a condition where he continues to lose inventory without a large pressure decrease. If there is a large pressure decrease, I probably am not in this situation because the pumps have been turned off. So it is a narrow window, and they would tell him, whatever your make-up system is doing, it isn't cutting it.

CHAIRMAN PALLADINO: Does he always know that

he is in this narrow window, or might he be in some other window where the observations give you different conclusions?

MR. MATTSON: The only way, if he is following his procedures and the system is behaving as we understand it to behave today, the only way that you can lose inventory and not lose pressure is by a small leak in the system.

The small leak may be right at the capability of the normal make up system. It is just beyond the capability of the charging system to make up the leak. It is not a big enough leak to cause the high pressure coolant injection portion of the emergency core cooling system to turn on, and the pressure to decrease rapidly, and the reactor coolant pump to be turned off. More his inventory continues to go down for some reason. The charging system isn't keeping up with it.

Today, the only indication you have of that in a pressurized water reactor is some indirect measure in containment. Maybe there was an iodine spiking going on, and you get a radiation level. Maybe you were near the tech spec limit with the primary coolant radioactivity, and you would sense that. Humidity may begin to increase in the containment, but the fan coolers, the normal air conditioning system would

probably keep up with most of that.

So there wouldn't be anything other than some nagging little indicators on the control room panel. But if you had this instrument, it would be giving you a clear indication that inventory is trending down for some reason in the reactor coolant system. The pumps are running, everything is going fine, but the inventory is going down. The pressure drop is changing in the case of the Westinghouse system --

CHAIRMAN PALLADINO: Would it be clear? Would the procedures be clear enough to tell you what you ought to do?

MR. MATTSON: Yes. We have looked at the procedures. We have looked at the way --

CHAIRMAN PALLADINO: Just by example, what kind of things would you do under those circumstances?

MR. MATTSON: I can turn to the Westinghouse emergency procedure guidelines. Remember we are, at this stage, reviewing guidelines, and not reviewing the exact procedures.

CHAIRMAN PALLADINO: Yes.

MR. MATTSON: One of the things that we recommend is that there be a two-step review of these systems. One, the generic approval, which we are prepared to give to the Westinghouse and

Combustion-Engineering systems; and then a plant specific approval to make sure that the training and the emergency procedure guidelines, and the control room reviews have been done the way we think they should be done before people turn this stuff.

So at the emergency guideline leve of review, the specific things that are in the Westinghouse guidelines -- Let me see if I can turn and read them to give you a feel: Symptoms for response to inadequate core cooling. There are a bunch of instructions about how to enter this step.

You go to FRC 1, response to inadequate core cooling. When all symptoms, and any one of the following symptom sets occur, the operator would have -- He has entered this, and being directed there from someplace else in the procedures, and the first parameter that is mentioned is thermal couples.

They say, there is a symptom set that if the thermal couples are greater than 1200 degrees Fahrenheit, he does one thing, and it directs him what to do. If they are greater than 700 degrees Fahrenheit, it directs him to do something else.

A containment condition, if he has got an abnormal containment condition indicated on the console in conjunction with a thermal couple greater than 700

degrees Fahrenheit, then that tells him something specific to do.

It goes on to reactor coolant pump status. If any of them are on. If all of them are off. The combinations of that with these other indices.

CHAIRMAN PALLADINO: The simple answer to what I was asking is "bring in more water," I presume.

MR. MATTSON: That is right.

(General laughter.)

CHAIRMAN PALLADINO: The question is, I presume that is generally the right thing, unless you have thermal shock problems.

MR. MATTSON: The how question is important to the operator. Your question of, are there different circumstances clearly ties to your question of what do you do. You bring in more water, but under different circumstances, by different routes.

MR. DENTON: Because of these complexities, we envision that the implementation of these would require development of procedure for how they would be used at that particular plant, as Roger said, incorporation in the training program, training of operators, do the job task analysis to make sure that it all fits, then begin to use it.

Rather than just stick it in and play with it,

we are proposing an approach in which it would be fully understood by the operators before they started relying on it, and they would incorporate it in their normal procedures and they would train their people to use it.

MR. MATTSON: I have essentially covered all the stuff in this package except the cost/benefit work that we did for the CRGR, if you are interested, that is at page 5. It would be a complete shift in emphasis, so if you are not prepared --

COMMISSIONER GILINSKY: There is another slide which covers the status of things.

MR. MATTSON: Yes, and I have not covered that. I could turn to that next.

CHAIRMAN PALLADINO: If you want to continue with the technical questions, I just have two more.

MR. MATTSON: Okay.

CHAIRMAN PALLADINO: What is the extent of upgrading the core exist thermal couples that the staff envisions as necessary if we approve this paper?

MR. MATTSON: The stuff that is in place inside the vessel essentially stays unchanged. The cables and transmitters between the vessel and the containment would have to meet environmental qualification and seismic requirements for a minimum number, not all 50 thermal couples that are in most

plants. I think a number of 16 would have to meet the environmental qualification and seismic design specifications.

Outside, in the control room, for example, the range of indication is much wider than it was before, so they have to change out the reading instrument and that kind of change.

CHAIRMAN PALLADINO: And it is well defined?

MR. MATTSON: Yes, those are all defined in NUREG-0737, Appendix B, if I remember correctly.

CHAIRMAN PALLADINO: Then the other, I guess, I would like to have a better understanding of why the staff does not recommend approval of the B&W instrument design, and what you would do to make it work -- What you are going to force them to do, if you force them to do something.

MR. MATTSON: There are a couple kinds of problems between us and B&W and the B&W owners that remain today. One problem we have already discussed. They have not done the detailed engineering. They have not done the detailed systems integration.

COMMISSIONER AHEARNE: Could I ask a question?

Joe, you said, approved the B&W design.

CHAIRMAN PALLADINO: They had a concept,

excuse me.

COMMISSIONER AHEARNE: But did you have more information?

CHAIRMAN PALLADINO: No, I was just remembering the last time. They had a concept, and it did not seem unreasonable.

MR. MATTSON: I think I am going to address that.

CHAIRMAN PALLADINO: All right.

MR. MATTSON: The first point is that they have not done the details. The second point is, the conceptual design level, which they have shown to you a year ago and which they have been showing to us, which at least one B&W licensee has proposed for its plant, we have a problem with the conceptual design, and that problem has to do with where they measure inventory and level.

Primarily, they do not propose, in the operating plants at least -- one plant under construction does, I guess, they don't propose to measure levels in the upper-head, and we think that it is essential that they measure in the upper-head. We want the system to include that like it does for Westinghouse and Combustion-Engineering.

COMMISSIONER AHEARNE: They insist on

measuring it just in the candycane?

MR. MATTSON: In the upper-regions of the candycane.

There is a second difference we have with the conceptual design, it wouldn't even go down to the hotleg for the candycane.

COMMISSIONER GILINSKY: What is the last thing we have told the owners of these plants to do, and have they answered our request?

MR. MATTSON: The last thing is an indication from the Commission meeting now nearly a year ago that there was a lot of confusion in this area, that we had set upon a course of rethinking the whole thing from the ground up. They have participated as owners groups and as vendors in helping us cost out the equipment and tried to resolve this controversy.

They are waiting for you decision frankly at the moment for Westinghouse and Combustion to proceeding with installation and turning on their systems. There are plants that are installed, calibrated, and only waiting for me to say, turn them on. At this point, because of the uncertainty, I have not done that.

There is another group of plants, the B&W plants, they haven't said this to me formally --

CHAIRMAN PALLADINO: You are getting too far

away from what I was trying to understand and I am afraid we are going to lose it because it is crucial to me.

I got your point that we were not doing the top head. What else?

MR. MATTSON: That is all. The difference over, we have not seen the details, and we would have to see those before we would approve it. We want the design concept to be expanded.

CHAIRMAN PALLADINO: Do they have a design concept that would measure the voids in the upper part of the head?

MR. MATTSON: I believe in the WPPSS plant now under construction, we have on the docket for WPPSS a conceptual level of design, no design details that say they would include the upper-head in their system.

MR. PHILLIPS: One correction. They haven't proposed formally anything that would measure the void content with the pumps running, and that is the reason we have said that we would accept pump current or pump power. We have checked that out in LOFT, and we feel that they could justify such a system to operate on essentially the same principle as the Westinhouse system. That has not been proposed formally, but they have rather informally discussed it.

CHAIRMAN PALLADINO: What would we tell them, if we say, go develop the system?

MR. MATTSON: The proposal is to issue orders to all the B&W plants saying, in 90 days, tell us what design you have chosen, confirm that it meets the requirements that we have been discussing here -- It has to be in the upper-head. It hasto work with the pumps on and the pumps off. It has to be over the full hotleg -- confirm that it meets those. Tell us when you are going to supply the design details, so that we can review them, and tell us when you propose to install them in your plant.

COMMISSIONER GILINSKY: Can they do that in 90 days?

MR. MATTSON: Absolutely.

COMMISSIONER ROBERTS: Is that a reasonable time?

MR. MATTSON: Yes, it is reasonable time.

COMMISSIONER AHEARNE: Is it --

MR. MATTSON: All it is is a commitment to a schedule.

CHAIRMAN PALLADINO: Except for one thing. You said, confirm that that works.

MR. MATTSON: No. Let me say it again. The idea -- It says January 1 in the paper, but it was

really 90 days which seemed to us to be a reasonable time period for the B&W operators, the B&W owners, the B&W licensees, to respond with: Here is the system we have chosen. Here is when we will meet. Here is when we will supply the design details. We agree to meet the criteria that you have specified in the order you issued to us. Here is when we will install this whole thing.

COMMISSIONER AHEARNE: In principle, is there any reason they couldn't install either the Westinghouse or the CE systems?

MR. MATTSON: No, they could do that. They could purchase either system.

COMMISSIONER AHEARNE: So, Joe, as we pointed out earlier, it is not unreasonable for us to order them to do that because they have been absolutely adamantly refusing. There are two other systems.

I am sure that B&W and its owners would prefer to use a B&W system, but they have refused to develop it. So I think at some stage, we could very well order them to meet a deadline which would them to go and buy the other systems.

CHAIRMAN PALLADINO: I wasn't against it. I wanted to know what they were going to order them to do.

MR. MATTSON: Require them to make up their

mind and tell us when they are going to get it installed.

The one slight hooker in what you said and what I said --

COMMISSIONER AHEARNE: You said it, I didn't. I asked the question, you answered it.

MR. MATTSON: The Westinghouse system, we are satisfied with for the Westinghouse pump. We would have some questions about using the Westinghouse system with the pumps running in the B&W plant. We may be able to get over those questions. But the CE would clearly work.

COMMISSIONER GILINSKY: Let me ask you this. Are the B&W owners in compliance with the directives or requests that we have made?

MR. MATTSON: Yes. We have never issued any formal requirement whatsoever to install a level or inventory tracking system.

COMMISSIONER GILINSKY: Or to supply a design?

MR. MATTSON: The staff has taken a position in some hearings, and in licensing new plants that we think it is highly desirable and the stuff ought to be added. But remember, the original requirement coming out of Lessons Learned and the Action Plan, and those

places, was: Put the thermal couple improvements on. Put the sub-cooling margin monitor on.

We are clear that is a requirement. Now study and propose designs to fill in any holes in inadequate core cooling that are left. It is the controversy over what the holes are and how to fill them, and how to make sure you are doing something good for safety, instead of something bad for safety, that we have been embroiled in in the last year, trying to agree finally on what are the holes and how do you fill them.

CHAIRMAN PALLADINO: Okay.

COMMISSIONER AHEARNE: Could I ask a question?

MR. MATTSON: Our proposal is clearly to make it firm now that they are required, for those people who haven't committed. That slide we had up, No. 6, says that 32 plus 21 -- 53 people have committed to put something in we think is acceptable, required or not.

COMMISSIONER GILINSKY: Every Westinghouse and CE.

MR. MATTSON: Every Westinghouse and CE PWR.

COMMISSIONER AHEARNE: In fact, a large number of them are in.

CHAIRMAN PALLADINO: There is only one thing about a 90-day period. We may say, yes, the

Westinghouse system will work, or the CE system will work. It might work with, perhaps, some other modifications that we might overlook if we try to force it too quickly.

MR. MATTSON: I am not writing an SER for the staff today. I am saying, it can be made to work. There would have to be a review.

CHAIRMAN PALLADINO: I don't want them to make such a hasty commitment that we say, Oh my God, I wish we had seen that.

COMMISSIONER ASSELSTINE: Roger, would the time period that you are proposing for the B&W plants --

MR. MATTSON: Hang on just a second, let me tie a knot on this, so that we can clear up the uncertainty.

The reason I am satisfied that that can happen is because there are Westinghouse plants that have bought CE systems. The CE system will work on other designs. The reasons that they have done that are complex. They have to know how many penetrations they have, whether they have pressure taps, or whether they have to cut holes in the primary system. Important questions, and the design flexibility between the CE and Westinghouse design is nice to have.

CHAIRMAN PALLADINO: But the people that proposed that may have taken longer than 90-days to reach that point, and that is all I am trying to say.

MR. MATTSON: I don't think it is fair to say that the B&W owners have been sitting back doing nothing in the last year. They have been watching this controversy quite closely. They have had an opportunity to watch this controversy very closely.

CHAIRMAN PALLADINO: Let's not be so arbitrary that we wish we had given them more time to look at what --

COMMISSIONER AHEARNE: We have given them --

COMMISSIONER GILINSKY: I must say that we have given them an awful lot of time.

CHAIRMAN PALLADINO: No. The plants that have come in and said, "We want to use -- The Westinghouse plants that have come in and said, "We want to use a CE device," we have given them much more thought than you might have given in 90 days to reach that decision. I am anxious to get where we want to go, but when I get there I want to make sure that we have the whole family with us.

COMMISSIONER ASSELSTINE: Does the 90-day time period require in all cases the B&W plants will either have to buy a Westinghouse or CE system?

MR. MATTSON: I don't believe so. I am satisfied --

COMMISSIONER ASSELSTINE: So they have the option for coming up with their own design.

MR. MATTSON: I am satisfied that B&W had done the design work a year ago to meet his 90-day commitment.

MR. DENTON: We really don't know what is behind the scenes. Obviously, B&W has participated fully in all the meetings and dialogue that we have had. They may well have the capability to supply it once it is required.

MR. MATTSON: For one thing, WPPSS bought such a system from B&W already, and has put on the docket for the WPPSS 01 application that they will put it in. So somebody has done the work.

MR. PHILLIPS: B&W says that their system will work. They say that it is not even a problem. They can design a system that will work. Their question is the cost/benefit of installation.

MR. DENTON: I think on the number of days, there is nothing magic about the picking of 90. It seemed consistent with our normal inquiry for commitments. Any other number of days is as good as another.

COMMISSIONER AHEARNE: Two minor questions, I guess.

I have not seen an ACRS letter out of the most recent meeting you had.

MR. MATTSON: I don't expect there will be one. It was a 20-minute briefing of the full committee, no significant objection to what they heard was going on, and I don't expect them to write. Their last letter said, "It looks like you are on the right course. We will stay in touch."

COMMISSIONER AHEARNE: That was the letter in April, I believe, and it said, "It looks like you are on the right course," but it was a little more, I guess, qualified. There was the one that also had --

MR. MATTSON: There were some qualifiers in the letter, and that is why I took the opportunity to go down there last week, to make sure that they had no pain over our moving forward.

COMMISSIONER AHEARNE: It said, "We believe the current approach of the NRC staff for dealing with the problem has sufficient merit that it should continue in proposed direction. We plan to continue our review of this area as further developments occur." They were agreeing with the following tentative conclusions of the NRC staff.

MR. MATTSON: Commissioner, the only thing that has really changed on the question of ambiguity, and what are you trying to achieve, since they wrote that letter -- the only thing that has changed is cost/benefit.

COMMISSIONER AHEARNE: My question really was, obviously, if you talked to them a week ago, or two weeks ago, you were at that stage saying, "These are now more than just tentative conclusions."

MR. MATTSON: Yes.

COMMISSIONER AHEARNE: You have reached conclusions because you are willing to recommend putting orders in.

MR. MATTSON: That is right.

COMMISSIONER AHEARNE: I wondered whether the ACRS was going to respond to that.

MR. MATTSON: There was nodding around the room. Mike Bender replied to the effect, "I know you are moving forward --

COMMISSIONER GILINSKY: There are several possibilities.

(General laughter.)

MR. MATTSON: You just got me in an awful lot of trouble. I want the record to be clear that that is your interpretation and not mine.

(General laughter.)

COMMISSIONER AHEARNE: The second question relates to the October status summary paper that you have supplied in this package.

MR. MATTSON: Yes.

COMMISSIONER AHEARNE: In the middle of it, in discussing one of the options, you are talking about what you mean by deleting environmental qualification requirements.

MR. MATTSON: Could you refer me to the page?

COMMISSIONER AHEARNE: It is in the introduction section, so it would be pages 1 and 2.

CHAIRMAN PALLADINO: Which enclosure?

COMMISSIONER AHEARNE: This is enclosure 9, it is the August 19 Stello paper, and it is a summary of the report dated October 1982.

MR. MATTSON: Yes.

COMMISSIONER AHEARNE: You talk about what you mean by deleting environmental qualification and you say: "This option, when we say delete environmental qualification, we mean that there need be no qualification by testing. But that the equipment would be expected by design or analysis to survive and function under design basis accident conditions."

It seems to me what you are saying is,

deleting environmental qualification means deleting testing, but it must be qualified by design analysis.

MR. MATTSON: That is what we tried to say. It was an interesting experiment, but it didn't work.

What we were after in the cost/benefit exercise was to try to answer the question of whether there was something less than full safety grade type requirements that would save some money, speed implementation, but still meet the safety function that we were after.

COMMISSIONER AHEARNE: It sounds like your description was, you still want it to be environmentally qualified, but the way of achieving that qualification did not require testing.

MR. MATTSON: Yes, that would save them some money, ad if they knew a way to do that, could they do it.

COMMISSIONER AHEARNE: Right.

MR. MATTSON: The answer we got back was that they didn't understand that. You have beaten on them so hard with the environmental qualification rulemaking that all they understand today is testing. They really were unable, as an industry, to answer the question in any meaningful way. "We don't know what EQ means without testing" was in essence their response. We

tried to see --

COMMISSIONER AHEARNE: Yes. I was having difficulty with that myself.

MR. MATTSON: Yes. We tried to see if there was a difference that could slide the bologna a little finer, to make it easier to implement, and still meet the safety function, but it didn't work.

COMMISSIONER AHEARNE: All right.

CHAIRMAN PALLADINO: Incidentally, in the ACRS letter of April 6, we still have these comments by Bender and Lewis. Bender is saying, "The proposed systems are not unambiguous and their response under all circumstances -- He says, "It would have been of doubtful value at Ginna or even the TMI accident system," speaking of the DP system.

MR. MATTSON: Yes. We very much disagree with the comments.

CHAIRMAN PALLADINO: But the early assurance about all the people being together --

COMMISSIONER AHEARNE: He didn't say that. He said --

MR. MATTSON: There are exceptions on the committee -- two.

CHAIRMAN PALLADINO: Exceptions of rather knowledgeable people.

MR. MATTSON: Yes, sir.

COMMISSIONER AHEARNE: They are all knowledgeable people, that is why they are there.

(General laughter.)

CHAIRMAN PALLADINO: Are there other questions?

COMMISSIONER AHEARNE: On page 4 of this particular paper that you have sent down, you say, "It was judged that a net safety benefit of some unknown magnitude exists." Did you do any estimates?

MR. MATTSON: I didn't, and my staff didn't, but the CRGR staff did. It was more of the kind of thinking they had done, and we had a blackboard discussion at the CRGR meeting.

There are those who would argue that there is a tenfold improvement in the reliability of the operator's performance to cope with an accident. It would be like adding a branch in an event tree in a PRA assessment. It would be a factor of ten.

I have some difficulty with that kind of argument, because I would content that no matter which reliability improvement for the operators you took to a discussion, you could assign the same factor of ten. This would be a factor of ten. SPDS would be a factor of ten. Some other parameter that you wanted to measure

that was important in the primary coolant system would be a factor of ten. You would keep using it over and over, and it wouldn't be a true factor of ten.

We tried that at the blackboard with the CRGR staff, Matt Taylor, who you know came from the Reactor Safety Study and worked in the Probabilistic Analysis staff here for a number of years, very good, one of our more accomplished practitioner of that art.

You can make numbers, very big uncertainties for the reasons I have just described, and you can compare, for example, the risk to the people offsite to the people who have to install these things -- 30 to 50 manrem just to install the inadequate core cooling package.

That kind of work was done, and the CRGR concluded on balance, having considered those kinds of things, that we should go forward with this instrumentation as being highly desirable. It is a qualitative judgment doing the best you can with quantitative analysis.

COMMISSIONER AHEARNE: I realize you are not here to speak for the CRGR, but the paper that you sent down does say something about them. It says, "The CRGR concluded that it is sufficient to require only a void indication inventory tracking system." My impression

was that they could have required more because this is what industry has been able to come up with.

MR. MATTSON: can you show what you are reading, I want to make sure I understand the context before I try to answer it.

COMMISSIONER AHEARNE: It is page 3, the last paragraph, "Enclosure 6." The paragraph that starts "Enclosure 6."

MR. MATTSON: We have a problem, you have a paper that we don't have.

COMMISSIONER AHEARNE: It is you paper 82-48.

CHAIRMAN PALLADINO: It is your basic paper.

MR. MATTSON: We don't have our basic paper. The system functions in such a way that the originators get it after you get it.

CHAIRMAN PALLADINO: I was going to compliment you.

MR. MATTSON: If we had delayed the briefing one day, we would have had it.

COMMISSIONER AHEARNE: Do you agree with everything that is in there?

MR. MATTSON: We wrote it, so we should.

Page 3, the last paragraph --

COMMISSIONER AHEARNE: You see where it says, "However, CRGR concluded that it is sufficient to

require only a void indication and inventory tracking system." I was just trying to clarify.

My impression was that they couldn't have required more because these couple of years that you have been going through have been a process of trying to find out what could industry provide, and they are proposing to provide something which turned out to be those two.

MR. MATTSON: That is part of what it means. But it is also maybe a clumsy attempt on our part to give credit to CRGR for finally beating through our thick skulls that to build the world's most reliable and best level indicator was not what we wanted and it wasn't even possible. It was inventory trending that we were really trying to satisfy, and that could be achieved unambiguously, not level. That is what that sentence is trying to communicate. Not that we studied whether to require more, it is that we are giving them credit for having made us realize that.

COMMISSIONER AHEARNE: But isn't it also true that these last two year processes reached the conclusion that if you want to require something now, this is what you can require. To require more isn't within reach.

MR. MATTSON: That is right.

CHAIRMAN PALLADINO: Are there more questions?

COMMISSIONER GILINSKY: I would just like to have Carl Michelson's thoughts on this, if he has any that he wants to share with us.

CHAIRMAN PALLADINO: Carl.

MR. MICHELSON: Do you want me to talk from the table?

I would like a clarification of on which subject you want to talk. Is it the ones discussed or some others?

COMMISSIONER GILINSKY: The general usefulness of these instruments and how we ought to approach the question of putting them in the reactors.

MR. MICHELSON: I, of course, have been on record a long time strongly advocating level indication. I have seen nothing transpire in the last two years or so that would change my opinion as to the need for level indication.

There have been, of course, during these past two years thoughts about including level indication to the bottom of the vessel. I would have considerable difficulties with extending level indicators to the bottom of the vessel, keeping in mind that a level indicator is really monitoring the density of a fluid,

and that the density variation up through the core is quite significant and you don't know how it is changing through the core. Therefore, the indication from the top of the core to the top of the vessel is the only one that I thought was ever meaningful and that was is, I believe, the only one that the staff is really is asking for. So I would agree with that completely.

I have some question about knowing how to measure void fraction based on delta Ps. The discussion was a little confusing when it talked about the pump versus the rest of the system. Either it is important, of course, to know what the flow rate is, some sort of mass void, volumetric flow rate, or something.

So you have to complicate the issue by how do you know what the flow rate is, because only if you know what the flow rate is, do you know how to interpret the delta P, and I didn't hear any discussion of the flow rate.

MR. MATTSON: The constant volume that they are displacing.

MR. MICHELSON: That is not quite the way they work under two-phase conditions, though.

MR. MATTSON: That part of the degrading, the drawing more power, vibration, that sort of thing, that is what I meant when I said that it had been tested with

high void fractions and everything in-between high and low void fractions in the test in France.

That problem has been addressed, but it is correlated for a constant volume, a constant speed of the pump, except as that speed degrades. As that speed changes with the changing fluid conditions, the inaccuracy goes up, but the trending is accurate. The trending is still valid. The inaccuracy, can you tell whether you have got 80 percent void or 75 percent void, no. Can you tell whether you are increasing or decreasing void, yes.

CHAIRMAN PALLADINO: Is that unambiguous if the pressure is also changing? The density is quite different from one pressure or another. Are the indications just as clear?

MR. MATTSON: With the pumps running, the pressure won't be changing rapidly. It might be changing slowly.

CHAIRMAN PALLADINO: It might be enough to confuse the situation.

MR. MATTSON: But not the trend. As the void fraction increases --

CHAIRMAN PALLADINO: Yes, especially the trend. This is another trend going another way.

MR. MATTSON: At any point in time, it could,

you are right. It could, but given a stable situation or a slow changing pressure situation, a monotonic pressure, a slow pressure change like a small leak in the system, where the pumps are running and where you would be interested in inventory, it is still a valid trending device.

If the pressure were doing this --

CHAIRMAN PALLADINO: There were times when the pressure was doing that.

MR. MATTSON: But unless the void fraction gets significant, and you are on the verge of turning pump soft, that is going to be a small perturbation in what is happening.

CHAIRMAN PALLADINO: I am sorry, I didn't mean to interrupt Carl's presentation. But changes in pressure is one of the things that I hope you have examined and feel that the operator really has a clear signal as to what he ought to believe.

MR. DENTON: We will make sure that it has been looked at, if it hasn't.

COMMISSIONER AHEARNE: You are sure that it has been?

MR. MATTSON: It has been.

CHAIRMAN PALLADINO: I am sorry, Carl.

MR. MICHELSON: What I was saying was a little

unclear to me, of course, not having had the benefit of any of the earlier presentations on the subject, I did not quite follow how it was possible to monitor delta P alone in such a situation, without also somehow monitor flow velocity or something of that sort, because the two, obviously, are quite related, and it was not clear, then, how that would even work. But I am sure that it has been taken care of.

There are a lot of other situations that we have discussed in the last couple of years, including an earlier discussion before the Commission by myself and others on the problems of multiple loss of coolant and secondary side failures occurring at the same time, leading to confusion on the part of the operator.

This might be compounded by steam tube rupture, and in essence this is what happened at Ginna, where they had primary side leak, secondary side leak, and steam tube concurrently. These are very confusing situations and I think Roger pointed out that this is one of the reasons for level indication, and indeed an important one.

Another confusing situation which he did not mention, which is also an important reason for level indicator, is the case wherein operators during such incident, for one reason or another, lay by a steam

generator with hot water on the secondary side, and then as they proceed to mitigate the incident, there is a point in time when that steam generator becomes the pressurizer for the system and starts to void the primary side tubing in a steam generator and transfers the inventory to some other part of the system.

Under these circumstances --

COMMISSIONER GILINSKY: This is when you have a leak in the tubes?

MR. MICHELSON: Yes, and it happened at TMI. They laid by the steam generator, because they thought it was leaking. Later on they brought it back in again.

The problem you get into, of course, is that the sub-cooling monitors don't understand this situation, and when the inventory starts to move around, the situation could even appear to be sub-cooled where the monitor instrumentation is located. Again, level indicators are very fine because you will suddenly see a rapid rise in level in this pressurizer, even a slow rise, and you woul be under the impression that things are getting better, when in essence all that was happening is that you are slowly voiding the tubes on the laii by steam generator.

Vessel level indicators are very helpful in

situations like this. At least, too, they help to understand what is happening as a transition occurs.

I think the final argument for level indication is that it will help in the situation we just haven't thought of yet. It is one more indication of what is happening, which could be very valuable. As in the case of TMI, it would have been very nice in that case to have had such an indicator, and there may be some other situations that we haven't thought of whereby it would be very important.

CHAIRMAN PALLADINO: Tom, or Jim, do you have other questions?

COMMISSIONER AHEARNE: Carl, do you have any sense of the relative value for Westinghouse/CE versus B&W?

MR. MICHELSON: Do you mean as the type of instrumentation?

I am really not qualified because I have not followed the development of the CE device. I am aware of its general principles of operation. I questioned some of the things earlier on, but I think those things were taken care of. So far as I know, it should be a viable instrument.

COMMISSIONER GILINSKY: I think that John was asking whether it might be important more often in a B&W

machine.

MR. MICHELSON: In the B&W machine, one of the most important instruments is the hotleg level indication, which perhaps the CE device could be used for, but I don't think that it has ever been proposed for that purpose.

MR. MATTSON: That's right.

COMMISSIONER GILINSKY: So you are after a combination of the CE device plus a change in difference in pressure measurement, a combination of the two.

MR. MICHELSON: If you are to cover both hotlegs and vessels, then you will want to use the CE device in the vessel, yes, then, you would end up with a combination.

MR. MATTSON: Nobody proposed to put a meter junction thermal couple chain down in the hotleg.

MR. MICHELSON: Right.

COMMISSIONER GILINSKY: To return to the previous question, are we more likely to need such an instrument in a B&W machine because of the design of the steam generator?

MR. MICHELSON: I will only express my own opinion on that question. In my opinion, it is more important to have level indication on a B&W type reactor than it is on a CE. If I had a choice to only handle

one or the other, I would certainly instrument the B&W first, and that means both hotleg and the top of the vessel.

CHAIRMAN PALLADINO: So you would say that it wouldn't be enough just to put, for example, a CE design.

MR. MICHELSON: It would be my opinion in that you would handle part of the problem, but not all of the problem in the case of B&W.

MR. MATTSON: We don't quarrel with that. Maybe we were speaking in too much shorthand when we discussed this before. We could put a CE system on and monitor voiding in the vessel in the B&W. It would not tell you about voiding in the candycane and with a no pumps off or on situation.

MR. MICHELSON: There is one other situation that wasn't mentioned this morning, which I had mentioned to Roger and discussed in the past. AEOD has sent out letters on it. That is, we are somewhat concerned about the case of upper-head injection plants, particularly where as a consequence of the event, the UHI has been intercepted and shut-off before we reached UHI injection pressure. Void proceeded to form at the top of the vessel, and might have even filled it. The UHI plants are quite a good arrangement for void

formation because they are so well thermally separated from the balance of the circulating system.

The concern would be, of course, to suddenly inject cold water at a later date into that voided vessel. I am not quite sure what all would happen, and it certainly needs to be looked at in detail.

MR. MATTSON: Carl is worried about the situation where the operator knows he has got a void, and if he doesn't have that kind of instrument to tell him about the growth or collapse of the void, he might reach for the UHI button to put water up there and collapse that void.

He would like to see that avoided, if it can, because the system wasn't designed to be used that way. He is worring about thermal shock, and collapsing of bubbles in the upper head, and cycling of nozzles and things that go along with that. This would help avoid that kind of situation.

CHAIRMAN PALLADINO: Was the question of thermal shock considered in your evaluation of the use or the actions that might come out of the information?

MR. MATTSON: Sitting in the back of your mind is the worry that there are competing interests that the operator has to satisfy. One is to not shock the pressure vessel, and the other is to cool the core, and

not in that order.

If an operator becomes too much concerned with the void interrupting core cooling to the point that he takes precipitous action to collapse it, the way he does that is by pressurizing and cold water, and heat removal from the primary system. That is in the wrong direction for pressurized thermal shock.

So even though it may be necessary to throw a lot of coli water at a core sometime, you want to know that it is necessary before you run that thermal shock risk. And this gives him more information about whether that bubble is really bothers it.

MR. DENTON: It will help to make the right decisions under those circumstances.

MR. MICHELSON: There is a particular aspect, of course, to this UHI question that is related to more than simply thermal shock of a vessel.

The UHI injection pipe is a long vertical pipe coming up from the head to about 40 feet or so above before it makes a right angle turn. In the process of the voiding that we are talking about, that pipe is the first thing to fill with steam. As it becomes steam filled, then the vessel head proceeds to become steam filled later.

So the cold water is really hitting this very

long extended pipe first. The hydraulic effects of cold water in the steam filled regions can create certain perturbations called hydraulic hammers, steam hammers, or whatever.

So it is a considerable concern to have these perturbations in that pipe because in the earlier UHI plants, at least, the design of the attachment of that pipe to the vessel was a rather weak one. The reason being is that it was put in afterwards, and so there was some very limited welding procedures that were permitted, and heat treatment procedures that were permitted.

So it is very important to keep the stresses in that nozzle to very low values, and of course this is not in the direction of keeping stresses to low values. It is unknown. In fact, it is difficult to analyze what kind of stresses you might induce. So I think it is important that it be looked at carefully or, better yet, make sure that it never happens.

COMMISSIONER GILINSKY: How many plants are we talking about here

MR. MICHELSON: They are talking about a handful.

MR. DENTON: We are talking about the more recently licensed plants, starting with Sequoyah, which

was the first USI plant.

MR. MATTSON: This is not something that is new to the safety review. It was addressed.

MR. MICHELSON: We have discussed this.

MR. MATTSON: You reach a point where you can't say that it is impossible. You can say that it has been considered. It has been included in the design, and it has been included in the review. It is still possible to have water hammer events. It happened in steam generators. It happened in ancillary systems for reasons that you can't anticipate.

The point of this discussion today, though, is whether the level indicator helps or hurts that problem. It helps that problem.

COMMISSIONER GILINSKY: I understand that it is desirable.

COMMISSIONER AHEARNE: One quick question on the cost/benefit. Could you explain why on the sub-cooling margin monitor, the costs for forward fit or backfit?

MR. MATTSON: If you read the CRGR letter, and the Commission paper closely, you will notice that we have put some qualifiers on the utility of these numbers, and that is a good example of one.

COMMISSIONER AHEARNE: You have a very strong

qualifier.

MR. MATTSON: The reason is that some people who provided us estimates of the costs only provided us with backfit or forward fit, not both. Because these are averages that we are reporting here, if somebody comes along with a gross overestimate of the forward fit costs for the sub-cooling margin monitor, he swamps the average.

What we looked at to check this was, the people who supply both forward and backfit costs, the backfit always higher than the forward. The answer is yes. Then, that is why we indicated a range. If you go to the right-hand column, you will see that that $1.750 million estimate is swamping everything.

COMMISSIONER AHEARNE: Okay.

CHAIRMAN PALLADINO: I am going to have to leave now. If you want to continue, I can ask somebody else to take over.

I found this a very beneficial session. You did cope with some of the problems that were, at least, concerning me. I presume you would like an answer pretty soon.

MR. MATTSON: We are ready to go.

CHAIRMAN PALLADINO: I would propose, rather than vote today, I would like to explore a few other

questions, and the Commissioners, as soon as they can, will indicate on a notation vote. I don't know whether this is one that we have to affirm now, but we will decide that later. We will try to get an answer to you quickly. I won't dilly-dally on that question.

Thank you very much, and we will stand adjourned.

(Whereupon, at 11:50 a.m., the meeting adjourned.)

NUCLEAR REGULATORY COMMISSION

This is to certify that the attached proceedings before the

COMMISSION MEETING

in the matter of: PUBLIC MEETING - Discussion of Reactor Vessel Water Level Indicator Program

Date of Proceeding: October 14, 1982

Docket Number:

Place of Proceeding: Washington, D. C.

were held as herein appears, and that this is the original transcript thereof for the file of the Commission.

Patricia A. Minson

Official Reporter (Typed)

Patricia A. Minson

Official Reporter (Signature)

PURPOSE

REQUEST COMMISSION

APPROVAL OF

RECOMMENDATIONS FOR

IMPLEMENTATION OF

TMI ACTION PLAN II.F.2 -

"INSTRUMENTATION FOR DETECTION

OF INADEQUATE CORE COOLING"

ISSUES REMAINING FROM JANUARY 1982 COMMISSION MEETING

*DEMONSTRATE NEED AND USES FOR PROPOSED INSTRUMENTATION

*ALLAY CONCERN ABOUT AMBIGUOUS INFORMATION

*EXAMINE COSTS AND BENEFITS

*INTEGRATE INTO EMERGENCY OPERATING PROCEDURES AND CONTROL ROOM DESIGN REVIEW

*ESTABLISH A RATIONAL SCHEDULE FOR IMPLEMENTATION

ACTIONS TO RESOLVE ISSUES

*FEBRUARY NRC/INDUSTRY MEETING

*COST/BENEFIT EVALUATION OF INVENTORY MONITOR

*PUBLICATION OF GENERIC DESIGN EVALUATION REPORTS

*CRGR MEETING (MARCH)

*APRIL ACRS MEETING

*COST/BENEFIT STUDY OF OVERALL ICC SYSTEM

*FMEA REVIEW

*SECOND CRGR MEETING (SEPTEMBER)

*OCTOBER ACRS + COMMISSION BRIEFINGS

SAFETY BENEFITS

*IMPROVE RELIABILITY IN DIAGNOSING THE APPROACH TO AND THE ONSET OF ICC, AND IN ASSESSING THE EFFECTIVENESS OF RESPONSE TAKEN TO RESTORE CORE COOLING.

*REDUCES CHANCE OF OPERATOR CONFUSION, MISDIAGNOSIS OR ERROR IN RESPONDING TO:

- INCIDENTS OF MODERATE FREQUENCY LEADING TO STEAM BUBBLE FORMATION IN THE RCS, E.G.,

  SG TUBE RUPTURES
  LOSS OF INSTRUMENT BUS OR OTHER CONTROL SYSTEM UPSETS
  RC PUMP SEAL FAILURES
  OVERCOOLING EVENTS
  NORMAL RCS COOLDOWN

- EVENTS INVOLVING MULTIPLE FAULTS

- SMALL BREAK LOCAs

*AIDS EARLY WARNING AND OFF-SITE EMERGENCY RESPONSE DECISIONS

INSTALLED COST (K$/PLANT)

FOR ESTIMATED PLANTS

Design Options

1. Reference Design - meets NUREG-0737 design requirements.
2. Delete all seismic design requirements from reference design.
3. Delete environmental qualification requirements, except seismic, from reference design.
4. Delete single failure design requirements (redundancy) from reference design.
5. Delete Class 1E power source requirement from reference design.

The NRR estimate of costs associated with each design option is shown below in Table I.

Table I

ICC Instrumentation	Fit Status	OPTION 1(c)	2(s)	3(s)	4(s)	5(s)	Range(c) INDUSTRY ESTIMATES
		NRR ESTIMATES					
Core Exit Thermocouple	BF	2,148	14	35	21	3	648-6,280
	FF	948	15	12	22	5	551-1,250
Subcooling Margin Monitor	BF	325	19	30	30	2	70-500
	FF	658	16	15	30	10	100-1,750
Inventory Trending W/RCS Pumps Off	BF	3,176	9	16	30	2	1,530-5,280
	FF	1,826	4	15	16	2	195-3,694
Inventory Trending W/ RCS Pumps On	BF	240	1	1	8	0	200-280
	FF	200	10	20	50	0	200
Overall ICC Instrumentation	BF	5,889	11	23	26	2	2,488-12,340
	FF	3,632	9	14	22	4	1,046-6,894

NOTE: C- Cost ($1,000/Plant); S- Savings in % (Compared with Option 1); BF- Backfit; FF- Forward Fit.

INSTALLATION AND PROCUREMENT STATUS

OF

INVENTORY TRENDING SYSTEM

(SEPTEMBER 1982)

*WESTINGHOUSE DP SYSTEM - 32 ORDERED

- 8 INSTALLED AND CALIBRATED (2 OLs)
- 2 INSTALLED, FILLED, AND NOT CALIBRATED
- 2 INSTALLED AND NEED MODIFICATION
- 4 INSTALLED AND WILL FILL
- 1 PARTIALLY INSTALLED
- 15 TO BE INSTALLED

*CE HJTC SYSTEM - 21 ORDERED

- 21 TO BE INSTALLED

RECOMMENDATIONS

*CE HJTC AND WESTINGHOUSE DP SYSTEM ARE ACCEPTABLE GENERIC DESIGNS

*B&W DP MEASUREMENT TECHNIQUES ARE ACCEPTABLE IN PRINCIPLE PROVIDED THAT THEY:

- MONITOR COOLANT INVENTORY FROM VESSEL HEAD AND FROM TOP OF HOT LEG TO BOTTOM OF HOT LEG
- ARE SUPPLEMENTED BY INVENTORY TRENDING WITH PUMPS ON; E.G., PUMP CURRENT OR PUMP POWER MONITOR
- MEET NUREG-0737 DESIGN REQUIREMENTS

*FOR THE DESIGN, INSTALLATION, AND UPGRADE OF ICC INSTRUMENTATION SUBSYSTEMS

- NUREG-0737 DESIGN SPECIFICATIONS ARE A REQUIREMENT
- FOR EXISTING INSTALLATIONS SOME DEVIATIONS MAY BE GRANTED WHERE JUSTIFIED AND CONSISTENT WITH EQ RULE

*LICENSEES NOT YET COMMITTED SHOULD BE ORDERED TO CONCLUDE THEIR DESIGN REVIEW AND SUBMIT DETAILED ENGINEERING, PROCUREMENT, AND INSTALLATION SCHEDULES BY JANUARY 1, 1983

*NEGOTIATE PRACTICAL SCHEDULES FOR IMPLEMENTATION ON CASE-BY-CASE BASIS

*PREREQUISITES TO IMPLEMENTATION OF VOID INDICATOR OR INVENTORY TRACKING SYSTEMS

- NRC STAFF REVIEW AND APPROVAL OF PLANT SPECIFIC INSTALLATION AND CALIBRATION SUBMITTAL AND EMERGENCY OPERATING PROCEDURE GUIDELINES FOR THE OVERALL ICC PACKAGE
- INTEGRATION OF THE OVERALL ICC SYSTEM INTO TASK ANALYSIS PORTION OF DETAILED CONTROL ROOM DESIGN REVIEW BY THE LICENSEE
- OPERATOR TRAINING IN OPERATION AND LIMITATIONS OF THE SYSTEM

BACKGROUND

*TMI-2 LESSONS LEARNED TASK FORCE, NUREG-0578, JULY 1979

*A LETTER TO ALL OPERATING NUCLEAR POWER PLANTS FROM HAROLD R. DENTON, ON "DISCUSSION OF LESSONS LEARNED SHORT TERM REQUIREMENTS," OCTOBER 30, 1979

*NRC ACTION PLAN DEVELOPED AS A RESULT OF THE TMI-2 ACCIDENT, NUREG-0660, MAY 1980

*NUREG-0737, CLARIFICATION OF TMI ACTION PLAN REQUIREMENTS, NOVEMBER 1980

*SECY-81-582, ADDITIONAL INSTRUMENTATION FOR DETECTION OF INADEQUATE CORE COOLING, OCTOBER 7, 1981

USES OF VESSEL INVENTORY TREND INFORMATION

*PROVIDE INDICATION OF RCS LIQUID INVENTORY

*UNIQUE INDICATION OF LOSS OF INVENTORY WITH RCPs ON

*INDICATE RELATIVE SIZE OF LOCA BY TRENDING COOLANT LOSS

*TRACK GROWTH OR SHRINKAGE OF UPPER HEAD BUBBLE

*DETECT APPROACHING LOSS OR RESTORATION OF NATURAL CIRCULATION

*EVALUATE EFFECTIVENESS OF SI TO REPLINISH COOLANT INVENTORY LOSS

*MONITOR AND CONTROL FEED AND BLEED OPERATIONS

*MONITOR AND CONTROL VENTING OPERATIONS

*AID DECISIONS TO TURN RCP PUMPS ON OR OFF

*EVALUATE CORE DAMAGE AND FLOW BLOCKAGE

*AID OFFSITE EMERGENCY RESPONSE RECOMMENDATIONS