NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING APPEAL BOARD

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In the matter of: :

METROPOLITAN EDISON COMPANY, ET AL. : Docket No. 50-289

(Three Mile Island Nuclear Station, : (Restart)

Unit No. 1) :

- -

Nuclear Regulatory Commission

Fifth Floor Conference Room

4350 East-West Highway

Bethesda, Maryland

Thursday, March 17, 1983

BEFORE:

GARY J. EDLES, Chairman

Administrative Judge

DR. JOHN H. BUCK

Administrative Judge

DR. REGINALD L. GOTCHY

Administrative Judge

APPEARANCES:

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C O N T E N T S

C O N T E N T S (Cont'd.)

EXHIBITS

NUMBER	IDENTIFIED	RECEIVED
UCS-50	565	
UCS-51	644	649
UCS-52	680	
UCS-53	746	785

P R O C E E D I N G S

(9:00 a.m.)

JUDGE EDLES: Please be seated.

Good morning, or perhaps I ought to this morning just say the top of the morning, gentlemen.

We start today with the Staff's witnesses, unless there is any unfinished business from yesterday.

If not, Mr. Cutchin.

MR. CUTCHIN: Staff would call Dr. Sheron -- recall Dr. Sheron, and Mr. Jensen to the stand.

JUDGE EDLES: Dr. Sheron and Mr. Jensen, I remind you that you continue to be under oath.

MR. CUTCHIN: I would remind the Board and the parties that we put in all of their evidence, and it appears in the transcript following page 83.

I have no redirect, and the gentlemen are available for cross.

Whereupon,

BRIAN W. SHERON

AND

WALTON L. JENSEN, JR.,

recalled as witnesses by counsel for the Regulatory Staff, having been previously duly sworn by the Chairman, were examined and testified further as follows:

CROSS-EXAMINATION

ON BEHALF OF INTERVENOR

BY MS. WEISS:

Q. The last sentence in your answer to question 4, gentlemen, on page 5, reads: "Both models predict that the boiler condenser process would be effective in removing decay heat if the condensing surface were uncovered as in the steam generators."

Does the approved B&W model which predicted this assume operation of one HPI pump?

A. (WITNESS JENSEN) That is an input to the code, but, yes. Normally in the model you would assume operation of one HPI pump for emergency core cooling.

Q. And it is your testimony that it is those calculations which predict boiler operation input of one HPI pump?

A. I think, among the calculations that were done, were calculations where HPI was delayed for 20 minutes, and then two HPI pumps were actuated.

Q. Can you tell me which calculations those were?

A. Yes. These were the ones that were -- well, they were small breaks of .02 and .01 square feet in the cold legs, and it was assumed that neither emergency feedwater nor high-pressure injection was available for 20 minutes, and then two HPI pumps were actuated in 20 minutes, I believe, in one case; and in another case the

emergency feedwater was actuated in 20 minutes.

Q. For the B&W analysis with one HPI pump, do you know what they assume with regard to when that pump is initiated?

A. I believe it is about a minute, which takes into account time for the diesel generator to come on and provide power to the pump. This would occur for a loss of off-site power condition.

Q. If the starting of the HPI pump is delayed, assumed to be delayed beyond a minute? Say, at 20 minutes we get one HPI pump. Does that affect the range of break sizes for which a condensing surface is required, or for which it is required to remove through the steam generators?

A. I don't know. I suspect it would, but we haven't evaluated that case.

Q. You mentioned in your testimony that the Staff did some audit calculations of the revised B&W code. Can you describe what those consisted of?

A. What audit calculations are you talking about, again?

Q. You mention them on the very bottom of page 5. The Staff did provide audit calculations of small breaks in B&W design plants using the RELAP4 computer code. These calculations are documented in NUREG 0565.

A. There was a .01 square-foot break in that case,

and that is in that document, and I don't remember what the other -- there were, I think, about two or three calculations. I don't remember what the other one was.

Q. Is it true that this audit calculation, at least for the .01 square-foot break with RELAP4, did not show an interruption of natural circulation?

A. At least not a profound interruption. There may have been some -- there were some oscillations in the calculation. There might have been an interruption, but it wasn't to a degree that was predicted by B&W.

Q. Do you remember answering -- telling me in your deposition, on the 25th of March, that the difference between the results of the RELAP4 audit and the results of the B&W calculation for that .01 square-foot break was that natural circulation was not interrupted in the RELAP4 calculation?

A. Probably. It wasn't substantial. It wasn't a significant interruption if it was interrupted. The pressure did not increase significantly above the point where natural circulation might have been lost. So, if it was lost, it was not a significant loss. It might have been a brief loss.

Q. Might have been a brief loss?

A. Yes, but it wasn't siginficant to the pressure response.

JUDGE BUCK: Ms. Weiss, I guess I don't understand the last answer. A brief loss of what?

WITNESS JENSEN: Of natural circulation.

In the equivalent analysis done by Babcock & Wilcox, there was a loss of natural circulation after a steam bubble formed in the top of the candy canes, and the pressure increased by several hundred psi, and the RELAP4 calculation that the NRC Staff did several months later, in that a significant loss of circulation was not calculated, and the pressure which was indicated by the fact that the pressure did not increase by several hundred psi, but remained at about slightly higher than steam generator pressure.

JUDGE BUCK: What do you mean by "slightly higher"? I'm trying to pin this down as to how big an interruption you got, or calculated or didn't calculate here.

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WITNESS JENSEN: It wasn't significant that you could look at the pressure versus time curve and identify a time when natural circulation was lost, but there were some oscillations in the curve, so there might have been some brief losses in circulation.

JUDGE BUCK: By brief losses, you mean how long a time?

WITNESS JENSEN: I think in terms of pressure increases, maybe about 25 pounds per square inch rather than several hundred pounds per square inch that was calculated in B&W's CRAFT calculation.

JUDGE BUCK: Thank you. Sorry, Ms. Weiss.

BY MS. WEISS:

Q As far as the plant behavior exhibited in these calculations, could you describe the difference in plant behavior between the RELAP4 calculation of the .01 square foot break and the B&W calculation of the .01 square foot break?

A (WITNESS JENSEN) There wasn't really -- the core was not uncovered in either calculation, which was, I guess, the most significant result , and the core remained cool, and the significant plant behavior was that the pressure increased by several hundred psi in the B&W calculation until boiler-condenser heat transfer was commenced, where some heat transfer to the steam generators

j-2-2

appeared to occur virtually on a continuous basis in the RELAP4 calculation.

Q Any other difference in plant behavior other than the several hundred pounds pressure rise in the B&W calculations?

A (WITNESS SHERON) The steam generator secondary pressure would probably vary slightly. In the Staff calculation, if decay heat is being removed, then you are adding energy to the secondary side, which would tend to hold pressure up. If you are not removing energy and have interrupted natural circulation, one would expect the secondary pressure to be decreasing during that period.

I can't confirm it. I don't have the curves in front of me. The calculations were done quite some time ago. But that would be an expected difference.

Q When was the last time that either of you inspected the curves for that RELAP4 audit calculation?

A (WITNESS JENSEN) About two months ago. I looked at the curves and the NUREG report.

A (WITNESS SHERON) I looked at the primary system pressure curve in the NUREG report, I guess, within the past two weeks.

Q Assuming that the plant was behaving in the manner predicted by, on the one hand, the B&W calculation,

j-2-3

and, on the other hand, your RELAP4 calculation, would the operators see any difference in the behavior of the pressurizer level?

A I would say, yes, there would probably be some differences in the pressurize level. I believe the B&W calculation shows the pressurizer level coming back on scale during the period of interrupted natural circulation. Again, I don't recall the RELAP calculation.

One might assume that if decay heat were being removed, the pressure might remain drained.

Q Does RELAP4 account for nonhomogeneity and nonequilibrium?

A (WITNESS JENSEN) It accounts for nonhomogeneity; it does not account for nonequilibrium.

Q Mr. Jensen, I took a deposition of you on February 22nd, and asked you that same question, and you answered no as to both.

Is there some difference in your understanding between now and then?

A No. Maybe I didn't understand the question. But the fact that the code does -- it does allow the steam and water to separate within the various control volumes, but it assumes that they are the same temperature.

Q How do you account -- and the B&W code is also

j-2-4

a nonequilibrium code?

I'm sorry. It is also a thermal equilibrium code?

A Yes, it is.

Q Can you account for the difference in results in terms of plant behavior during a .01 square foot break LOCA between the RELAP4 calculation and the B&W calculation?

A No, I cannot.

Q Mr. Sheron, can you?

A (WITNESS SHERON) I imagine after inspection of both of the codes in detail, one could identify why there are differences, but I haven't done that.

Q Did the audit calculation, the RELAP4 calculation, use the actual flow versus pressure characteristics of the TMI HPI pump?

A (WITNESS JENSEN) I don't know.

Q So it could have been just a generic analysis, as far as you know, for B&W?

A It could have been, and it probably should have been, because it was put in a generic report for an analysis of all B&W reactors. So I doubt that they would have specifically designed the input to be for TMI-1.

Q This RELAP4 calculation was done by EG&G, was it not?

A Yes.

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Q When they did the RELAP4 calculation, did they try to determine the range of break sizes for which heat removal through the steam generator would be required?

I'm sorry. For which boiler condenser heat removal would be required.

A I don't know what they did at that time. I've talked to them since, and they have told me that they have done calculations that indicate that it would be required for breaks of slightly over .01 to .005, if only one HPI train were available.

Q On page 6, Mr. Sheron and Mr. Jensen state your bottom-line conclusion, and that is that the system must eventually drain down because the steam generator is the highest point in the system, and expose the condensing surface before the core is uncovered.

Strike that question.

To the advanced code, and I take it when you use that phrase, you are referring to RELAP5 and TRAC; is that correct?

A Yes.

Q Do those codes show that the boiler condenser mode of natural circulation would be established for any small breaks for TMI-1?

A (WITNESS SHERON) The calculations that were performed were not -- did not look at an entire spectrum,

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so we can't really answer the question for any small break.

For the small break that we did look at, which was the .01 square-foot break, with one HPI, and the calculation was only done with RELAP5, that calculation did not show the establishment of boiler condenser in the sense that B&W calculates it.

Q Did that calculation show that a condensing surface was uncovered?

A It's difficult to say. Obviously, whenever you are removing heat, and there is steam on the primary side, then there is a condensing surface available.

Did it expose a condensing surface in the sense of acquiescent level, let's say, on the primary side dropping down, such that a steam could contact the tubes in the sense that the B&W calculation predicted, the answer is, no.

Q. The calculations done with B&W's approved model indicating the need for boiler-condensing, were those done before or after the TMI accident?

A. They were done after the TMI accident.

Q. Am I correct that there were no calculations showing a need for boiler-condenser cooling before the accident?

A. I don't know the answer to that question, because I was not the reviewer of the B&W model with respect to its compliance to 50.46.

Q. Do you know whether that is true or not, Mr. Jensen?

A. (WITNESS JENSEN) I wasn't working with the model, either, at that time, and I don't know what calculations were done, either by B&W or by the Staff.

Q. We thought that you were one of the original reviewers of the B&W codes; is that correct?

A. No.

Q. Is it true that the approved B&W code without the additional need in hot leg piping does not calculate steam collecting at the top of a candy cane?

A. (WITNESS SHERON): Yes, that is correct.

Q. Therefore it would calculate a continuous liquid natural circulation throughout a LOCA --

A. No, I wouldn't refer to it as a continuous liquid.

I believe it would calculate a continuous two-phase circulation.

A. (WITNESS JENSEN): It could calculate boiler-condenser, also. But it wouldn't calculate an interruption of natural circulation.

Q. You state at the bottom of page 5 of your testimony that following the TMI accident, B&W did some more small-break calculations for sizes smaller than those that had been done for Appendix K, that these indicated that heat removal by boiler-condenser would be required. I'm interested in the following sentences, or sentence: "The calculations were performed to provide a basis for revisions to Small-Break LOCA emergency procedures."

Why were such revisions necessary?

A. (WITNESS SHERON): At the time I think the accident showed that there was a defficiency in the emergency operator procedures at TMI-1 -- I'm sorry -- at TMI-2, and there was a general concern regarding the operator procedures for treating small breaks in general, very small breaks that did not depressurize and remove all the decay heat through the break, typically those that were analyzed for licensing.

In order to I would say both either reaffirm the capability or the acceptability of the existing procedures and/or to improve the procedures, these calculations were

performed, so that we got an idea of plant response.

Q. Could you be a little more specific about what you refer to as the obvious deficiency in the procedures after TMI, that was demonstrated after TMI?

A. I think that had to do with the fact that the HPI termination criteria did not recognize the possibility of a saturated primary system, voids in the primary system, and as a consequence, the operators terminated HPI early based on pressurizer level.

Q. How does an operator know now for TMI-1 if he has a condition of void in the reactor coolant system?

A. (WITNESS JENSEN): He knows that he has no voiding if the reactor system is subcooled.

Q. In other words, primary system temperature is his indication of whether or not he has voiding?

A. The combination of temperature and pressure which would predict whether the coolant could boil or not, and he has a meter in the control room that would show that, plus he also would actually be able to calculate and compare to the water trapped in the system, to check the saturation.

Q. Dr. Sheron, do you agree with that?

A. (WITNESS SHERON): Yes, I do.

Q. Gentlemen, I want to show you a document dated July 11, 1979, from B. W. Sheron to Z. Z. R. Rosztoczy,

Subject: TMI-2 Turbine Overspeed Trip of 3/6/79.

MS. WEISS: I would like to have the document marked for identification as UCS No. 50, please.

MR. CUTCHIN: Mr. Chairman, I would note once again that here is another exhibit that has not been prefiled, or the parties have not been put on notice of, and this is now about the fourth or fifth. Let's see where it goes, but it is a continuing practice with UCS.

MS. WEISS: It is not my understanding, Mr. Chairman, that the party who is cross-examined has to identify for the parties whose witnesses are being cross-examined what documents are being used in cross-examination.

JUDGE EDLES: I think I'll let you use this for the purpose of cross-examination for the moment, Counsel.

Go ahead.

xxx (The document referred to was marked UCS Exhibit 50 for identification.)

xxx BY MR. POLLARD:

Q. Dr. Sheron, did you write this memorandum?

A. (WITNESS SHERON): Yes, I did.

Q. Turn particularly to page 2 of the enclosure. The last paragraph on that page says: "To account for a pressure and level increase while system temperatures are

dropping, either boiling is occurring in the system, or fluid is being added to the system. Since the coolant was approximately 100°F below the saturation temperature, boiling does not appear likely. Makeup flows necessary to match the data are excessive, however (approximately 640 gpm needed at t equals 6 minutes, and 1000 gpm at t equals 7 and one-half minutes)."

Then you attach a graph showing what the system behavior actually was compared to what it should have been.

My question to you is: Did you ever resolve the problem that you discuss in here as to what caused the [illegible]m behavior?

MR. CUTCHIN: Mr. Chairman, I'm going to object. I would like to see how this is connected at all to a small-break loss-of-coolant accident situation, since the title of the memorandum is TMI-2 Turbine Overspeed Trip. I fail to see the relevance of what happened during that transient to what might happen during a Small-Break LOCA transient.

JUDGE EDLES: Mr. Pollard, do you want to tie it together?

MR. POLLARD: In the questions we were asking the witnesses before we referenced this document, we were focusing on the sequence of events from the TMI-2 accident to how we know today the operator is not going to

misinterpret information. We asked the witnesses a series of questions as to how today the operator would recognize voiding that he would then be in the boiler-condenser mode. The answer we received was, by the subcooling margin, comparing the temperature and pressure.

Here is an incident that occurred at TMI for which all of the indications available to the operator, according to these witnesses' testimony, should not result in voiding; yet the behavior of the system was precisely as it was during the accident. That is, that the pressurizer level was going up, even though the new indication that we are going to rely upon on restart of unit 1, according to these witnesses, that said that the pressurizer level should not go up.

MR. CUTCHIN: May we respond?

JUDGE EDLES: Are you finished?

MR. POLLARD: Now, later on in these witnesses' testimony, they begin talking about their review of emergency procedures for the boiler-condenser mode. We haven't yet got to that portion of today's cross-examination dealing with the Staff's response to Board Notification 83-21, but it is my impression of that prefiled testimony, these witnesses have made the assumption that the operators will select the correct procedure for a Small-Break LOCA and follow it.

I think we have here an example of an incident which would have given all the same indications to the operator that would cause him to go to the Small-Break LOCA procedure when this is in fact not a Small-Break LOCA.

JUDGE EDLES: Mr. Cutchin?

MR. CUTCHIN: Mr. Chairman, it again is apparent that we are trying to get into the details of the various procedures. These witnesses are not here to talk about review of procedures. I did not even understand that to be within the scope of the reopened proceeding, other than to the extent that the operator would raise his steam generator water level from the 50 to the 95-percent level in order to cope with the Small-Break LOCA. I think it is just another attempt to broaden the scope of the review, and this particular transient here has nothing to do with a Small-Break LOCA directly.

MR. BAXTER: Mr. Chairman, if I may endorse Mr. Cutchin's response. I did not object to the last couple of questions asked to the witnesses about operator recognition of subcooling because I thought somehow it was going to be linked back to other questions on the adequacy of the evaluations done with the models of boiler-condenser cooling.

It does seem to me that the Board had been asked previously and ruled on January 26th that there was

no need for additional questions relating to procedures to be followed by the operators for decay heat removal, and particularly the boiler-condenser cooling mode.

There has, while we have been in session, been a Board notification which in part addressed procedures for boiler-condenser cooling and the Board has made available its response. I do not think, absent some Board determination, that we are going to expand the proceeding to go into that, when additional information comes to the Board in the normal course of its deliberation on a case and it decides whether or not it needs to reopen the record and go into it. I don't understand that we have reached that position here.

Just one last thing. I'm sorry. These procedures were put in the record before the Licensing Board. The Staff safety evaluation reporting on their conclusions that the Small-Break LOCA procedures were adequate was put in the record before the Licensing Board, and UCS was given every opportunity to cross-examine fully and brief the record developed below on those procedures. They have in fact not changed. And that is the conclusion that came out of this most recent review of Board Notification 83-21. We are on appeal here, and there is absolutely no reason to be going over this ground again.

MS. WEISS: Mr. Chairman, the question asked

nothing about specific procedures.

It is our position that a computer analysis, or any of the many computer analyses we have been offered -- and I think there are five or six between the various witnesses in this case -- of system behavior is only good so far as it corresponds to what one would actually see happening in the plant over the period of time that the analysis attempts to make its predictions.

In the case of Small-Break LOCA in particular, what is happening in the plant has a substantial amount to do with what the operator perceives and how he acts upon what he perceives. We don't intend at this point to go into any of the details of any procedures, but we think it is a highly relevant point. If the operator cannot be expected to distinguish, for example, between a Small-Break LOCA or some other accident, and if on the basis of that he does not take the appropriate actions, and that plant does not conform to what the assumptions are in the computer analyses, then the computer analyses are simply not useful.

I think it is important to remember how the TMI-2 accident happened, where an operator turned off emergency core cooling because he was afraid that his plant was going solid, because his indications led him to believe that that was happening and that that was worse,

and we think that we are addressing and will be addressing throughout the examination of these witnesses whether an analogous situation doesn't exist now for TMI-1.

MR. BAXTER: No one is suggesting, obviously, that procedures in training aren't important, and that is why the Licensing Board examined it in exhaustive detail below, but that is not the scope of this proceeding.

MS. WEISS: I hardly endorse the characterization of the examination as exhaustive at the tail.

MR. BAXTER: Below.

MS. WEISS: Below, above, or in between.

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JUDGE EDLES: Mr. Cutchin?

MR. CUTCHIN: The last argument I heard went into the question of the adequacy of operator training to recognize and use the correct procedure, and that clearly is not a proper subject for this proceeding.

MS. WEISS: It is not the adequacy of operator training. It is the adequacy of plant instrumentation to tell anybody what condition the plant is in.

JUDGE BUCK: Let me cut this off for a moment. I don't want to get into procedures, the Board does not want to get into procedures in this part of the review. But I think that we should hear the answer to this last question, not on the basis of procedures, but on the basis of, is there a method of identifying the difference between a small break LOCA and some other kind of a LOCA.

So, I will permit the answer to the question. This Board will permit the answer to the question.

WITNESS SHERON: What was the question again?

BY MS. WEISS:

Q I have the same problem you do. I think we better take maybe a step backward and have you explain for us, if Dr. Buck wouldn't mind, what the event was that you are describing in the document that is marked for identification UCS 50.

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A (WITNESS SHERON) The event you are referring to was brought to the attention of the Bulletins and Orders Task Force by an inspector, Mr. Dorwin Hunter, in Region 3, and he was expressing to us a concern that when he was looking at the -- I guess the files at TMI -- he was part of the team that was inspecting the files there, including previous transient events that had occurred at the plant. He did not understand the behavior of the system with respect to the temperature, pressure, pressurizer level traces, what have you. He was concerned -- he thought he saw a voiding occurring in the high portions of the vessel, and I was asked to examine Mr. Hunter's concerns, and to determine whether indeed there was some new phenomenon which we were not properly accounting for in our own analysis, methods and codes, or whether the behavior of the plant could be explained.

Mr. Hunter's concern was primarily with respect to the pressurizer level behavior. If you will look on the last figure of this document, he was concerned that the reason the pressurizer level -- what he thought he saw was that the pressurizer level came roaring on down until it his, somewhere it looks like about 60 inches, at which time it came to a screeching halt, and started going up. And he was very much concerned that this was because we were creating a big steam bubble in the

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upper head due to flashing, and that was holding up the pressure.

What I did is, I looked at -- and these figures here are all based on very crude hand calculations with estimates of coolant volumes and the like -- but what I did was, I tried to explain the initial, I would say, break point in the pressurizer level coming down and to explain that that was strictly due to the contraction of the fluid in the primary system, and the calculation was basically to show that when one did have a reactor trip and went on circulation flow with essentially no power except decay heat generated in the core, the temperature of the fluid exiting the core decreased very rapidly to about the cold leg temperature.

This cooling off of all of the fluid, which I call the hot fluid that would be in the -- I guess the vessel upper head and the hot leg piping, down to the steam generator, would contract, and this contraction would manifest itself in a drop in pressurizer level. And what I was trying to show was that I could approximately predict the amount of pressurizer level drop that one would expect to see just due to contraction with no steam formation.

That is what the curve shows on the last figure, the predicted, the dashed line, which shows the

j-4-4

results of that hand calculation up to that point.

Now, as I pointed out in this memo, beyond what looks like about 6 minutes, the pressurizer level continued on down, whereas my hand calculation based on the information I had would have expected a slight increase in level due to, I guess, the safety injection flow, or make-up flow.

I would have to go back through my records to find out if I had actually continued this evaluation and explained the continuing decrease.

I remember that I pursued it for some time. But, again, it was only pursued from the standpoint of explaining the initial break point in pressurizer level, and whether or not steam was being formed in the upper head because of that.

Q You say in the memo that beyond five and a half minutes, which is what period you were just talking about, the last part of your answer to the question, measured temperatures indicated that the pressurizer level should be contracting, whereas, the data show both the pressure and pressurizer level increasing.

This discrepancy was not resolved, and more data will be needed in order to make a final determination, if unexpected phenomena are occurring.

That is on the front page of the memo.

j-4-5

A Yes, beyond five and a half seconds.

Q Five and a half minutes?

A Five and a halt minutes. I'm sorry.

Q And then on page 2 of the attachment, you elaborate just a bit more on that. You say to account for pressure level increase while system temperatures are dropping, either boiling is occurring in the system or fluid is being added to the system.

Since the coolant was approximately 100 degrees Farenheit below the saturation temperature, boiling did not appear likely. Make-up flows necessary to match the data are excessive, however. Approximately 640 gallons per minute needed at 6 minutes, and 1000 gallons per minute needed at 7 and a half minutes.

And then if I turn to the last graph, is the dashed line the predicted pressurizer level over time?

A Yes.

Q And the solid line is the actual measured pressurized level over time?

A Yes.

Q And they diverge quite markedly at about five and a half minutes?

A Yes, that is correct.

Q Did you ever resolve that?

A I'm not sure. You know, I remember working on

j-4-6

this, and I think I had reached a certain point. Either I had gotten an explanation to my satisfaction, or there was a problem that I just didn't have sufficient input data in which to try and resolve it. I would have to go back through my files to find out exactly how this was closed out.

JUDGE BUCK: Let me ask, Mr. Sheron, has this type of reaction shown up, or does it have any relation to what you would expect to see in a small break LOCA?

WITNESS SHERON: Only from the standpoint that both the small break LOCA and this event, or any turbine trip event will result in a decrease in pressurizer level, and a decrease in system pressure.

JUDGE BUCK: For the full period of time that you are talking about here?

WITNESS SHERON: No. A small break in the range that we have been discussing in this hearing, namely, .01 square foot, the pressure would continue to decrease, whereas, for a turbine trip or for an event like this, system pressure should come down to some point somewhere between, say, 1700, 1900 pounds, depending upon the shrinkage and the like, and then stop.

JUDGE BUCK: So you think they are identifiable, between the two of them?

WITNESS SHERON: Yes. The initial shrink due

to a turbine trip, or whatever, should not actuate safety injection flow; whereas, a small break of the size we are talking about would decrease to actually a safety injection flow.

JUDGE BUCK: Thank you.

MR. BAXTER: Mr. Chairman, I then move to have all the previous testimony in response to this line of questions stricken as irrelevant to the scope of this proceeding, and totally adding nothing more than a confusing situation in terms of an old document, which the witnesses have not had a chance to review or consider whether or not the situation presented here has been analyzed in the last four years, an event that occurred prior to the TMI-2 accident itself.

I think we have heard from the last answer that this is not related at all to the scope of the proceeding.

MS. WEISS: I don't think that is how the answer could be construed, and we would like to be able to ask a couple more questions.

JUDGE BUCK: The point that I was allowing was to show whether or not this accident was identifiable from a small break LOCA. The answer from Dr. Sheron is that it is, and with the pressure curves being different, and that is, I think, as far as we go in this, because we do not want to get into procedures.

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I have to agree with the Licensee on that point.

MS. WEISS: What we want to ask him, Dr. Buck, is whether during a small break LOCA an operator might not see that it measured pressurizer level over time going up while the actual is going down.

JUDGE BUCK: He's already answered that.

MS. WEISS: I didn't understand the answer to the question, if that is what he said.

JUDGE BUCK: Is that correct, Mr. Sheron? Did you answer that particular question in answer to my question as to how these curves --

WITNESS SHERON: If I could explain. The difference that you would see between an actual small break in a primary system as opposed to an event like this turbine overspeed, both events would produce an initial drop in pressure, although you will note that in this event there was a sudden surge in the pressurizer level, which one would not expect to see during a small break.

Notwithstanding that, the pressures in both events would go down. For the small break, as I said, the pressure would continue to go down and actuate the safety injection system. In addition, the system would saturate as indicated on a subcooling meter or just

from the temperature and pressure measurements.

In this event, the pressure decreased and the pressurizer level decrease is halted, and the HPI would recover and refill the system, and the difference primarily would be that the system would remain in a subcooled state with respect to hot and cold leg temperature measurements.

One would not expect to see them go saturated.

JUDGE BUCK: Thank you. What length of time is involved in getting this difference?

WITNESS SHERON: It is kind of hard to say, because, you know, the time involved is dependent upon the break size, but one would presume within a period of minutes.

JUDGE BUCK: Thank you.

JUDGE EDLES: I'll overrule counsel's objection to strike or to require that we move on to another line of questioning at this point.

Ms. Weiss, let me make a general observation, that I have some degree of sympathy with Mr. Cutchin's concern, that some of the documents that are being presented for introduction into the record are at least, it seems to me, in the nature of anticipatory rebuttal, and might have been produced at an earlier stage so that everybody could

have had a look at it.

We have allowed these to come in so far because they have been by and large relatively short, and the witness has refreshed his recollection quickly, and there doesn't seem to be too much prejudice, and this is an administrative hearing.

After all, we are not trying the case before a jury.

But I do have some concerns with the fact that some of this information, you know, might have been made available at an earlier stage.

So I would, just without attempting to compromise your legitimate right to cross-examine, I would try to suggest that you be circumspect in your use of such documents.

MS. WEISS: Mr. Chairman, considering the time that we had available to prepare this cross, and the time that we had with these documents, I really think that it is totally unfair to suggest that we were holding back and not informing people what our plans were.

I also don't understand that there is any obligation to tell the opposing party what cross-examination is going to be.

JUDGE EDLES: I'm not suggesting that there is an obligation to tell them what cross-examination is. I

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think we are getting, it seems to me, into an area in which cross-examination might well border upon sort of an anticipatory rebuttal, and anticipatory rebuttal is the kind of thing that we would ordinarily put into the direct case.

But I'll let you drop that line of questioning and move on to something else.

MR. BAXTER: Mr. Chairman, to clarify my understanding, I did not hear an offer of this exhibit, and I don't believe it has been admitted by the Board. It has simply been marked for identification and used during the cross.

MS. WEISS: Mr. Chairman, considering the problems with the documents -- and we do have quite a few more we wish to question on -- Mr. Pollard and I would like to discuss whether we don't want to make a motion to file rebuttal testimony, which may be the cleanest way to deal with this in view of the statements that the Board has made before, that the hearing would be an appropriate time to ask for rebuttal testimony. That may well be the best way to handle it.

JUDGE EDLES: Mr. Baxter?

MR. BAXTER: I don't know what we are bargaining here. It is not Licensee's position that it is inappropriate for UCS to produce documents and question the witnesses without having filed them with us in advance. We think that is a perfectly appropriate technique for cross-examination. We do not think that exhibits should be offered into evidence that had not been made available to the parties in advance to give them a chance to rebut them, and so far, Ms. Weiss hasn't done that. So I don't have any objection to the procedure employed so far during the UCS cross-examination.

My objections have been more to the relevance of the documents they are producing to question on as opposed to the fact that I didn't get a copy of it until a couple of weeks ago.

So I don't see yet that we are at any point of impeding the examination this morning.

MR. CUTCHIN: Let's proceed, Mr. Chairman, and see where it goer, because I, too, am not anxious to delay anything. But as long as they are going to be used for cross, and we have a reasonable time to examine them before they are being used for cross, then I won't object. But I will object to their being introduced into evidence.

MS. WEISS: I move UCS-50 into evidence.

MR. CUTCHIN: I object.

MR. BAXTER: So do I, Mr. Chairman. I think the cross-examination made clear that the document is not relevant.

JUDGE EDLES: Ms. Weiss, I'll deny the motion to introduce the document into evidence. That is without prejudice to your being able to make a motion at the close of the hearing for an opportunity for rebuttal, and other parties may then respond to that motion, and we will consider it at that time.

I think that is probably the most sensible and expeditious way to proceed at this time.

BY MS. WEISS:

Q Was one of the post-TMI requirements, Dr. Sheron, that Licensees make their emergency procedures symptom-oriented rather than event-oriented?

A. (WITNESS SHERON): I don't think there was ever specified in one of the TMI requirements the words specifically "system-oriented." I think, although I would have to check, it was more general, like one must upgrade and improve the emergency procedures. The word "symptom-oriented" may have been used. I don't know.

Q. Can you describe the difference between symptom-oriented and event-oriented?

MR. CUTCHIN: Objection, Mr. Chairman. I would like to see where this is leading with respect to the scope of this particular testimony that is supposed to be the subject of cross-examination. I would like it tied to the direct testimony somehow as to how these answers are necessary to proceed.

JUDGE EDLES: Ms. Weiss.

MS. WEISS: You know, it is the same general point that I tried to make about a half an hour ago; that the computer analysis is only so good as it corresponds to what is happening in the plant, and for a Small-Break LOCA the actions which the operator takes determines what is happening in the plant to a very large extent. If he doesn't understand or if he is not given the appropriate indications to distinguish between certain kinds of accidents, then he may take inappropriate action like he did during TMI-2, and the plant would not be in the same

condition as the assumptions which are made in the computer analysis.

We think, for example, that that is precisely the concern that Dr. Lahey -- the first concern that Dr. Lahey expresses in BN-83-21, that whereas it is necessary to have steam generator level raised to 95 percent on the operating range, to get a condensing surface which is necessary if we are in a condition which one needs boiler-condenser. On the other hand, there are other accidents for which it is dangerous to raise steam generator level to 95 percent, and if the operator believes that he is in one of those instead of in a Small-Break LOCA and takes the wrong action, then all the computer analyses that show the core is uncovered are relevant.

MR. CUTCHIN: I renew my objection, Mr. Chairman. I think that makes it blatantly clear that she's trying to carry this proceeding well beyond the scope for which it was reopened.

MR. BAXTER: Can I just remind the Board that B&W operator guidelines were placed in the record below. They are Exhibit No. 12. And all this was available for exploration before the Licensing Board, and was explored by that Board. And none of these questions, at least as far as we can determine, involved operator procedures.

JUDGE BUCK: We believe that question is beyond

what we are trying to get at here. There are always problems of procedures, and I don't know where we are going as to whether this thing is -- what was it, symptomatic or event-oriented. When you come down to procedures, you do the best you can with them, and I think this has all been gone through and revised since the TMI-1 event, or TMI-2 event. And so I don't see really the relevance of this to the purpose of this hearing.

MS. WEISS: Well, if I may just put it on the record, and the Board, I suppose, has ruled. But in response to your observation that you don't see the relevance of whether the procedures are event or symptom-oriented, it was precisely the lesson learned from TMI that the procedures should be symptom-oriented so that the operator is responding to the indications given him from his instrumentation, and he does not have to know what event he's in. He doesn't have to diagnose what event he's in, for the precise reason that if he does have to diagnose the event he's in, in order to know what action to take, there is a grave chance that he will take the wrong action. I think that applies directly to this case.

JUDGE EDLES: I don't understand the objection to go to the fact that that is a relevant consideration in the restarted proceeding. As I understand the objection, it goes to the fact that that isn't really relevant to

questions 4, 5, 6, and 7 that we have asked in ALAB 708, which is the subject of the reopened hearing.

MS. WEISS: I suppose it is the Board's prerogative to say what it wants to hear about, and I think I have laid our position out clearly, that the computer analyses in the abstract, if they do not conform to what one can expect to happen in the plant, are relevant. That is our position, and the Board has ruled.

JUDGE EDLES: Okay. Then the Board has ruled. Why don't you move to something else, please.

MS. WEISS: Unfortunately, Mr. Chairman, that knocks the pins out of our entire cross-examination of these witnesses. So we would like a break.

JUDGE EDLES: Would you like a short time to regroup?

MS. WEISS: Yes.

JUDGE EDLES: Okay. We will take a 15-minute recess.

(Recess.)

JUDGE EDLES: Please be seated.

BY MS. WEISS:

Q Gentlemen, can we go to page 9 of your testimony. In the first paragraph, which actually begins on page 8 in response to question 7, you state that there are at present no experimental data from a test facility geometrically similar to the B&W design confirming the boiler condenser mode of natural circulation, and then you go on to describe some discussions that you are involved with now with respect to changing the girder facility and the last sentence, as your testimony originally read on that paragraph, was, "The purpose of the testing is not to confirm the effectiveness of boiler-condenser heat removal." And you added another sentence: "Rather, its purpose is to satisfy the confirmatory research needs of the B&W design and to provide additional confirmation of operating guidelines."

I'm interested in the word "additional." Given that you state in the first sentence that there are no experimental data from a test facility geometrically similar to B&W, what is this confirmation additional to?

A (WITNESS SHERON) The geometric similarity -- I don't know whether I pointed it out in this testimony or previously -- is really only important when one is looking at perhaps like gravity-dominated flows, and the

j-6-2

like.

What I think I'm telling you is that for a large break LOCA, for example, the actual plant geometry, I think, is not very important to the overall results.

Q What about for a small break LOCA?

A For a small break LOCA, yes, it is.

Q So, for a small break LOCA, what is this confirmation additional to, given a lack of any test data from a geometrically similar facility?

A There are certain aspects of all analysis models that would be evaluated against fundamental experimental data.

For example, semiscale and loft, although they are not geometrically similar, some aspects of those facilities can be applied to the verification of the computer models for the B&W plant; separate effects testing, for example, the Oak Ridge heat transfer tests, are certainly applicable to any PWI, since they were only core-tested, and didn't involve primary system geometry.

So these only refer to those aspects that are involved with the overall geometry dependent behavior.

Q Why is the geometry dependent behavior important for, as you say, operating guidelines?

A As we have pointed out in, I guess, many

j-6-3

documents in the past, we are interested in confirming the behavior of the plant during this transition period between the bubbly two-phase natural circulation and the establishment of boiler-condenser.

Q And for that purpose, you need test data from a geometrically similar facility; is that correct?

A We believe that is correct.

Q You state, also on page 5, "We are relying on detailed computational analyses which have been performed by both B&W, the NRC Staff, and our contractor, EG&G Idaho, to demonstrate the efficacy of boiler-condenser natural circulation."

The B&W analyses to which you refer there, and upon which you are relying, are the original calculations done in May of 1979; is that correct?

A That is correct.

Q Then I'll proceed to the next half of the sentence.

Are there any detailed computational analyses which have been performed by the Staff upon which you rely here, or you refer to in this sentence?

A Yes. Dr. Jensen performed a calculation.

Q Could you describe it, please?

A (WITNESS JENSEN) There were also calculations by EG&G, but the calculations that are referenced in the

testimony --

Q Excuse me. The question was the Staff calculation.

A Right. Okay. The Staff calculation was -- it was similar to a feed and bleed calculation, except that there was not any feed added for about 30 minutes. It was assumed that the HPI system did not come on for about 30 minutes until the system got highly voided, and the purpose of this was to produce a highly voided state within the reactor system so that when the emergency feedwater was turned on, then there would -- the conditions for which boiler-condenser would be needed would exist.

So, at about 30 minutes, then, it was assumed, then, that the emergency feedwater was turned and boiler-condenser was calculated to occur.

Q And did you do this calculation because the EG&G calculations did not show the occurrence of boiler-condenser, so you did a calculation where you in essence forced conditions where boiler-condenser would occur?

A Yes. The EG&G calculation showed condensation of steam on the steam generator tubes, but it was a more continuous natural circulation phenomena, where the whole loop was flowing -- steam and water together -- past the steam generator tubes, and it wasn't the separation

effect that was predicted by Babcock and Wilcox.

Q In this EG&G calculation, that was for a .01 square-foot break, correct?

A Yes, it was.

Q And they used RELAP5?

A Yes, they did.

Q And when was this done?

A It was done in January.

Q Are there any other detailed computational analyses besides the B&W May 1979 analysis, the EG&G .01 square-foot analyses, and the calculations which you described where you voided the reactor coolant system upon which you rely in this sentence?

A Well, there are basic hand calculations that were done to show the effectiveness of boiler-condenser calculations. There were also calculations done on the TRAC computer code, but these show that there were two high-pressure injections -- these assumed that there were two high-pressure injection trains in operation, and that they did not uncover the condensing surface. There was too much water added to the system.

Q So, those are essentially irrelevant?

A Yes, to this issue of boiler-condenser, but they are relevant to the issue of small break LOCA, I think.

Q And you indicated hand calculations. Were

those heat transfer calculations?

A Yes. That was in the testimony.

Q Excuse me.

A Yes. These are the ones that are presented later on in this testimony.

Q Would you describe those as detailed computational analyses?

A Yes, I would.

Q. Could you describe the difference between RELAP5 and RELAP4?

A. Only in a very general sense.

RELAP5 solves the more detailed versions of the mass and energy equations, and the RELAP5 code does allow nonequilibrium conditions to exist within the control volumes.

Q. With respect to the noding of the physical plant systems, how does RELAP4 differ from RELAP5?

A. It is up to the user to input the noding in either code.

Q. What about the RELAP5 calculation that was done and is described in this testimony? What was the noding there?

A. It was fairly detailed, I believe.

Which calculation? The EG&G calculation, or the NRC calculation?

Q. The only RELAP5 calculation I'm aware of is EG&G. Am I wrong?

A. Well, there was the one --

Q. The .01 square foot break.

A. The .01 square foot break. Okay. That had 8 nodes within the steam generator, and it had a fairly -- multinodes within the reactor vessel, and it was divided up to some detail.

Q. For RELAP5, can you tell me how many nodes there are in the primary side of the steam generator?

A. This was the EG&G noding scheme. They could have used a different noding scheme. But I believe they have 8 nodes on the primary side of each steam generator, and they also had an equivalent 8 nodes on the secondary side of the steam generator.

Q. For the RELAP4 audit calculations, how many nodes were there on the primary side of the steam generators?

A. I don't remember.

Q. Do you know how many nodes there were on the secondary side of the steam generator?

A. No, I don't.

Q. Can you describe at all how the nodes correspond to the steam generator for RELAP5? Do you know how it is divided?

A. I think it was divided into approximately eight equal segments. But I'm not completely sure.

Q. You state that the objective of the EG&G analysis of the .01 square foot break was to duplicate to the extent possible an analysis performed by B&W, documented in Licensee's Exhibit 5, in which natural circulation is calculated to be lost and then is reestablished in boiler-condenser.

Dr. Sheron, did the analysis in fact duplicate

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the B&W analysis?

A. (WITNESS SHERON) With respect to detailed behavior, no, it did not.

Q. Would you describe the difference, please.

A. The B&W calculation which was performed in the May 1979 blue book for the .01 break showed an initial depressurization, I believe it was probably reaching a minimum of somewhere around 600 seconds, I think, followed by repressurization up to about 1600 psi at about 1500 seconds. At this point the condensing surface was calculated to be uncovered sufficient to remove decay heat. The pressure came down after 1500 seconds.

In the EG&G calculation they did not calculate the interruption of natural circulation, and they showed what I think I refer to in my testimony as a chugging behavior in the primary system. This maintained the pressure much lower than in the B&W calculation during the period that they had interrupted natural circulation

Q. Before I go on to ask you to describe what this chugging consisted of, can you tell me whether there were any differences in the input with respect to plant parameters between the B&W May 1979 calculation and the EG&G .01 square foot break calculation?

A. The B&W calculation was a generic calculation. I don't really know how close it simulated TMI-1.

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Our calculation used the TMI-1 input parameters, or input parameters representative of the TMI-1 plant.

Q. For power level?

A. I believe so. Power level, HPI flow, and the like.

Q. Could you describe to me as specifically as you can the physical behavior of the plant which is predicted by RELAP5 in the .01 square foot calculation? In other words, explain to me what is happening in the plant that is described as a chugging phenomena.

A. The behavior which I will describe: First off, this was obviously not based on my personal inspection of each and every calculated parameter, but it was based on my conversations with the EG&G personnel that performed the calculation.

What was happening was that once you had the break initiated in the system, you get an initial draining of the pressurizer, the pressure drops; you will eventually reach a saturation condition in the primary system. You get flashing, boiling, et cetera. You will accumulate sufficient steam in the primary system hot legs to interrupt natural circulation. Up until about this point I think both the Staff calculation and the B&W calculations are fairly similar, and probably perhaps for a little bit beyond that.

What happens next is the fact that you have interrupted natural circulation steam generated in the core; it now cannot be condensed and starts to accumulate on the hot leg side of the primary system, and the pressurization is sufficient to open the vent valves. This passes steam generated in the core, which accumulates in the upper part of the vessel through the internal vent valves into the upper annulus, the downcomer, into the cold leg.

In the analysis, you will note on page 10 it says only one of the two HPI pumps was assumed operable. The steam generated in the core due to decay heat could not be entirely condensed by the HPI flow entering the cold leg. Therefore, there was an accumulation of steam in the cold legs. This net accumulation of steam was calculated to displace some water in the cold legs as it accumulated there.

As I understand it from EG&G, this would cause water that was stagnant in the steam generator -- and you have to understand what this water was doing. There was a level of water on the primary side in the steam generator that had been cooling off due to heat transfer to the secondary but was not being replenished by warmer water from the hot leg, since there was no circulation. So this water was basically stagnant and cooling off in the generator.

As the steam was accumulating in the cold legs and displacing water, it was, as I understand, pushing this water back up in a reverse flow you might call it, back up into the generator towards the candy cane in the hot leg. You can think of it as just some sort of a bubble expanding and it is pushing water in both directions as it expands, as it accumulates.

This cooler water, as it started contacting the steam in the upper portions of the generator in the hot leg, started to promote condensation. This condensation would cause a drop in pressure as you condensed steam in the primary system. It also -- this dropping the pressure would tend to cause -- would put, I guess, a positive driving pressure differential between the core and the steam generator, and what you got was like a surge of fluid, of two-phase fluid that was in the hot leg, kind of getting sloshed over into the steam generator, carrying steam, what have you, liquid, into the generator. There was heat transferred then, in which you transferred decay heat to the secondary side, and then the system would settle down again.

As it settled down, there was phase separation and you interrupted natural circulation again. And the process continued, as I understand it.

I believe the curves that were shown showed a

number of cycles that occurred on the secondary side pressure, and it behaved accordingly.

Mr. Jensen is pointing out like figure 7-3, which shows what I call the chugging of the fluid.

The flow that you see in 7-3, Mr. Jensen just told me, was the hot leg flow.

Q. Would you take a look at figure 7-1 in your testimony.

A. Okay.

Q. Is it true that -- well, let me back up.

This figure depicts primary system pressure and secondary system pressure in both loops for the chugging phenomenon that you have just described; correct?

A. Well, it just describes the pressure during the transient. It is not for any unique phenomenon.

Q. But these are the curves from the RELAP5 calculation?

A. Yes.

Q. And the system behavior during this period of time is what you have just described at some length as the chugging phenomenon; correct?

A. Yes.

Q. Is it true that the indications that the operator would receive with respect to system pressure, steam generator pressure, are quite different if the system is behaving as

depicted in figure 1, than they would be if the system is behaving as in the B&W analysis?

A. (WITNESS JENSEN) I think in both of them you will see that he would see that his reactor systems were saturated, and he would take the steps called for for a saturated reactor system.

The fact that it is saturated for a long period of time and just now returned to a subcooled condition would indicate that a Small-Break LOCA was in progress.

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Q Figure 7-1, looking at curves that show steam generator pressure versus time, would those graphs be different if the plant were behaving as predicted by the B&W model in the May 1979 calculation?

A Yes, they would be different.

Q How would they be different?

A In this plot, the times when natural circulation is lost, is seen by the fact that the pressure is decreasing within the steam generator. When the slug of water comes over the steam generator tubes and momentarily restores natural circulation, the pressure increases again within the steam generator.

If natural circulation were lost for a longer period of time, as in the B&W calculation, there might be more of a decrease in the secondary system pressure. However, once the 50 percent level had been obtained within the steam generator, there would be no further decrease.

Q Is it correct that if the plant were in a stable boiler-condenser mode of cooling, that you would not see these alternate cycles of pressurization and depressurization in the steam generator?

A Yes, that is true.

MR. CUTCHIN: For clarity of the record, Mr. Chairman, could we get a definition of stable

boiler-condenser, so we won't have confusion as to what that means.

JUDGE EDLES: Maybe Mr. Pollard wants to offer one first, and see if the witness understands and agrees with it.

BY MR. POLLARD:

Q Would you characterize the prediction of the B&W model as a stable boiler-condenser mode?

A (WITNESS JENSEN) Once boiler-condenser was established, it was not lost. However, there was a time when there was no heat transfer to the steam generator calculated.

Q Once it was established, would you characterize the B&W model prediction as a stable boiler-condenser mode?

A Yes.

BY MS. WEISS:

Q Is there any experimental data on a facility geometrically similar to TMI upon which you could make the determination of whether B&W prediction of plant behavior during boiler-condenser or the RELAP5 prediction of chugging for a .01 square-foot break is a correct prediction of what in fact the plant would be doing?

A The major consequence of both of the calculations was that --

Q Mr. Jensen, the question is, is there any

experimental data upon which you could determine which one of those is a correct description of plant behavior?

A What I was about to say, I think they are probably both correct, and they both show the core to be covered.

Q They both show very different plant behavior, don't they, Mr. Jensen, in terms of -- for example, pressure in the steam generators?

A There is some difference within the pressure response, and there is no plant data specifically like a B&W reactor system.

Q So you don't know which in fact is a correct description of what will happen for a .01 square-foot break; correct?

A As far as these pressure plots are concerned, no, I don't.

Q Has any other computer analyses done for B&W load loop plants ever exhibited the chugging phenomenon that you described, Dr. Sheron?

A (WITNESS SHERON) There are two other calculations that I'm aware of. One is the old RELAP4 calculation. I don't know whether that showed what I referred to as the chugging phenomenon. The same phenomenon was calculated in RELAP5.

Also, B&W has performed the same calculation

j-8-4

with their new model which does not show this repressurization in the same manner that the original calculation did.

I'm not sure if during the period of time where the pressure remains low whether any sort of a chugging phenomenon similar to what the Staff calculated was occurring or not, since we haven't really gotten into the review of that analysis.

Q Did the calculations reported in your testimony assume the operation of both steam generators?

A Yes, they did.

Q Has NRC performed or contracted to be performed, or ordered to be performed, any calculations to determine the adequacy of boiler-condenser to remove sufficient decay heat through only one OTSG at TMI-1?

A (WITNESS JENSEN) We asked B&W to do a calculation, and it was done, and it showed there to be very little difference between the results for one steam generator and two steam generators.

Q Where are those reported?

A They are in the big report that -- let's see, I think it is Exhibit 5, or something like that.

Q If the objective of asking EG&G to do a .01 square-foot break with RELAP5 was to duplicate the B&W analyses, why didn't you use the same core power level and

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HPI flow parameters that were used in the B&W analysis?

A (WITNESS SHERON) In the time available to perform the calculations, there were two overriding concerns.

One was that the request came as a result of this hearing which is for TMI-1, and therefore, we have been establishing models representative of TMI-1.

They used the same input deck to do a boiler-condenser calculation that you would use to do a feed and bleed calculation. So that was the first concern.

The second was that to set up a new deck, what I would call for generic B&W plant, would, A, involve having to obtain all of the input information that was used by B&W in 1979. That would be a very time-consuming effort.

Number 2, to input that information into the computer code and then to perform the initialization, in other words, the steady state balancing of the code, which you need to do before you can execute any sort of a transient, takes a substantial amount of time, and to perform both of those things in the available time would have been very difficult, if not impossible.

Q The consequence of using both a different code and different input parameters is that you can't tell when you get different system behavior whether it is

attributable to the difference in parameters or the difference in code; is that correct?

A Not necessarily. A lot of times you can only resolve differences based on detailed evaluation of both the analyses and the computer code. You can first try by isolating certain effects and looking for differences there, and then you can either attribute them to different input parameters or perhaps different modeling techniques.

Q In this case, you have already told me that you don't know what accounts for the difference in the plant behavior predictions between the B&W analysis and the EG&G analysis; is that correct?

A We haven't examined it in any detail. I haven't said that we have thrown our hands up in disgust and said we give up. We just really haven't had the time to try and understand the differences.

Q I would like to ask you in some more detail the EG&G calculation of the .01 square-foot break.

Can you describe for me in the calculation how the emergency feedwater flow as a function of time is determined?

A (WITNESS JENSEN) It was based on what was required -- well, let's see. First, one emergency feedwater pump, one motor-driven emergency feedwater pump for TMI-1 was assumed to be available, and that flow was used

until the level reached the 50 percent level within the steam -- the 50 percent level on the operating range within the steam generator, and there it was assumed that the feedwater was throttled back.

Q. All right.

A. I believe on table 7-1, you can see that at 2010 seconds, that the emergency feedwater flow was terminated because the level had reached 220 inches, which corresponds to a 50-percent level on the upper range.

Q. Why didn't you raise it to 95 percent?

A. It wasn't -- it just wasn't assumed in the calculation.

BY MR. POLLARD:

Q. Mr. Jensen, isn't it correct that in Board Notification 83-21 --

MR. CUTCHIN: Mr. Chairman, I've watched this switching back and forth. If we are going to keep doing this, and the questioners can rest while the witnesses are put to the test, I'm going to start asking for a break.

JUDGE EDLES: I don't think there has been any undue double-teaming at the moment, but I'll keep my eye on it.

Go ahead, Mr. Pollard.

BY MR. POLLARD:

Q. Is it not correct that one of the Staff learned from reviewing the B&W versus GPU trial, that at the 50-percent level on the operating range would not be a sufficiently high level to maintain the boiler-condenser mode; isn't that correct?

A. (WITNESS SHERON) The Staff knew that about 1979.

Q. And I think perhaps you were here yesterday. Do you recall Dr. Jones saying that if the primary and secondary side levels in the steam generator were at the same height and there was no EFW flow, that there would be very little heat transfer from primary to secondary?

A. (WITNESS JENSEN) Yes, I remember that.

Q. Would you agree with that?

A. (WITNESS SHERON): Yes, I agree.

Q. Do you agree, also, Mr. Jensen?

I'm not trying to shut off either one of you.

A. (WITNESS JENSEN): Yes, I agree with that, also.

Q. So that am I correct, then, that in the EG&G calculation, you terminated EFW flow when you got to the 50-percent level on the operating range, and that after that point you would have ceased the boiler-condenser mode once the primary system level reached 50 percent on the operating range?

A. The primary system level in fact didn't get to 50 percent on the operating range. Instead we got this slug flow effect, this intermittent loop flow.

Q. Was the emergency feedwater flow rate from 37.52 seconds until 2010 seconds calculated solely as a function of steam generator pressure using the TMI-1 emergency feedwater pump characteristics?

A. I'm not completely sure. They might have just used a constant flow until the level got up to 50 percent.

Q. Do you know what that flow rate was?

A. It was 460 -- it would be 460 gallons per minute.

Q. Into each steam generator?

A. No. That would be total.

Q. So, do I understand your answer, then, that you don't know wehther they varied EFW flow as a function of steam generator pressure or held it constant, but if they held it constant they would have done so at 460 gallons per minute total EFW flow; is that correct?

A. Yes.

BY MS. WEISS:

Q. Can you tell me, please, in what respect the plant behavior predicted by EG&G and described in table 7-1 will duplicate what happens at TMI-1 during a Small-Break LOCA if the operator follows procedures correctly, assuming he follows his procedures correctly?

A. (WITNESS JENSEN) Well, first we would expect that there would be more emergency feedwater than was assumed here, because this assumes loss of two pumps.

There was not any assumed action by the operator to raise the level to 95 percent as weould be done at TMI-1. I think that is all I know, as far as what would actually happen at the plant compared to this case.

I only can place reliance on the ability of the Code to be able to predict the response of the plant.

Q. Let me ask you again: Why didn't EG&G assume steam generator levels raised to 95 percent on the operating range?

A. I guess I don't know. It would have been an additional complexity on the input, and I guess they wanted to see what would happen if he didn't raise it up to 95 percent, and if that was needed or not.

Q. I don't know what you mean, they wanted to see what would happen.

Didn't you tell EG&G what to do?

A. I didn't tell them what to do with the 95 percent.

Q. Didn't you tell EG&G that you wanted to duplicate the B&W analysis for the .01 square foot break?

A. The B&W analysis also, I don't believe, assumed the level was raised to 95 percent.

Q. You are saying it is your belief that the B&W analysis doesn't assume that the level was raised to 95 percent?

A. Yes.

Q. Do you have any analysis, then, at all, of a Small-Break LOCA for TMI-1 which assumes steam generator levels raised to 95 percent on the operating range as the operator is told to do?

A. There was the analysis that was done by Los Alamos that assumed that two high-pressure injection pumps were in operation. They assumed 95 percent.

Q. None with one HPI pump?

A. No. I can't think of any.

JUDGE EDLES: Ms. Weiss, I would like about a five-minute break. Is this a good time for you?

MS. WEISS: You can have a break, Mr. Chairman. This is a good time.

JUDGE EDLES: Okay. We will take five minutes.

(Recess.)

JUDGE EDLES: Please be seated.

Would you be kind enough to close the door in the rear, once you have got the whole crew back, and Ms. Weiss, you can begin again, unless that is redundant.

MS. WEISS: Recommence. That is not redundant.

JUDGE EDLES: That is a lawyer's word that I probably would be criticized for using by a good English professor.

MS. WEISS: I always try not to use lawyer's words.

JUDGE EDLES: Just start.

XX BY MS. WEISS:

Q Can you tell me, Jr. Jensen, with reference to the EG&G calculation of the .01 square-foot break -- either Mr. Sheron or Mr. Jensen -- I know from your last series of answers that you have terminated emergency feedwater when the steam generator level was 50 percent in the operating range.

Could you tell me, up until that point, which is 2010 seconds, what was the behavior of steam generator level over time in the EG&G calculation?

A (WITNESS JENSEN) I don't really know. I suspect it was gradually increasing, because a lot of the water coming in would have been boiled away by the chugging phenomenon. So I suspect that when there

was low heat transfer to the steam generators, the level would have been increasing, and when the slugs went across, the level would have started to decrease again, I suspect.

Q You say you suspect. Have you taken a look at the data from the calculation, the EG&G calculation?

A No, I haven't.

Q So you are speculating at this point?

A Well, yes, more or less. This is what I would suspect that it would do. It would have to do this, in fact, because if you were not removing much heat from the steam generator, then the less heat you were removing, the faster it would fill, and if you were removing a large amount of heat, then the feedwater would tend to be boiled away.

Q But you are saying that we wouldn't see a steam generator level drop, and then rise smoothly to 50 percent; we would see some oscillation back and forth?

A Yes, that would be what would happen in this calculation. Of course, it was just one pump, and so it would tend to raise slower than it would be if the full feedwater capacity -- if the full emergency feedwater capacity were available.

Q Do you know how low the steam generator level got, and at what point in the calculation that was?

A I don't know. Again, if there had been no heat transfer, they would have risen fairly rapidly. The fact that there was heat transfer kept the level from rising.

Q What assumptions were made with respect to the rate at which steam was dumped from the steam generators as a function of time?

A It was calculated to be relieved by the steam dump, and it was modulated with pressure.

Q Is this something that the operator is supposed to be doing?

A No. It was done with an automatic system.

Q The ICS?

A I don't think so. I'm not sure what operates the steam dump. But it does -- it is set to open valves when the system reaches a certain pressure. If it did not work, then the atmospheric dump valves would have come on and relieved the steam at a slightly higher pressure.

Q So you were using a turbine bypass?

A Yes, I understand that is what they used.

XX BY MR. POLLARD:

Q Mr. Jensen, I thought in this scenario, it was attempting to duplicate the loss of off-site power. I thought that is what accounted for -- as I recall, during the deposition, the reactor coolant pumps tripping; is that

j-10-4

correct?

A (WITNESS JENSEN) Well, they assumed the trip. They assumed the reactor coolant pump did trip.

Q Are we trying to duplicate something here involving the loss of off-site power, or not?

A These things would occur when there was a loss of off-site power.

Q Would you agree that for a loss of off-site power, you could not use the turbine bypass valve?

A Yes. I think that is correct.

However, it would have made very little difference in the calculation, because had it not opened, the atmospheric dump valves or the safety valves would have come open at very close to the same pressure.

Q Can you tell me what the difference in pressure is?

A I think it's about 10 pounds per square inch.

XX BY MS. WEISS:

Q Did the EG&G calculation, the .01 square-foot break using RELAP5, calculate the primary to secondary heat transfer coefficient and heat transfer area, or was that an input to the calculation?

A The heat transfer area is input to the calculation. The heat transfer coefficient is calculated internally in the code.

Q Does the code differentiate between the situations when the tube is covered by water, steam, or a condensate film, RELAP5?

A Yes, it does.

Q Could you explain how?

A As I said, there were eight different regions within the steam generator, and for each region, the code calculates the condition within the various regions, the thermodynamic conditions, and from those, and also the difference in temperature between the tubes and the fluid within the node, the code determines what would be the correct heat transfer correlation to use, and then calculates the heat transfer coefficient based on that correlation.

Q For the RELAP5 calculation, what assumption is made with regard to how many steam generator tubes are wetted by emergency feedwater?

A The code calculates that internally. I did ask EG&G that question, and they said that all of the steam generators -- they indicated that all of the steam generator tubes were calculated to be wet. I don't think this would have made much difference in the response of the code, since when natural circulation was regained for brief periods, the flow would pass by the whole length of the steam generator tubes, or would pass by the point

where the emergency feedwater is injecting, as well as the 50 percent level.

Q It doesn't make any difference, because your calculation doesn't show boiler-condenser anyway?

A Not a stable boiler-condenser, yes.

Q You say that EG&G calculates how many steam generator tubes are wetted, and in this case, they calculated that 100 percent are wetted; is that correct?

A The code calculated that, as I understand from talking to EG&G.

Q Dr. Sheron, with respect to the question generally of whether the EG&G calculation duplicates the B&W calculations for the .01 square-foot break, and focusing on the fact that the parameters, the plant parameters differed that EG&G used, as opposed to those that B&W used, was it your feeling before EG&G did this calculation that such variations in reactor power level or HPI flow characteristics would not significantly affect the overall conclusion about whether or not boiler-condenser was established for any particular sized break?

A (WITNESS SHERON) That is correct, as long as the key parameters which would affect such a calculation did not vary significantly with respect to what paramaters -- or what values were selected, say, in the B&W calculation. One would not expect any real

differences in the overall phenomenon logical behavior.

Q. But in hindsight it turns out to be the case that boiler-condenser wasn't established, stable boiler-condenser, for the EG&G calculation.

Does that mean that you were wrong in your expectations?

A. No. As a matter of fact, I think it confirms what we have stated for quite some time, and that is that, although we do not really -- or we are not really capable of calculating the phenomena which occurs during this transitioning period, from bubbly two-phase natural circulation to a boiler-condenser, or whether a boiler-condenser even establishes that we have a chug flow here. I think we have sufficient uncertainties in our modeling techniques and the like that we would like to get experimental data to see how to do that. But it did confirm that no matter who is running this calculation, they can't make the core uncover.

Q. Assuming that the operator does what it is assumed that he will do; correct?

A. Correct.

Q. And in fact you have not yet found a break --

A. I would point out, also, the analyses that were just performed by EG&G as well as B&W were for a level on the secondary side being raised to 50 percent, and even they showed that the core remained covered when in fact an

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operator -- and even the original B&W calculations in Exhibit 5, the May 1979 blue book, assumed the emergency feedwater level was only raised to 50 percent, and they did not show any failure of natural circulation for that reason.

Q. Well, do you or don't you get a sufficient condensing surface to remove decay heat assuming you end boiler-condenser and need boiler-condenser at 50 percent on the operating range?

A. That is a difficult question, because the need to raise the level beyond the 50 percent point to the 95 percent point is based on assuring that one will get a sufficient static head of fluid in the primary side such that that static head of fluid is sufficient to drive water over the lower lip of the pump, the pump inlet. In other words, you have to get this monometer effect. You have to get the level on the pump suction piping up over the pump inlet.

Q. It is a pump discharge, isn't it?

A. Inlet.

Q. Inlet?

A. Well, it is the lowest point that one would have to push fluid over such that it could run down into the vessel.

Q. I'm sorry. Did I interrupt you?

A. No. I was just trying to point out that, you know, the analyses only assumed the level was raised to 50 percent, when in fact raising it to 95 percent could do nothing but really enhance natural circulation and help the situation.

Q. Well, I'm trying to question about whether the analyses would show that boiler-condenser is established at 50 percent, at the 50 percent level on the operating range, are correct or not? I mean, are they correct with respect to what we know about the design of the plant?

A. I think there is a question that may have been raised regarding the effectiveness of 50 percent, because one has to go back and look at how dependent were the analyses that relied on 50 percent on the effectiveness of the spray on the tubes. Those analyses quite honestly assumed that the spray was 100 percent effective in contacting tubes. I don't think we have gone back and evaluated in detail what sort of trade-off might be involved between the effectiveness of the spray heat transfer versus whether the level was raised to 50 percent or to 70 percent or 90 percent, or what have you.

Q. Am I correct that you don't yet have an explanatory text from EG&G on the covering of the .01 square foot calculation with RELAP5?

A. That is correct.

Q. And you expect that sometime in May?

A. I'm hoping for April. They just told me that it is going to cost me more than I anticipated.

Q. Dr. Sheron, is it to your belief that the plant will actually exhibit the chugging behavior predicted by RELAP5 under the conditions of a .01 square foot break?

A. I think any behavior which I described to you would be speculation. I think we maintain we would like to learn how this plant would behave in between its transitioning period.

My own personal opinion is that it would not exhibit the degree of repressurization that B&W predicted, although there would probably be some repressurization and there might indeed be some chugging. I imagine the pressure trace would be closer to the RELAP5 calculation than to the licensing-type calculation performed by B&W.

Q. Why would you expect that the plant might not repressurize in the manner predicted by B&W?

A. I guess for a number of reasons. One is that I had seen some initial calculations of the girder facility performance, or the predictions of its performance, even with the single loop; and I don't recall seeing the same extent of repressurization in that facility.

So, again, that is very qualified because I don't like to say that the girder facility looks exactly

like a B&W plant with respect to the performance. One has to use the computer codes. But that is one indication, perhaps, that if there is the similarity in the small break, then that did not exhibit it.

Also, because the RELAP5 code is just more detailed. It accounts for nonequilibrium, whereas the CRAFT code doesn't. So hopefully it is calculating the phenomena perhaps a little more accurately.

Q. Has the chugging behavior predicted by RELAP5 ever been observed in an operating plant?

A. I'm not aware of any.

I don't think, you know, even if one were to look at a small break, that an operating plant is not sufficiently instrumented that one could definitely say what was occurring in terms of chugging phenomena. One would have to infer from the measurements that are available, which are typically just pressures and temperatures, and infer it from a computer code analysis.

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Q A computer code analysis done after the event; is that what you are referring to?

A Yes.

Q Has the chugging phenomenon ever been observed in a test facility geometrically similar to the TMI-1?

A Obviously not, because we said there are no test facilities geometrically similar.

Q Can you just briefly describe for me the difference in nodilization between RELAP5 and the B&W calculations of 1979, using the CRAFT computer code?

A (WITNESS JENSEN) The number of nodes was somewhat greater in the RELAP5 calculation. Certainly, in the area of the steam generators, in the B&W model, there were three nodes, I believe, in each steam generator, whereas, in the RELAP5 calculations, there were 16.

Q That is primary and secondary side combined?

A Yes.

Q And is it true that RELAP5 uses what you believe to be a more realistic steam generator heat transfer model for the code itself, the computer code itself?

A It is certainly more detailed. I don't know right now whether it is more realistic or not.

Q On page 12 of your testimony --

A Excuse me. I'm thinking of the new B&W model,

yes.

Excuse me. The RELAP5 would be more realistic than the old B&W model.

Q Can you describe for us what the differences are between the new B&W model described in Licensee Exhibit 86 and the two previous B&W models?

A (WITNESS SHERON) I could repeat the differences which Mr. Jones identified yesterday.

Q Well, if that is the --

A You know, the model, as Mr. Jones said yesterday, was submitted to the Staff in November of 1982. It has been assigned within the Reactor Systems Branch to a lead reviewer. His work will be augmented by the Los Alamos National Laboratory, and initiated work on review.

I have not been personally briefed by this individual yet on how this review is progressing, and summarized what differences have been identified in these documents.

Q Then, I guess it is fair to say that as of today, Dr. Sheron, the Staff has no opinion on whether the new B&W model is accurate or acceptable under 50.46?

A That is correct.

Q I want to try to sum up the testimony over the last couple of days and see if we can list how many

different predictions of system behavior there are for the .01 square foot break for TMI-1.

First, there is an original pre-accident calculation by B&W? They never did a .01 square-foot one before the accident?

A We don't know of any. There may have been some work done back prior to the earlier stages of the model approval. But neither Mr. Jensen or I were involved at that time, so I can't answer that.

Q There is a May 1979 calculation with the revised model?

A That is correct.

Q And then there is a most recent B&W calculation with the new model?

A Yes.

Q And there is some audit calculations done by EG&G with a code called RELAP4?

A That's correct.

Q And there are some new EG&G calculations just for a .01 square-foot break with RELAP5?

A Yes.

Q Do any of these calculations use identical input parameters?

A I haven't personally cross-checked the inputs for every code, but my reaction would be probably, no.

Q Do you know whether that is for sure, no, Mr. Jensen?

A (WITNESS JENSEN) I doubt it very seriously.

A (WITNESS SHERON) You have to remember that at least in a couple of those calculations, there was no intent to make them consistent.

Q Right. Certainly if they intended to, they would meet their intention.

And is it true that each one of these calculations predicts somewhat different plant behavior, putting aside for the moment that each one of them in your view shows that the core is adequately cooled; they show that the plant goes through some very different things to achieve that, in the process of achieving that?

A Yes. I think the RELAP5 calculation and the original RELAP4 calculation are, as far as my memory serves me well, fairly similar. So my own personal opinion would be to lump those two together as being at least consistent.

Q Did you say RELAP4 and RELAP5, you would call consistent?

A Yes, from the standpoint that neither exhibited any significant repressurization, but kind of repressurized to above the steam generator safety valve set point, and, pardon the expression, but the pressure sort of

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pumped around there.

Q But RELAP4 didn't show chugging?

A Again, I didn't look at that calculation in detail, so what caused that pressure to behave like that, I don't know.

Q In RELAP5?

A RELAP4.

Q RELAP4.

On page 17 of your testimony, you describe a calculation of a hypothetical transient where you force the plant into the boiler-condenser mode.

The scenario that you imposed on the calculation is clearly one that would not occur if the operators follow their procedures; is that correct?

A (WITNESS JENSEN) I don't think it would, no.

Q It is beyond the design basis, certainly, for this plant?

A Yes.

Q Would you say that that is unrealistic?

A As far as what would really happen in the plant, I don't think this would happen in the plant.

Q Now, on page 20, you are talking about your scoping calculations with respect to heat transfer, and you say the heat transfer coefficients were determined to be high.

How did you make that determination?

A I calculated the heat transfer coefficients.

Q You looked at the kind of metals that there were; is that correct?

A Yes.

Q How did you account for the condensation occurring at the higher elevation in the tubes? Did you assume that the condensed water runs down the inside of the tube, or did you neglect its presence?

A I assumed that the condensed water ran down the tubes, which was most of the resistance of the heat transfer, in fact.

Q When you say the overall heat transfer coefficient, was that an average heat transfer coefficient?

A This would be the average for a tube between the -- for a tube length of about 30 feet.

Q On the secondary side, did you have different heat transfer coefficients for the different parts of the tubes?

A I only looked at the capability for boiler-condenser, so I assume that we were talking about a particular region per unit square footage for which boiler-condenser was occurring.

Q So, you assumed boiling on the secondary side when you performed the heat transfer calculation?

A Yes.

Q What level of water did you assume in the secondary side?

A I assumed that the operator would rise the level to 95 percent.

Q Why did you make that assumption when the EG&G calculation is based on 50 percent?

A The purpose was to show that if the operator raised the level to 95 percent, that an adequate condensing surface would exist even though the reactor system level decreased to a level to the top of the code legs.

Q You assumed different basic conditions for your heat transfer coefficient calculations and your heat transfer analysis; is that correct, for the steam generator level?

A Yes, I did.

Q. Now, assuming the steam generator level is at 95 percent, does that entirely cover the tubes?

A. No, it does not.

Q. Did you assume different heat transfer coefficients, then, for the different parts of the tubes on the secondary side?

A. I assumed in this calculation that there was no heat transfer at any other place than between the 95 percent level and the top of the cold legs.

BY MR. POLLARD:

Q. Mr. Jensen, I'm going to focus on your testimony on page 20 in combination with the answers to the questions that you just gave Ms. Weiss.

Am I correct that when Ms. Weiss asked you for a temperature difference between the primary and secondary system of approximately 20 degrees Fahrenheit, an overall heat transfer coefficient of 584 btu's per hour square foot degree Fahrenheit was determined?

In answer to that question, I thought you said that you, in calculating that 584 btu heat transfer, you assumed a 30-foot length of tube; is that correct?

A. Yes, I did, and I did that in the heat transfer equation for condensation to make the equation conservative. The longer length that is assumed, the thicker would be the film thickness. To have a shorter length would create

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a larger heat transfer coefficient.

Q. And then later in response to another question, did I understand that you, in this calculation, that you took credit only for that tube area between 95 percent on the operating range and the inlet to the pump?

A. The highest point in the cold leg, yes.

Q. The heat transfer surface area is 226 and 20 hundred square feet. Is that both steam generators total?

A. That is both steam generators, and that is the total area of the inside surface of the steam generator tubes.

MR. POLLARD: I meant to say 236,020 square feet.

BY MR. POLLARD:

Q. Originally in your testimony you had a sentence that said the resultant heat transfer rate would be 355 megawatts thermal or 14 percent of full reactor power. As I understand it, that sentence has now been deleted from your testimony.

Can I ask you, please, why did you delete that sentence?

A. In rereading the testimony, I determined that that sentence really wasn't meaningful and it might cause confusion.

Q. On page 21 of your testimony, the first full sentence on that page says, "Auxiliary feedwater enters

the steam generators near the top of the tube bundle and in running down the steam generator tubes would create an additional area for steam condensation above the cold legs."

Will you please quantify for me that additional area in terms of what percent of the total tube area, or some other method of quantifying it?

A. The tube area is a function of flow. As I understand, it is about 10 percent of the tube area.

Q. Is it 10 percent of the tube area or 10 percent of the tubes?

A. It would be 10 percent of the cross-sectional area, about, at a level of about 95 percent of the operating range, and it would be somewhat less above that level, which would be the same as 10 percent of the tubes.

Q. Perhaps I recall Mr. Jones' testimony differently from yesterday. As I recall, he said that at tube support plate 12 the feedwater would get about 10 percent of the tubes, and then above that tube support plate it would be a significantly smaller percentage. And what I'm trying to get from you is, in your testimony, when you say the auxiliary feedwater entering the steam generators near the top of the tube bundle creates an additional area for steam condensation above the cold legs, I want to see if you can put for me some quantitative value to your word "additional."

A. It would be a function of the flow rate going to

the steam generator, and it would be maybe about -- well, let's see.

MR. CUTCHIN: Mr. Chairman, if the witness knows the answer, I wouldn't mind him answering, but if he's going to have to make a calculation, I just as soon he make it and we get a correct number on the record, rather than speculation. I don't think speculation is going to help.

WITNESS SHERON: I might be able to answer the question.

If you look at the B&W report, evaluation of Small-Break LOCA operating procedures and effectiveness of feedwater spray for B&W designed for operating NSSS --

JUDGE BUCK: This is Exhibit 87 you are talking about?

WITNESS SHERON: I forget the number.

MR. CUTCHIN: Yes, it is.

WITNESS SHERON: You will note on page 2-11 equation 2 is -- this is a correlation which relates, as you can see, the total wetted surface in square feet down to a distance Z below the emergency feedwater injection plane to the wetted surface at the injection plane, and this number obviously varies between 1 percent at the elevation Z equals zero, or at the emergency feedwater injection plane, and as it says down in the -- looks like the second paragraph, the percentage of wetted tubes increases linearly until at

16.5 feet below the injection point equation 2 indicates 10 percent of the tubes were wetted. The wetted area is assumed to remain constant at 10 percent until the feedwater enters the pool. At 16.5 feet below the injection point, and I think if you turn to figure 2-3 of the same report, you can see the injection point is at elevation 49 foot, one and three-eighths inches.

The top of the operating range is at somewhere right below the 34-foot elevation. So, 34 feet from 49 feet is going to give you roughly 15 feet, or at the top of the 95 percent level you are going to be right at the point where the wetting becomes 10 percent.

BY MS. WEISS:

Q. Dr. Sheron, I'm sorry. I don't mean to interrupt you.

A. (WITNESS SHERON) Yes.

Q. It was my understanding that the document that you are reading from, GPU-87, is a description of their new calculation of emergency feedwater spray for the new CRAFT code; correct?

A. That's correct.

Q. And isn't it correct that you did not receive a copy of that document until after your testimony was submitted?

A. Yes.

Q. And at this point w'm trying to explore the basis for the statements made in your testimony.

A. Okay. You are not referring, then, to the new data.

Q. Well, I take it from your answers that the new B&W emergency feedwater spray calculations didn't enter into your testimony; you didn't have them at the time. That is not what you are describing here on pages 20 and 21?

A. Correct. But I guess our interpretation of Mr. Pollard's question wasn't clear whether it was pre-receiving this data or whether we were to factor in this data.

Q. Okay. I understand.

Well, the calculations that you are referring to on page 20 and 21 of your testimony, you say B&W calculates that boiler-condenser and actual circulation would not be established until at least 1500 seconds. That is about eight lines up from the bottom of that page. The calculation you are referring to there is with the approved or the revised model, not with the new model; correct?

A. (WITNESS JENSEN) That's true, but I think the new model showed that boiler-condenser was established at 1500 seconds, also.

Q Fine. And you said in your original testimony that 18 percent of the steam generator tube surface area would be required to remove 2.5 percent of full power. You changed that to read 7 percent of the stem generator tube surface area would be required to remove 2.2 percent of full power.

Will you explain to me why you made that change?

A Yes. There are several reasons. The reason for changing the 2.5 to 2.2 was, I went back and looked at the curve of decay heat power as a function of time, and read the curve more carefully, and determined it was 2.2 percent at 1500 seconds, rather than 2.5 percent.

Also, in rereading the testimony, I realized that it was more meaningful to discuss the condensing heat transfer of availability between the top of the 95 percent level and the cold legs, rather than the top of the core, as I had previously.

Q So you changed the definition of steam generator tube surface --

MR. CUTCHIN: I would like the witness to be able to finish his answer, Mr. Chairman, before he's interrupted with the next question.

JUDGE EDLES: Has the witness finished his answer?

WITNESS JENSEN: No, sir.

JUDGE EDLES: Go ahead, Mr. Jensen.

WITNESS JENSEN: And then to illustrate that there was still a lot of available heat removal, because as the surface area is increased, the system pressure would only have to increase slightly more, to be able to remove this amount of heat.

So, I changed the 10 percent temperature difference between the primary and secondary to a 20 percent difference between the primary system temperature and the secondary system temperature.

BY MS. WEISS:

Q Do you mean 10 degree, or 10 percent?

A (WITNESS JENSEN) 10 degree, excuse me. 10 degree, and then a 20-degree difference.

All right. Now, using a 20-degree difference, then only 7 percent of the steam generator heat transfer area would be required to remove 2.2 percent of full power, rather than an 18 percent steam generator tube surface area with the 20 percent -- 18 percent of the steam generator tube surface area would be required to remove 2.5 percent of full power if a 10-degree temperature difference was assumed between the primary system and the secondary system temperature.

Q You originally stated, Mr. Jensen, that

18 percent of the steam generator tube surface area would be required, and 27 percent would be available.

You changed it to say that 15 percent would be available, but now only 7 percent is required; correct?

A Yes.

Q And you had to change your assumption of temperature difference from 10 degrees to 20 degrees in order to get from 18 percent to 7 percent that is required?

A Yes.

Q If you continued to use your original assumption of the 10-degree temperature difference, then you would have to change your bottom-line conclusion? That is, there would not be a sufficient condensing surface; is that correct?

A Well, it was kind of close. The effect would be, would be the primary system temperature would begin to increase to the point where the heat would be removed by the secondary system, and by the available condensing surface.

Q 15 percent is less than 18 percent; correct?

A Yes.

Q And you haven't dore any additional calculations between the time this testimony was filed and the time you changed the numbers; is that correct?

A I make a lot of calculations. I believe these

numbers are correct.

Q The new numbers. The old numbers are wrong, but the new numbers are right?

A The present testimony is correct.

Q And that means as it was originally filed, it was wrong?

A No, it wasn't wrong.

Q They can't both be right. They used different assumptions.

A Yes.

Q Mr. Jensen, I'm showing you and the parties, and giving the reporter three copies of a letter from Mr. Eisenhut to Mr. J. J. Mattimoe, B&W Owner's Group, and it is identified by a docket stamp from the Public Document Room at NRC, April 1, 1982.

Would you take a look at that, please.

Are you familiar with that, either Dr. Sheron or Mr. Jensen?

A (WITNESS SHERON) Yes, I am. I prepared it.

Q You prepared it?

A Yes.

Q Well, maybe we can short-circuit this, then.

The letter appends a five-page attachment entitled "Staff Concerns with the B&W Small Break MODEL."

A Yes.

Q Did you also prepare that?

A Yes, I did.

Q Is that an accurate statement of the bases for the Staff's determination that there is a need for verification of the B&W small break LOCA model against integral systems data?

MS. WEISS: While he's looking over that, could I have that marked for identification, please, UCS 51.

(The document referred to was marked UCS 51 for identification.)

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WITNESS SHERON: The concerns identified in the five-page enclosure were at that time not specifically -- we were not specifically saying that we must have experimental, or integral system experimental verification. As you note in the cover letter, third paragraph, it says, "While the Staff continues to endorse the need for model verification against integral system data, we have agreed to work with the B&W Owners' Group over a six-month period, ending in June 1982, in order for the owners to prepare and present a program to the Staff that will provide acceptable small break model verification, including all thermal-hydraulic phenomena of interest, without the need for a new test facility. In order to help facilitate your planning" -- the enclosure was provided.

At that time, our negotiations with the owners were such that we were in what we call the negotiating stage. We believed that integral systems test data was needed. The owners' position at that time was they did not believe that one needed integral system test data to resolve the Staff concerns.

NRC management was not at that time in a position to require integral system test data from the owners, and, in fact, at the December 17th meeting -- I'm sorry -- it wasn't December 17th, I believe it was an October 23rd meeting, '982 -- at which time it was agreed by the senior NRC management and B&W Owners' Group management that the Staff would work with the owner's technical Staff for a period of six months, to examine the Staff concerns and to determine what was the best way that they could be addressed or resolved.

This did not necessarily a priori mean there must be an integral system test facility, either a new facility or modification of an existing facility.

It was merely what are the concerns, what is needed to address them.

BY MS. WEISS:

Q In fact, at the end of the six-month period, the B&W Owners' Group had not succeeded in convincing you that there was a need for integrated system

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data; correct?

A (WITNESS SHERON) Yes. The study extended to about nine months, but the result is, that is correct.

Q What I'm trying to focus on is the concerns that you state in that attachment are still Staff concerns with respect to the B&W models' ability to predict small break LOCA behavior?

A I think we have to some extent convinced ourselves that they are not the same concerns that they were at the time this was written.

Q Okay. I would like you to tell me in that case which of these are no longer Staff concerns, or which are not concerns in the manner in which they were stated in this letter.

A Okay. I think 1. is still valid.

Q One is Interruption of Natural Circulation.

A Yes.

Two I guess that is still valid. We haven't received any information to eliminate it yet as a concern.

Three is still a concern.

Q. That is hydraulic stability following accident recovery.

A. Yes. That would expect operator guidance.

And then, I believe on the fourth page, it says there are other concerns which have kind of fallen out from these overall phenomenonlogical uncertainties. The cooldown and depressurization following small break, that remains the same. I think the break isolation has been -- I think we have fairly well got that one squared away with respect to the condensing surface. Raising the level to 95 percent should not produce any more -- you know, the concern has been answered.

The tube rupture is -- I guess the general concern that was expressed is we would like to see data, integral system data in the area of managing steam generator tube ruptures.

So I would say, yes, I think they are still all valid, except for the break isolation.

Q. Given that -- given your statement that this represents a reasonably accurate characterization of the Staff's present concern in the B&W small-break model, I would like to move the admission of UCS-51 into evidence.

JUDGE EDLES: Any objection?

MR. CUTCHIN: It would depend on the purpose, Mr. Chai man. Because I think if we recognize that the

purpose is as explained on page 9 of the testimony, and I would like to confirm that that is still the witness' testimony, otherwise I think we are going to have confusion, I have no objection to its being introduced. If it is for some other purpose, I would like to hear what that purpose is.

JUDGE EDLES: Read the sentence for me, Mr. Cutchin, that you are referring to on page 9.

MR. CUTCHIN: On page 9 of the testimony, at the bottom of the paragraph that is continued starting on page 9, it says: "The purpose of the testing is not to confirm the effectiveness of boiler-condenser decay heat removal. Rather, its purpose is to satisfy the confirmatory research needs for the B&W design and to provide additional confirmation of operating guidelines."

With that understanding, I have no objection to its being put in.

MS. WEISS: All I hear that he did was made an argument, Mr. Chairman, and didn't make an objection to the admission of the evidence, but an argument to its weight.

MR. CUTCHIN: I think we have to know the purpose, because otherwise we are going to run into the same problem we have run into in this hearing many times; and that is evidence put in for one intended purpose has been attempted to be used for other purposes. And I think that adds to

confusion and doesn't help the record.

JUDGE EDLES: Mr. Baxter, any comments?

MR. BAXTER: I don't object to the testimony being admitted. I do think we have to be careful about the data, but we have already talked about the fact that as to the statement on the Staff's understanding that operators will be trained to use a high-point venture mode steam bubbles, that that was a position that was subsequently amended by the operators when they revised ATOG guidelines in the summer of 1982. And I would like to make clear we are not agreeing to an investigation of steam generator tube ruptures, even though that is mentioned in the last paragraph.

But with those clarifications, I don't have any objection.

JUDGE EDLES: Mr. Adler?

MR. ADLER: No, we have no objections.

JUDGE EDLES: The document is moved into evidence.

(The document previously marked UCS Exhibit 51 for identification was received in evidence.)

XXX

MS. WEISS: Thank you, Mr. Chairman.

JUDGE EDLES: Ms. Weiss, let me ask you a question on timing. Give me an idea about how much longer you are likely to be running this morning.

MS. WEISS: Half an hour, approximately.

JUDGE EDLES: That is fine.

BY MS. WEISS:

Q. If I could turn your attention to --

JUDGE EDLES: Excuse me, just to clarify. Since my colleagues didn't understand the ruling, I would like to finish your cross-examination before the lunch break, and unless there is objection to that, take a lunch break at that point, and then come back with any further cross-examination, Board questions and redirect.

BY MS. WEISS:

Q. To the submission that was sent to the parties in response to BN-83-21 which has been labeled BN-83-21A the third page in that package is a letter from Roger Mattson and Hugh Thompson to Darryl Eisenhut, Subject: Follow-up Evaluation to Board Notification BN-83-21 for TMI-1, the letter states that: "We have completed our evaluation, and have concluded that the information does not adversely affect our present conclusions regarding the ability of TMI-1 to achieve and maintain decay heat removal by natural circulation through the steam generators under transient and accident conditions." And the last sentence is: "Our generic evaluation for the remaining B&W design plants will be issued in the near future."

Why is there a need for a generic evaluation

focusing on the lower loop B&W plants if the Staff has already completed its evaluation as is stated here for TMI-1?

A. (WITNESS SHERON) The generic plants have different power levels, different HPI, flow rates, and I guess the clearest example is in -- what is this, 87? The B&W report that was submitted. You will note that figure 3-2 is for 177 fuel assembly lower loop plant.

Figure 3-3 is specifically for TMI-1. Figure 3-4 is specifically for Davis Besse, which is a raised loop. So the analysis which the Staff performed, or the evaluation we performed on the B&W analysis, is based on the way B&W basically categorized their evaluation, and they evaluated TMI-1, Davis Besse, and basically all other B&W plants. We just limited our evaluation to the TMI-1 information in this report in order to meet the Friday deadline, and we were not able to say that the conclusions we reached and the Board Notification were generally applicable until we complete the generic evaluation.

Q. If I could direct you to Dr. Lahey's concern, and I think -- why don't we go to the enclosure, which begins on the fourth page of this package.

Am I correct that the section background, and the section, the issues, going through from page 1 to the middle of page 3, are verbatim from BN-83-21?

A. They are essentially verbatim. I think I recall changing one or two words when I went through it. But there was nothing of substance.

Q. Now, would you go to page 2, please, that middle paragraph, beginning "The first concern was raised by Dr. Lahey." It deals with procedures and relates to whether or not the operators have sufficient instructions and training to assure that they will raise the secondary level of the steam generator to 95 percent of the operating level under all conditions necessary to assure natural circulation.

I take it that you have responded to that concern? You have gone back and looked at least at some of the procedures and determined that they do in fact instruct the operator to raise steam generator level to 95 percent?

A. I haven't personally. Other members of the Staff have.

Q. And you are satisfied that they have adequately responded to that concern?

A. I don't think that is mine to judge.

Q. You have exercised no personal responsibility over the evaluation described in here?

A. Well, that is why you see a jointly signed memo from both Dr. Mattson and Mr. Thompson. Mr. Thompson is responsible for procedures, and his signature is

basically his assurance that his staff has performed this review. I have no authority or responsibility for his areas.

MR. CUTCHIN: Mr. Chairman, for clarity of the record, if one looked at page 9 of the same document, the emergency procedure and operator training adequacy portion of this report, as I understand it, and it can be confirmed with the witness, was prepared by Mr. Thompson's people in response to the Board's request that we address that aspect of procedures review in this follow-up notification.

BY MS. WEISS:

Q You can't vouch here today for the accuracy of any of that section of BN-83-21 that responds to Dr. Lahey's concern; is that correct?

MR. CUTCHIN: Obviously, Mr. Chairman, we are here --

MS. WEISS: If you don't have an objection, I would like to have a yes or no.

MR. CUTCHIN: I do have an objection.

JUDGE EDLES: Why don't you frame your objection as you would like to, Mr. Cutchin. Go ahead.

MR. CUTCHIN: We are now getting into a situation where we are pressuring the witness to vouch for something that he has already said that he had no responsibility for. Now, this follow-up Board Notification was prepared at this time at this Board's directive. I presumed to give them

the same kind of confidence they would have had for any follow-up Board Notification so that they could decide whether they believed that the matters addressed in the Board Notification warranted some action on their part.

This proceeding has not been reopened to go into the details of a lot of procedures. Now, if the Board feels that it needs a witness here to address those details, of course the Staff will do everything it can to bring the proper witness; but we did not bring that witness here, because that is not what the proceeding was about.

MS. WEISS: I have not yet asked anything about procedures. I only asked the witness if he can vouch for the accuracy of what has been presented by his counsel, and I'm entitled to a yes-or-no answer to that.

JUDGE EDLES: Ms. Weiss, let me see if I understand Mr. Cutchin's point.

Your point is that the witness is here prepared to address portions of the document but not other portions.

MR. CUTCHIN: That is correct.

JUDGE EDLES: If you want to proceed, Ms. Weiss, to ask which portions the witness is here to discuss --

MS. WEISS: That was exactly what the question was, Chairman Edles.

JUDGE EDLES: Go ahead.

BY MS. WEISS:

Q. You are not prepared today to vouch for the accuracy of any of the portions of this BN-83-21A which respond to Dr. Lahey's concerns; is that correct?

A. (WITNESS SHERON) I am not prepared to vouch for any portion of this which deals with the adequacy of training or procedures.

Q. And if you go to page 9, am I correct that the discussion beginning on page 9 under number 2, emergency procedure and operator training adequacy, and continues on to page 10, represents that portion of BN-83-21A which is purportedly responsive to Dr. Lahey's concerns?

A. With respect to the adequacy of operator training and emergency procedures, yes; that is purported to be responsive.

MS. WEISS: Mr. Chairman, I move to strike -- well, it's been over in the evidence.

BY MS. WEISS:

Q Without regard to whether it is accurate or inaccurate, have you read that portion of BN-83-21 in response to Dr. Lahey's concerns?

MR. BAXTER: Mr. Chairman, I object. I don't know why we are wasting time. The Board has ruled this morning already that it is not investigating the adequacy of operating procedures and training for decay heat removal.

JUDGE EDLES: Ms. Weiss, I don't have any problem with the witness answering that particular question, but where is this likely to lead?

MS. WEISS: You directed the Staff to respond to Dr. Lahey's concerns, and this is the document -- and Dr. Wallace's concerns. This is the document that purports to respond to it.

Now, if we are not allowed to question about it, then your direction that they respond to it was a nullity.

MR. CUTCHIN: I would disagree, Mr. Chairman.

I think it comes about due to the Board notification process. The Staff is charged with notifying Boards of anything that may be relevant to an issue that is

before a board. Then once the Board has these notifications, the Board decides whether they believe that they are satisfied or that what they see in this notification warrants their doing something further.

This is true with every Board notification.

Now, as I said a few moments ago, I did not understand the Board to say, address the follow-up Board notification and bring witnesses prepared to reopen the hearing on other aspects than are presently opened on.

That is up to the Board. If the Board decides that it needs more than it normally receives in the follow-up Board notification, that is for the Board to decide, not for an Intervenor.

JUDGE EDLES: Ms. Weiss, do you have any difficulty now with Mr. Cutchin's assessment?

MS. WEISS: I sure do, Mr. Chairman.

I think that they, first of all, have totally mischaracterized Dr. Lahey's concern. It is not a question of the adequacy of procedures, secondarily, a question of the content of training. The question is whether the operator is presented with a fundamental inconsistency which could have very important safety implications.

That is, on the one hand, for a small break

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LOCA, he is instructed to raise steam generator level to 95 percent, and as Dr. Lahey says, if he does not, he probably won't have a sufficient condensing surface to remove the decay heat.

On the other hand, there are specific plant circumstances in which it is not desirable to raise the level to 95 percent. You will see that that is exactly what is stated by Dr. Lahey on page 2 of this document.

Thus, specific plant circumstances dictate the appropriate steam generator level, and the manner to achieve this level. This presents the operator with a situation in which, if he diagnoses the event as one of those for which it is undesirable to raise pressure -- steam generator level to 95 percent -- he will not get a condensing surface. And if he misdiagnoses it as a small-break LOCA, he will get a condensing surface, but he will have a dangerous situation in the plant.

We seem to have a fundamental inconsistency which Dr. Lahey raises. All they do is go and see if the small-break LOCA procedures tells the man to raise the steam generator level to 95 percent. They make no attempt whatsoever to determine whether there is a basis in the instrumentation of the plant and the plant behavior

upon which we can reliably determine that the operator will distinguish between those events in which it is necessary to have steam generator level up and those events where it is dangerous to have steam generator level up.

JUDGE EDLES: Hold for one moment.

Maybe I need some additional help in terms of the procedures available to parties to cases in light of Board notification. Forget for the moment that there is a reopened hearing.

What procedures are available to parties to alert the Board to matters which they wish the Board to consider, by way of reopening or whatever?

I don't mean to undertake in the context of the existing case. But when a Board notification comes in and there are new matters which might call into question an ultimate safety determination.

Mr. Cutchin, do you want to address that for a moment?

MR. CUTCHIN: I am aware of no mechanism as long as the matter is still before some Board, other than for a party who is not satisfied that the Board doesn't reopen on that matter, to move for reopening and make the proper showings.

Now, maybe we have gotten a little off track

right here at the moment. If indeed the Board is concerned about what technical problems raising the level to 95 percent might create with respect to other transients than the Small-Break LOCA, then perhaps these witnesses can address those. But if one is talking about the adequacy of all of the procedures and how they fit together and so forth, that is my point. These are not the witnesses to address that.

But that went a little further than what you asked for. But I think the only mechanism that I'm aware of is that for the party who is not satisfied with what the Board is doing, to make a showing to convince the Board to do something different.

JUDGE EDLES: Mr. Baxter?

MR. BAXTER: I would agree, assuming, which is not always the case, that the subject of the Board notification is deemed to be relevant to the scope of the proceeding. The Staff dossier on the broad side, in terms of what they choose to send adjudicatory Boards, and if the Board decides the new information was simply not relevant to the scope of the proceeding, then I think a petition to the Director of Nuclear Regulation under Section 2.206 to institute a proceeding would be the other remedy available.

MR. CUTCHIN: The Staff would agree with that.

JUDGE EDLES: Ms. Weiss, do you want to address that?

MS. WEISS: I don't have any quarrel with what is being described. The fact is, there aren't any procedures in the rules on what you do with Board notification, and clearly, the Board has the authority to open any case -- any issue before it sui spondes, given it is an important safety issue, and I think the parties always have the opportunity which we have used in this case to inform the Board of our view with regard to the significance of the information that has been provided in an attempt to convince the Board that it ought to reopen sui spondes, and then, of course, there is always an opportunity to make a motion to reopen.

JUDGE EDLES: But aren't we in that area now, where to the extent that there are matters raised in the Board notification and the Staff's response to it, that that really is not the kind of thing that we ought to be taking up this morning, but is something which, if you feel strongly about, that you are welcome to alert either this Board to reopen, I suppose, or file directly with the Commission?

MS. WEISS: Well, if that is how the Board chooses to handle it, yes, we would make a determination whether it is necessary --

JUDGE EDLES: I'm asking your help on the facts here, now.

MS. WEISS: Our view of the facts is -- and I think that we have taken this position from the very beginning and in maybe three or four post-appeal pleadings before this Board --

JUDGE EDLES: And were successful at least in one of them.

MS. WEISS: Right.

-- that one can't look in the abstract at the safety analysis; that one must always keep one's eye on the relationship between plant behavior and operator behavior, in addition to the calculations that we get from the computer analyses. So when the Board reopens the hearing and says talk to us about the adequacy of boiler-condenser, the adequacy of feed and bleed, or the adequacy of emergency feedwater, UCS always interprets that to mean is it adequate given what one can expect to be happening in the plant and how one can expect the operator to be behaving. We think that is one of the primary lessons of the TMI-2 accident and one of the reasons why we are sitting here at all.

The Staff and GPU, on the other hand, always take the narrowest possible position with respect to the limitations of the scope of the proceeding. We don't

believe that you can answer the questions that are already before you on this remand adequately without looking at these questions.

I think that is the fundamental difference of opinion between the parties.

JUDGE BUCK: Well, may I get into this a little bit?

I think we are on two different problems here. Because what this hearing is really about, as I understand it, is whether the plant is adequately built, designed, and that sort of thing, to operate. I think you always have to put a proviso in, no matter how well you design a plant, how well it is built or anything else. The final question comes down to whether the operators have, one, the proper guidance; two, the proper training; and finally, that they do what they have been told to do. But that is an entirely different subject. And if one starts to go into a hearing, a narrow hearing like this, for example, talking about a particular situation in the plant, which is a Small-Break LOCA, and then starts to look at procedures for this particular thing, what you end up with is going into full procedures for the plant, the full training program, the full requirements, and all that sort of thing.

I don't know how you separate those two. What you are getting into, or trying to get us into, is a full

review of one, the NRC requirements on operation; two, the Applicant's training program; and finally, their management program, to make sure that their training program and their operators do the proper thing. And I think that is far beyond the scope of the hearing that was given to us basically by the Commission.

MS. WEISS: Dr. Buck, we haven't asked any questions -- we certainly haven't asked questions about the detail of procedures or training, or management, that would justify, I think, your description of what you think is going to happn. All we have been looking at is whether it is reasonable to assume that the plant will be behaving in the manner in which the computer calculations assume it was behaving, and I submit that if we could divide -- if we could divide safety in the way in which you suggest, that is, if we could find that there is reasonable assurance that this core will be cooled under all reasonably expectable circumstances, based only on the level of analysis we have had today, then the TMI-2 accident would never have happened.

JUDGE BUCK: Mr. Baxter, you would like to get a word in here before I make another speech.

MR. BAXTER: Thank you. Yes.

Ms. Weiss is approaching it as if we are beginning a new hearing and developing a new record on

decay heat removal capability and the lessons learned from TMI-2.

We are certainly not doing that. The Appeal Board, when it makes its final decision in this matter, has before it that entire record, and it covers all of the things that Ms. Weiss is urging now is so important, and they had the opportunity to confront that evidence below.

In this case, any fair reading of ALAB-708 is that the Board is concerned, as Dr. Buck just articulated, about the capability of the machine. These analyses are designed to test that capability. My goodness, if we were trying to realistically predict what was happening in the plant, we would use two HPI pumps; we wouldn't be here talking about steam generator removal. We wouldn't be using .01 value. We would be using one.

MS. WEISS: And you would never have had the --

MR. BAXTER: Excuse me.

The Board has been asked several times by ECS, since then, in its January 26th Order, and again most recently when it granted the subpoena, it has made clear we are not going to all issues associated with decay heat capability. I think it is clearly a situation where we just happen to be in session when a Board Notification comes up, and I think the Chairman is exactly right.

If UCS feels that the proceeding now needs to be

reopened in some further way, they ought to go through the same kind of procedure they would go through if we weren't here.

MS. WEISS: Mr. Baxter keeps saying this was dealt with below, Mr. Chairman. But this is new information. BN-83-21 with respect to this fundamental inconsistency between the need to achieve the 95 percent level for sufficient condensing surface and the fact that there are plant conditions in which that is dangerous is fundamentally new information. That is why we are here today instead of last week, because the Board has said this is a significant new safety concern.

MR. BAXTER: It certainly isn't. We knew about the potential that overcooling might be undesirable, not dangerous -- it doesn't say dangerous -- before the TMI-2 accident.

What was learned after the TMI-2 accident was that for Small-Break LOCAs it ought to be raised to 95 percent. I don't know when Dr. Lahey has discovered this. But essentially that is what the report, both from the B&W Regulatory Response Group, and the Staff says, is that we have looked at the procedures, and they are perfectly adequate, and the fact that we don't want overcooling in some non-LOCA situations may be new to Ms. Weiss, but it is not new information.

JUDGE EDLES: I think I agree with what was Mr. Cutchin's earlier analysis; that the Board Notification procedure, because it occurs at a time that we happen to be in a reopened hearing, has caused a bit of a problem. But I think I will rule it out of order at this time insofar as you want to discuss procedures, and perhaps even training matters. Obviously I cannot foreclose you from pursuing these matters in other forums or through other channels; nor would I choose to.

MS. WEISS: Do I take it that the ruling, while prohibiting us from questioning about procedures and training, doesn't prohibit us from questioning about other aspects of the Board Notification and the response thereto?

JUDGE EDLES: Those that are related to questions 4 through 7 of the Order reopening the proceeding.

Let me just ask the reporter if from his perspective if this is a good time to take a break.

(Discussion off the record.)

JUDGE EDLES: Why don't we take an hour and a half for lunch and return at 2:30.

(Whereupon, a luncheon recess was taken at 1:00 p.m., to reconvene at 2:30 p.m., this same day.)

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AFTERNOON SESSION

(2:30 p.m.)

JUDGE EDLES: Please be seated.

As known in the baseball business, a late-arriving crowd.

Will you continue with UCS' cross-examination.

MS. WEISS: I'll throw out the first ball.

Whereupon,

BRIAN W. SHERON

AND

WALTON L. JENSEN, JR.,

resumed the stand and were examined and testified further as follows:

CROSS-EXAMINATION (Resumed)

ON BEHALF OF THE INTERVENOR

BY MS. WEISS:

Q. The second part of BN-83-21A responds to those concerns raised in BN-83-21 with respect to the effectiveness of emergency feedwater spray; is that correct?

It begins on page 3.

A. (WITNESS SHERON) Yes, item 1.

Q. Dr. Sheron, were you the principal preparer of this bulletin, BN-83-21A?

A. Yes, I was.

Q. And when you say at the bottom of page 3

the Staff has reviewed this report and our evaluation follows, you are referring to yourself personally?

A. Not really. Mr. Jensen, I believe, has reviewed it, as well as one other member of my staff has seen it, I believe, and between the three of us, have put this together. I was the principal drafter of the document, although they both reviewed it and commented on it regarding its technical accuracy and to whether stuff should be added, deleted and the like.

Q. As of Monday, am I correct that you had not read the report that is referenced there, GPU Exhibit 87, I believe?

MR. BAXTER: Which Monday?

MS. WEISS: March 3rd. March the 7th.

WITNESS SHERON: Yes, I only received it Friday afternoon, the previous Friday afternoon.

BY MS. WEISS:

Q. And you were here Monday, the 7th, and Tuesday, the 8th?

A. (WITNESS SHERON) That's correct.

Q. And your report was completed by 10:00 a.m. on Friday, the 11th?

A. Yes. Well, the report was completed and assigned by Dr. Mattson and Mr. Thompson and given to the Division of Licensing, I think it was about 10:00 a.m.

Friday morning, although Mr. Jensen reminded me that the content of the report had been presented to us previously by the B&W Owners Group. I think we indicated it was at a meeting on February 23rd.

Q. When you say the content of the report was presented to you at that meeting, would it be accurate to say the conclusions of the report were presented to you at the meeting, but none of the detailed analyses or the equations or the graphs?

A. No. There was no text that was in the report that was presented, and I don't believe any of the correlations were presented, although the data was presented. For example, the curves -- most of the figures that are in this report were presented. I think there is a Staff meeting notice that was issued by the Division of Licensing, and that contains the two Vu-Graph packages that were presented to the Staff at that time.

Q. When did you read the report?

A. Wednesday -- Thursday following the hearing.

Q. Do you know whether the equations for emergency feedwater spray effectiveness are accurate?

A. Are you referring to the two equations?

Q. Yes.

A. I don't --

Q. Can I have what you are saying on the record,

please.

A. (WITNESS JENSEN) We compared the equations to the Oconee data and they seemed to give about the same result.

JUDGE EDLES: To what, Mr. Jensen?

WITNESS JENSEN: To the Oconee data. There was some data presented by B&W on some tests in the Oconee data.

BY MS. WEISS:

Q. Is the Oconee data in the report, Licensee's Exhibit 87?

A. (WITNESS SHERON) Yes, it is.

Q. Can you direct us to it?

A. (WITNESS JENSEN) It's figure 2-7.

Q. It is my understanding, while we are looking for figure 2-7, that the computer analyses used by the Staff, that is, RELAP4 and RELAP5, both assume 100 percent wetting of the steam generator tubes.

A. They assumed that the spray is mixed at the elevation of the auxiliary feedwater header, and if conditions for wetting do occur, they assume wetting across the entire surface, and the EG&G calculation, as I said, did calculate a large amount of wetting.

The later calculation they did with the boiler-condenser, the code calculated -- at first, when the aux feedwater was initiated, it calculated that

there was no wetting, and then at the end of the calculation, about 20 percent.

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Q Can you tell me -- I'm looking at Figure 2-7.

Can you tell me what data you had from which you constructed this figure?

A B&W constructed the figure, and these are thermocouple -- based on thermocouple readings from the Oconee tests.

The black dots indicated the location of tubes that were shown to be wet by the thermocouple data, and the white circles show thermocouples that were not indicated to be wet.

Q Does that indicate the total number of thermocouples available? Are those all of the data points?

A I think this is a composite of data points, and it indicates the amount of spreading of the water around the elevation -- around the location of one of the seven injection ports.

Q If we actually looked in the Oconee steam generator, would we find a thermocouple at each point where there is either a circle filled in black or an open circle on Figure 2-7?

A Well, at the time of the test, yes, you would have found one then.

Q And we would have found no other thermocouples?

A I don't know.

Q And is this the only data that you had for

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verifying the equations?

A Well, we also looked at the Alliance test, Alliance Research Center data, as indicated by Figure 2-10, which shows the amount of wetting at the particular elevation of the emergency feedwater nozzel, and we compared that also to the information of the amount of plugged tubes given in Figures 2-17 and 2-18, and based on these figures, we tried to calculate if the amount of wetting surface that B&W's equations included was correct. And we got about -- at least at the 95 percent level, we got about 10 percent, which is about what B&W got.

Q At the 95 percent confidence level?

A The 95 percent level on the operating range.

Q I'm sorry. Because the question was in my mind, with this amount of data, can you attach any uncertainty to the equations given for emergency feedwater spray?

A We haven't done an uncertainty analysis. I feel that there is some large amount of cooling available from the emergency feedwater spray. I looked at the tracing of the measure plots and temperature plots from Three Mile Island Unit 2, particilarly at the time about eight minutes into the accident, when the emergency feedwater system was first activated. And there was an immediate -- the steam generators were dry at that

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time, and there was an immediate drop in the reactor system pressure temperature, and it indicated that there was a good deal of spray effectiveness at that time.

Q Dr. Sheron, do you have any sense of the degree of uncertainty one should attach to the equations in Licensee Exhibit 87?

A (WITNESS SHERON) No. I concur with what Mr. Jensen said. We haven't done an uncertainty analysis on the data presented. Again, we think we pointed out that we really are not relying on the spray effectiveness to demonstrate the ability to establish boiler condenser or remove decay heat during a small break.

A (WITNESS JENSEN) We feel there is a lot of time for the operator to take action to raise the level up to 95 percent, so it is not really critical on how effective the spray is.

Q Well, that is an interesting answer, because it ties back into the first part of this Board Notification, doesn't it?

Can you tell me for what cases a forced circulation is not desirable to raise the level to 95 percent?

A I think that if there is a loss of forced circulation so that the reactor system becomes saturated, that it is probably desirable to raise the level to

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95 percent, regardless of the transient.

Q The question was, for all cases of loss of forced circulation, you added a qualifier.

Can you answer the question without the qualifier?

A If forced circulation is lost, I believe it is desirable to raise the level to 95 percent.

Q In all cases?

A Yes.

Q Then you would disagree that specific plant circumstances dictate the appropriate steam generator level?

A No. I you have not lost natural circulation, and if you have a lot of cooling on the secondary side, it would not be desirable to raise the level up to 95 percent.

Q Would you take a look at page 2 of Board Notification 83-21A. It is actually page 2 of the enclosure to Board Notification 83-21A.

The statement is made, the bottom of the first full paragraph: "However, because of overcooling considerations, it is not desirable to raise the level to 95 percent for all cases of loss of forced circulation. Thus, specific plant circumstances dictate the appropriate steam generator level and the manner to achieve this level. The operating procedures and training to describe the correct actions are therefore important to the issue."

Do you agree with that?

MR. CUTCHIN: Objection, Mr. Chairman.

Here we go again, and we are getting back into questions on procedures. It seems that every time it gets cut off, we come back with another approach from another angle. I think the Board has ruled several times that these are not appropriate questions.

JUDGE BUCK: Could we have the question repeated, please.

MS. WEISS: I simply read him the last six lines, and I asked if he agreed.

JUDGE BUCK: What is the enclosure? I don't have the right enclosure here. Can you tell me which one

it is precisely?

MS. WEISS: It is just labeled enclosure.

Do you have Board Notification --

JUDGE BUCK: Would you read the sentence again that you are talking about; tell me where it is, and which paragraph.

All right. Can you tell me exactly the sentence that you are talking about.

MS. WEISS: I'm reading from page 2 of the enclosure, BN-83-21A, and this part is verbatim from BN-83-21, starting on the sixth line from the bottom, that full paragraph, the only full paragraph on the page.

JUDGE BUCK: Okay.

MS. WEISS: Would you like me to read it over again? I just read him those three sentences.

JUDGE BUCK: Read exactly what you read.

MS. WEISS: "However, because of overcooling considerations, it is not desirable to raise the level to 95 percent for all cases of loss of forced circulation. Thus, specific plant circumstances dictate the appropriate steam generator level and the manner to achieve this level. The operating procedures and training to describe the correct actions are therefore important to the issue."

And I asked if he agreed or disagreed with these

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statements.

A (WITNESS JENSEN) I think I agree with the statement, and --

JUDGE BUCK: Wait. Just hold on one moment.

JUDGE EDLES: I think I'll let the witness answer that question, and we will proceed question by question from there.

WITNESS JENSEN: What I would --

JUDGE EDLES: Mr. Jensen, if you want to take it sentence by sentence, that is fine with me.

WITNESS JENSEN: I think when I answered Ms. Weiss earlier, I meant it was desirable to raise the level to 95 percent for a complete loss of circulation, a loss of natural circulation. I meant to indicate that that would be when it is desirable to raise the level to 95 percent, not on the loss of forced circulation.

BY MS. WEISS:

Q All I really want to know, Mr. Jensen, is whether you agree with those three sentences.

A (WITNESS JENSEN) Yes, I do.

Q Dr. Sheron, do you agree, also?

A (WITNESS SHERON) Yes, I do.

MS. WEISS: Those are all the questions that I have on this document.

BY MS. WEISS:

Q Gentlemen, I'm handing you a copy of a memorandum authored by Mr. Sheron dated October 25, 1982, to Raymond Fraley, Executive Director of the ACRS, Subject, ACRS Concerns on RCS Vents, Feed and Bleed.

I would like to have it marked for identification. I think we are up to UCS 52 for identification.

(The document referred to was marked Exhibit No. UCS 52 for identification.)

XXX

BY MS. WEISS:

Q Are you the author of that document, Mr. Sheron?

A (WITNESS SHERON) Yes.

Q Anticipating objections, I want to make it clear that I'm not going to ask you about feed and bleed. What I want to do is discover whether there are any technical implications from this document which apply to the issue surrounding boiler-condenser.

MR. BAXTER: Mr. Chairman, may I ask that we take a few minutes in place to look over this document.

JUDGE EDLES: Yes. Let's take a few minutes to look over the document.

(Pause.)

JUDGE EDLES: Are you ready, Mr. Baxter?

MR. BAXTER: Yes. Thank you.

JUDGE EDLES: Go ahead.

BY MS. WEISS:

Q. Dr. Sheron, I'm interested in enclosure 1, titled "Post Feed & Bleed Recovery of a B&W Reactor," and particularly the discussion which begins at the top of the second page of that enclosure.

You discuss the ATOG Guidelines, A-T-O-G, and state that they instruct the operator to bump reactor coolant pump following bleed and feed operation for which feedwater has been restored, and then you say, "This action may be required even though feedwater has become available since steam formation in the reactor coolant hot legs may prevent the self-initiation of natural circulation."

My question is: In this scenario, you have assumed that feedwater is restored and is available. Under those circumstances, why is it required to bump, or operate a reactor coolant pump to promote circulation?

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Why wouldn't boiler-condenser become established?

A. (WITNESS SHERON) The reason that one would not establish -- well, it is not boiler-condenser that we are talking about here right now. You are talking about reestablishment of a single-phase natural circulation. The phenomena that is being referred to here is that when you are refilling the primary system after it has been voided and natural circulation has been interrupted, you have steam that exists in the hot legs and however far into the steam generators -- depending upon how far the level went down during the accident.

As you refill the system, you are pushing cold water up and you are refilling essentially from the bottom up, with steam being trapped in the high points of the system, including the top of the vessel and the hot leg candy canes.

There is a concern that the interface between the water and the steam, even though you have cold water going in, you get heat transfer which occurs across the interface from the steam to this colder water.

By condensing steam, you transfer the heater evaporization, which goes into raising sensible heat in a layer of water at the interface, raising the temperature of that water to the saturation temperature corresponding to the steam temperature.

What happens is that now you cannot condense the steam bubble further because you cannot remove this heater evaporization by heat transfer through the water very readily; the reason being is that this layer of water very close to the interface saturation, and the steam is essentially here. With a very small evaporation distance, the rate of heat exchange is low, and it takes a finite amount of time to transfer this heat.

The concern is that as you are filling, the steam bubble does not condense but rather would compress, and only very slowly condense.

I believe there was a Board Notification on this item which was written by Mr. Etterington, and I think we forwarded it to the Board in September, explaining this concern. It has been around a while. This is again one of the uncertainties that we have with the analytical models.

BY MR. POLLARD:

Q. To continue on that same paragraph, Dr. Sheron: It says if a reactor coolant pump cannot be bumped or if feedwater is unavailable, the guidelines instruct the operator to continue to depressurize and cool down the reactor system by venting through the PORV. No guidance is given for the possibility that the PORV will not open. (Presumably high pressure feed and bleed will continue.) Although not in the guidelines, another course of action will be to open the high point vents to exhaust the trapped steam in the hot legs. When sufficient steam were exhauseted and replaced with HPI water, natural circulation cooldown would be established if feedwater were available.

My question is: Could I interpret this document correctly to say that with respect to the normal transient operator guidelines for Oconee 3, at least at the time you wrote this memo, they are instructing the operator essentially not to rely upon boiler-condenser? They are instructing the operator to either try and bump the pump, or if he can't bump the pump, to depressurize and cool down the system by venting through the PORV?

MR. CUTCHIN: Objection, Mr. Chairman. We have gotten there again. The witness, in answering the first question, made very clear that nothing in this

memorandum had anything to do with the efficacy of boiler-condenser cooling. We are now getting back into what did the procedures instruct the operator to do, to do something else other than to get into boiler-condenser natural circulation.

JUDGE EDLES: Mr. Pollard, do you have any observations and comments?

MR. POLLARD: As I understand the Board's questions, you are interested in the ability of boiler-condenser mode at Three Mile Island Unit 1 to remove sufficient decay heat. I think this is relevant because if the operators are being trained not to rely upon the boiler-condenser mode, we are generally wasting our time here.

MR. BAXTER: This document is about a situation after bleed and feed operation where there are inadequate core cooling situations. The Board's request is, as I understood, for a small loss of coolant accident, will a boiler-condenser work.

MR. POLLARD: If we had a Small-Break LOCA at Three Mile Island Unit 1 and emergency feedwater were not immediately available, starting up of the HPI pumps, as we have already discussed in some of our previous briefs, might cover the condensing surface. At some point, if feedwater is then restored, I'm interested to

know whether at this point we are going to be in boiler-condenser at Three Mile Island Unit 1 or whether the operator is going to try and get back to natural circulation using purely liquid. I didn't ask the question, as I think the answer is, that the ATOG Guidelines for Three Mile Island Unit 1 are being developed from the Oconee guidelines.

MR. BAXTER: I think all the evidence so far produced by the Licensee and the Staff makes it clear that for boiler-condenser cooling in the Small-Break LOCA situation, we rely on feedwater and that we have to have feedwater at some given point in time in order for that process to take place.

We are now engaged in a hypothetical where we don't get feedwater; then we have feed and bleed cooling, and what happens after that.

MS. WEISS: No. You have feedwater. Feedwater has been restored.

MR. BAXTER: After it has been lost, and feed and bleed had to be resorted to. That is what the document is about.

MR. POLLARD: Some of the analyses in the testimony by both the Licensee and the Staff did indicate there was a delay in initiating feedwater for up to 20 minutes. That was some of the analyses that we talked about in this

hearing.

MR. BAXTER: But you don't get into feed and bleed in that time.

JUDGE BUCK: Mr. Pollard, I think you are reading too much into this document, to begin with. I'm talking about the ACRS document.

The ACRS raises many points in its questions. They have apparently raised some questions about high point vent and feed and bleed. I look at this document as being a description of what happens if you get into feed and bleed and you get certain effects coming in, certain things happening, and then these are some of the possibilities that you can go to. You can eventually get down to, or immediately get down to boiler-condenser, or you can do other things. And I don't read this thing as telling the operator that the last thing he is to try under any circumstance is boiler-condenser, because a report to the ACRS on what the Staff's attitude is on high point vents, the problems with high point vents, and problems with feed and bleed, it is just simply that; no more.

JUDGE EDLES: I'll sustain the objection.

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BY MS. WEISS:

Q I would like to ask the witness -- in fact, we wanted to ask before the Board had decided -- let me ask now, to explain to us on the basis of the objections that we have heard, if we had a situation such as you describe in your memo to the ACRS, where feedwater was lost and then restored, would that be any different, the plant conditions be any different from the case of a Small-Break LOCA using boiler-condenser for TMI-1?

A (WITNESS SHERON) Yes. I think the conditions are quite different. The situation referred to in the memo is a refilling of the primary system. You have covered your condensing surface. You are no longer relying on boiler condenser to remove decay heat. You are in the process of re-establishing single-phase natural circulation following a small break in which you have gone and established a boiler-condenser mode of decay heat removal.

Once you have established conditions so that the high pressure injection system injects more water than is being lost out of the break, you would refill the system in the same manner here.

If the system filled, and I think this was pointed out very clearly in Board Notification of last July -- and I don't know the number -- in which a memorandum to

Mr. Henry Meyer was attached, we spelled out in, I think, some painful detail what the options were with respect to the way the plant might behave.

If one were to refill the system, and if for some reason you did not get good heat transfer from the steam and the subcooled water coming from the bottom such that the steam bubble did not condense sufficiently to allow water to flow over the top of the U-tube and re-establish circulation, and you had indeed covered up the condensing surface by filling the system, what would happen is, you would be in a condition of having no heat removal path and an interrupted natural circulation because of the steam bubble; the pressure would go up, due to the heat being generated, and not being able to escape. This, by raising the pressure, does two things.

One, the break flow increases.

Two, the HPI flow would go down. The system would drain back down until one established a condensing surface again, and you re-establish boiler-condenser.

BY MR. POLLARD:

Q Dr. Sheron, maybe if I -- I have to keep letting you go on, because counsel objects if I interrupt you, and I'll be happy to let you continue this, but perhaps we can save some time if we can go step by step.

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During feed and bleed cooling -- let's assume we have feed and bleed cooling with no emergency feedwater. Is it not possible at some point for some break size during feed and bleed cooling that the water level on the primary side of the steam generator tubes would correspond to perhaps 50 percent on the operating range?

A (WITNESS SHERON) On the primary side?

Q Yes, sir.

A No, I don't believe so.

Q Well, if we have for some size break, and we are in feed and bleed cooling, the pumps got started up, and we are trying to refill the system up towards the point where we would eventually open the safety valves; correct?

MR. BAXTER: We are already in feed and bleed cooling?

MR. POLLARD: Yes, sir. We had an accident. Small-Break LOCA. We have no feedwater.

WITNESS SHERON: All right.

BY MR. POLLARD:

Q We start blowing the water out of the primary system.

A (WITNESS SHERON) All right.

Q We start up our HPI pumps.

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A All right.

Q Is it not possible that in some Small-Break LOCA, at some point during that transient, the water level on the primary side of the steam generator is some length inside the tube, it could be 50 percent on the operating range?

A Oh, yes.

Q Okay.

Let's say we are in the feed and bleed cooling mode, with the primary side level + about 50 percent on the operating range, and then feed and bleed is restored -- excuse me -- emergency feedwater is restored.

A Okay.

Q The conditions of the plant at that time in terms of EFW flow, how much water is in the primary side of the steam generator, how much steam is in the primary side of the steam generator; there would be no difference, would there, between a similar situation where we had always had emergency feedwater and were operating in the boiler-condenser mode?

A Yes. There would be two differences.

One is that the pressures would be different in the system. The second would be in what case you had a break in the system. So you have different energy removal paths available.

Q I thought in both cases I had postulated we were in a Small-Break LOCA, but that's okay.

A Both cases are with a small break?

Q Yes. As far as at this point in time, the condition of the plant, that point in time being where we had been in feed and bleed, primary side level at some point within the tube, so that there would be a condensing surface if feedwater were restored; how is that plant condition different than if we had always been in the feed and bleed mode, other than pressure?

A Offhand, I don't know of any substantial differences that might exist.

Q. Under these conditions does the pump need to be bumped or not?

A. I'm sorry? Are we in feed and bleed or small breaks, or what?

Q. As far as the plant condition, we just established, I hope, that the plant condition was no different at the point in time where we had been in feed and bleed and then emergency feedwater was restored compared to the situation where we had always been in the boiler-condenser mode.

A. No. Pump bump is not a required action. It is a desired action, but it is not required to maintain core coolant.

Q. Then back to your memo, where you say the guidelines instruct the operator to bump the pump and this action may be required, and what you are saying there is only required if the operator was attempting to restore natural circulation? Is that what you mean by "require"?

A. Yes. Yes, if one is trying to restore a single-phase natural circulation, one may need to bump the pumps.

Q. And that is in fact what the operator guidelines instruct the operator to do?

MR. CUTCHIN: Objection, again, Mr. Chairman.

JUDGE EDLES: I'll sustain that objection.

MS. WEISS: No further questions.

JUDGE EDLES: Mr. Baxter.

CROSS-EXAMINATION

ON BEHALF OF THE LICENSEE

BY MR. BAXTER:

Q In earlier testimony, gentlemen, Dr. Sheron, in your response to a question from UCS, at about transcript page 85, you were asked about the shutoff pressure for the HPI pumps at TMI-1, and you said you weren't sure, but you believed it was 2700 pounds. And then about ten pages later, Judge Buck assumed that number in questioning of Mr. Jensen, and the testimony went on from there.

Mr. Jensen, have you been provided with any --

JUDGE EDLES: Excuse me. I see disgruntled faces.

Are you having trouble following?

MS. WEISS: I can't tell whether that is the boiler-condenser questioning or the feed and bleed questioning. And I object to recross on the feed and bleed questioning.

MR. BAXTER: There is an error in the testimony, Mr. Chairman. We don't think it is preferable to leave the record in error, if that is a nit-pick whether we are in feed and bleed today. We were talking about feed and bleed for about an hour.

MS. WEISS: I hardly consider it a nit-pick,

considering who's been making the objections.

JUDGE EDLES: How long will it take?

MR. BAXTER: Long enough to get the HPI pressure from 2700 to 2900 pounds.

BY MR. BAXTER:

Q Have you since been provided with information based upon the FSAR, HPI curve for TMI-1 that shows that the shut-off pressure is higher than the 2700 you testified to before?

A (WITNESS SHERON) Yes. I've been informed that the HPI pressure is 2900 pounds per square inch.

Q Earlier today, Ms. Weiss was discussing with you the original CRAFT code and its capability to predict steam collection in the hot legs.

Is it true, Mr. Jensen, that the approved CRAFT code does allow for steam to separate into different volumes?

A (WITNESS JENSEN) Yes, it does.

Q And when you were talking about the inability to predict an interruption in natural circulation, you were speaking, were you not, of the original model and not the revised model with the additional noding?

A Yes. It is my understanding that the purpose of the additional node was to provide the code with the capability to predict loss of natural circulation.

Q And it in fact did predict such, did it not?

A Yes, it did.

Q. Ms. Weiss was also asking you some questions about the aduit calculations that the Staff perfromed with RELAP4 of the work performed in 1979 by B&W with what has been termed here the revised model. And I would like to refresh your memory somewhat with some passages from NUREG-0565, which is the Staff's generic evaluation of the B&W Small-Break LOCA analyses issued in February 1980, and which is in the record as Board Exhibit 4.

MS. WEISS: What are you refreshing his recollection about?

MR. BAXTER: I'm reading from page 4-31 of this exhibit, a section entitled "Model and Modeling Differences," which discusses the differences between the B&W predictions and the Staff audit calculations.

We will read together this paragraph.

BY MR. BAXTER:

Q. "One difference which has an effect on the Small-Break LOCA analyses is the critical flow model used to obtain the break flow. The Staff analyses used the Henry Fosk HEM model. B&W uses the Vernulley equation for subcooled flow and the Moody model for saturated and tube-phased flow. The B&W model resulted in high temperatures during the subcooled portion of the blowdown leading to a somewhat faster system depressurization."

Is that information correct?

A. (WITNESS JENSEN) Yes, it is.

Q. And does that account for some of the differences between the RELAP4 audit calculations and the B&W calculations with the revised model?

A. It would account for some of the differences.

Q. You were also asked about the extent to which the Staff calculations predicted a loss in natural circulation, and on the very next page, 4-32, it states that in the B&W analysis the loss of natural circulation is quite pronounced, resulting in the repressurization to 1750 psia at about 1500 seconds.

JUDGE EDLES: Mr. Baxter, maybe if you would read a little more slowly, it would make it easier for the reporter.

BY MR. BAXTER:

Q. In the Staff analysis, natural circulation is lost for a much shorter period and the pressure tends to hang up while the steam generator pressure is near the safety valve set point.

Is that an accurate description of the differences with respect to the interruption of natural circulation?

A. (WITNESS JENSEN) As far as I know. I said this morning there might have been some previous losses of natural circulation, but I didn't think they were very significant.

Q There have been some discussions about the fact that various analyses performed by B&W are generic.

In fact, given a Small-Break LOCA analysis by D&W as generic, is that not intended to be a bounding analysis and would it not in fact have a therefore higher power level than exists at TMI-1 and as the testimony in the licensing hearing showed, about a 10 percent lower HPI flow rate for TMI-1?

MS. WEISS: I object to that without reference to a specific analysis. It seems to me that Mr. Baxter is asking Mr. Jensen what B&W intends to do by its generic analysis, unless he is talking about some specific Staff generic analysis.

MR. BAXTER: I believe Mr. Jensen is qualified as a reviewer on the Staff of the B&W Small-Break LOCA analysis work performed by B&W. He testified before the Licensing Board on those subjects.

JUDGE EDLES: I don't understand your objection, Ms. Weiss.

Try it again for me, please.

MS. WEISS: First of all, I don't know which analysis is being referred to. Second of all, he's not identified any specific analysis. He talked about generic analyses. It seems to me that the question Mr. Baxter is asking Mr. Jensen is --

JUDGE EDLES: Excuse me. I thought we had a specific generic analysis in mind.

Am I correct on that?

MR. BAXTER: It seems to me in several places today when we were talking about the B&W Small-Break LOCA analyses, whether it was the revised model, the old model, or the new model, it was a point that was emphasized in the cross-examination that, oh, it was generic. And my question applies to all of them. I think it is not a question of B&W's intent. It is a question of the assumptions of whether they are conservative, and I'm sure in his role as a Staff reviewer, Mr. Jensen knows that.

MS. WEISS: That is a different question than the one asked.

JUDGE EDLES: I interpret that as a withdrawal of the objection.

Go ahead, Mr. Baxter.

WITNESS JENSEN: Okay. I think we compared the power level of the B&W generic model with that of Three Mile Island Unit 1 and said that the power level was about 12 percent higher than the B&W generic model, and the flow rates for a high pressure injection are lower in the B&W model than they are for Three Mile Island Unit 1. And I think the difference is something like 10 percent.

BY MR. BAXTER:

Q. So the generic analysis is conservative for TMI-1?

A. (WITNESS JENSEN) Yes. It is my understanding that the purpose of the generic model of B&W is they attempted to take the worse conditions for all of these class of plants, the lower loop 177 fuel element plants, and to make it a composite model, which would be conservative for all the plants.

Q. Ms. Weiss read to you a sentence or two from Board Notification 83-21. Because of overcooling considerations, it is not necessary to raise the level to 95 percent for all cases of loss of forced circulation.

Is that news to you gentlemen as a result of something uncovered in the B&W/GPU lawsuit?

A. No.

Q. Did the Staff in fact know about those overcooling considerations well before the TMI-2 accident?

A. The Staff has done a lot of detailed analysis and study on overcooling of B&W reactors.

Q. There was some examination today, Dr. Sheron, about the additional confirmatory experimentation that is to be done, the integral system testing, and at the oral argument we had before this Board on September 1 last fall, you were called to the podium to answer some questions about

that subject, but you weren't under oath then.

I would like to read back to you what you said then and ask you whether this would be your testimony today.

You said that the reason we are requesting the confirmatory experimental data is basically one that we have looked at the models, we do believe that we find the plant in conformance with the Regulation 50.46, and Appendix K; is that correct?

A. (WITNESS SHERON) Yes, it is.

Q. And Judge Buck then asked you, do you have any problems with the models themselves. Do you think they are satisfactory? Do they need correcting or anything of that nature? And your answer was as follows:

"We have looked at the models, we have looked at the verification that has been provided to date by the Licensees, and based on that information provided, we have sufficient assurance that the plant can be operated safely. However, there is longer term confirmation that we believe is needed in order to, as I would say, confirm this assurance that we have right now."

Are those statements true?

A. (WITNESS SHERON) Yes, they are.

MR. BAXTER: Those are all my questions. Thank you.

JUDGE EDLES: Mr. Adler. Mr. Dornsife?

MR. DORNSIFE: I just have one short series.

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CROSS-EXAMINATION

ON BEHALF OF THE COMMONWEALTH OF PENNSYLVANIA

BY MR. DORNSIFE:

Q. The various analyses that were done by Staff audit calculations and B&W, particularly for the .01 square foot break, what assumptions -- what did the analysis assume as the amount of HPI flow that was lost out of break? Do they all assume the same loss?

A. (WITNESS JENSEN) I believe that in the RELAP5 code, the code calculates the amount of HPI water that is lost out of the break. I believe that in the B&W calculation it is assumed that 30 percent of the water was lost out of the break.

Q. What is that based on, the 30 percent? Does the RELAP code predict something that is fairly close to that, and what is it based on?

A. My understanding is the 30 percent that B&W calculates is just what falls out of their code calculation goes out the break. I don't believe that it is a specified number that is input.

In other words, 30 percent goes out regardless. It is just a matter of the way the code calculates the flows and the flow splits. The same is true with the Staff codes. It is a matter of how the flow splits occur.

Q. Was that the worst case? That assumes that a nozzle was broken off in the HPI injection line?

A. I believe that is the worst case, since the break is in that location.

I'm sorry. I think if one puts the break actually directly opposite the HPI injection in the primary pipe, then one would have a hole in the vicinity of the HPI injection.

Q. Do you know why -- the B&W Licensee Exhibit 87, for the Davis Besse analysis, why it is assumed that 50 percent of the flow is lost through the break?

MR. CUTCHIN: Mr. Chairman, I would normally enter an objection here, because I don't know that Davis Besse has anything to do with TMI. But since it is the State, I'll let the question go. I think it is irrelevant to what we have here.

WITNESS JENSEN: I think it involves the fact that some of the B&W plants have cross-connections between the nozzles in the high pressure injection system, and perhaps Davis Besse does not.

So, in the case of Three Mile Island Unit 1, the nozzles are cross-connected, and they are also equipped with cavitating venturas, and this cavitation would prevent more than 30 percent of the water being lost from the farrier of the cold leg around the vicinity of

any one high pressure injection nozzle.

BY MR. DORNSIFE:

Q. For for TMI-1, that 30 percent, in your opinion, is conservative?

A. Yes, it is. There has been analyses presented by Three Mile Island to show that 30 percent was conservative and that less water could be lost from any one nozzle than the 30 percent for Three Mile Island Unit 1.

MR. DORNSIFE: I have no further questions.

JUDGE EDLES: Redirect, Mr. Cutchin?

MR. CUTCHIN: None, Mr. Chairman.

JUDGE EDLES: Any further cross, or recross?

MS. WEISS: Just one, Mr. Chairman.

FURTHER CROSS-EXAMINATION

ON BEHALF OF THE INTERVENOR

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BY MS. WEISS:

Q. Last Tuesday, March 8th, Mr. Baxter read to you from an affidavit that you had written, Dr. Sheron, and the portion that I'm interested in appears on page 260 of the transcript.

MR. BAXTER: I'm sorry, Ms. Weiss. I read from that page?

MS. WEISS: You read from that page.

MR. BAXTER: That was oral argument.

MS. WEISS: This is last Tuesday.

MR. BAXTER: I'm sorry.

BY MS. WEISS:

Q. "We have always maintained that the results from Semiscale and other test facilities are primarily for code verification purposes. Our confidence in understanding large PWR behavior, including feed and bleed operation, is predicated on confidence in the computer codes which calculate the behavior. The main objectives of the scaled tests are to look for new or unique thermal hydraulic phenomena associated with transient and accident scenarios, and to assure that the computer codes are capable of predicting the observed behavior."

I take it that this general observation also applies to large PWR behavior, such as boiler-condenser; is that correct?

A. (WITNESS SHERON) Yes.

Q. Would you say that the EG&G RELAP5 calculation for the .01 square foot break which calculated a plant behavior different from any calculated by B&W, or previously by the Staff, suggests any uncertainties about the confidence one has in the ability of the codes to calculate large PWR behavior?

A. Yes. I think that the analyses that we have obtained from EG&G, I think I stated before, it substantiates our previous position that there is a large

uncertainty that exists in the ability to correctly predict thermal hydraulic behavior during the transitioning period from bubbly two-phase natural circulation to either what now may be boiler-condenser or perhaps a chugging type of flow during a small break.

MS. WEISS: I have no further questions.

MR. BAXTER: Mr. Chairman, could we have that last question read back, please.

j-25-1

JUDGE EDLES: Would the reporter please read it back.

(Record read)

JUDGE EDLES: Any further questions?

If not, I think these witnesses are now dismissed with the thanks -- I'm sorry. I apologize. I'll never hear the end of that. My colleagues.

Go ahead, Dr. Buck. I apologize. I'm sorry.

xxx

BOARD EXAMINATION

BY JUDGE BUCK:

Q My questions concern your testimony on pages 9 and 12 in your testimony, and while I appreciate the terminology tnat you use in here on this bubbly chugging, which reminds me more of my college days than it does reactors, I have a question about the physical possibilities of the scenario that EG&G has proposed here.

Have you looked at that from the point of view of the way in which they describe it, of a physical possibility of getting a bubble to come out of the top of the reactor, go up through the cold legs, and force water out of the steam generator?

A (WITNESS SHERON) In terms of the physical reality of the situation --

Q That's what I'm talking about.

A There is nothing that precludes it. There is a flow path through the vent valves. They are quite large.

j-25-2

Q And then it goes into the cold leg; right?

A Yes.

Q And as I understood your testimony this morning, it was that the water in the steam generator, in the primary steam generator, had been cooling for a while, so it is cooler than, shall we say, the temperature at the top of the reactor?

A Yes.

Q So this would be below saturation temperature?

A Yes.

Q All right.

My first question is, how do you get a steam bubble to go up through -- or push a long area of water out when that water is below saturation and will, therefore, condense the bubble?

A The steam that is being generated in the core is flowing through the vent valves into the cold leg, and it is -- as part of that water condenses -- I'm sorry. As part of the steam that is flowing through the vent valve condenses, the heater vaporization is going to raise the water temperature locally in the cold leg in that region.

Q All right. That, then, is more dense water, which will tend to stay down?

A Well, it is also at saturation temperature. I

j-25-3

think your concern is how can steam push a subcooled --

Q Let's say it is at the beginning of the cold leg. You've got a lot of water in the cold leg and a lot of height in the water in the steam generator.

A Well, the steam, by its physical presence in there, is going to displace volume.

Q But this is steam, now, not hydrogen. It is steam going into water that is considerably colder. This is water that is below saturation point.

A No. I think you are maybe not understanding. The cold water is over -- in other words, you have the vessel. You have a horizontal length of cold leg piping, there is the pump, and then there is a longer vertical section, a lower U-bend, and then the bottom of the steam generator. That is the suction piping, or what we call the loop seal.

Then in the steam generator there is a column of cold water. The water that is being displaced is the water that is inn the cold leg, the horizontal cold leg piping. That water is being heated up by the steam flowing into it from the upper part of the vessel.

As that steam flows into it, some of that steam condenses. It is the heater vaporization that is being heated up in the condensation process that goes that -- as I said, the HPI flow is coming in in the cold leg.

Q Against the flow of the steam?

A Yes. They are all coming together in there. Part of that HPI water is condensing the steam.

In other words, the HPI water is cold.

Q Isn't there enough HPI water coming in there to condense that steam?

A Not all of it. We are dealing with only one HPI pump.

Q How do you get water going into the lower part of the reactor, then?

A There is a column -- the vessel is full right now, except -- I'm sorry. It's not full. The vessel has enough water in it that it is covering the core, and the level is probably somewhere perhaps around the hot leg elevation or so. So the vessel is full, and it is just boiling, it is a boiling pot, and it is boiling off, creating steam.

Q All right. What is maintaining the level of that water?

A Well, no. That level is slowly dropping.

Q It's got no water coming in the bottom, then?

A No, because there is no natural circulation. If you have reached a point where you have interrupted natural circulation, which is, I think, where we are in this accident, the level is just dropping very slowly.

j-25-5

Q I thought you were pushing HPI into that?

A I am, but I'm losing water out of a break, as well.

There is liquid being lost out of the break; there is liquid coming in from the HPI. At this point in the accident, the leak flow still exceeds the HPI flow. So there is a net loss of mass from the system.

Q All right. But I'm not leading so much to the loss of the mass as I am to the heat that is being lost. You've got a certain pressure above the reactor; right?

A Yes.

Q That reactor is now opened up over the hot leg to the steam generator?

A I'm sorry.

Q Are you assuming that the hot leg is now nothing but steam, or is there --

A There's probably some water in the hot leg.

Q All right. Then your pressure up -- if there is water in the hot leg, and you've got a pressure that is holding that up, being built up by the reactor; is that right? Otherwise, it would just run back down?

A I think the level is actually at the hot leg in the vessel. In other words, the water is at the elevation of the hot leg, which there is steam above and water below.

j-25-6

Q So, basically, then, the pressure in the top of the steam generator is the same as the pressure at the top of the core?

A Yes.

Q Okay. Now, I don't see the pressure level here that allows one to push up a column of water into a pressure at the top of the steam generator, which is equal to the pressure at the top of the reactor?

A Okay. I understand what you are saying.

What you are doing is, it is a displacement process again.

As you put steam into the cold leg -- now, it is not just the -- yo' can visualize it as maybe a slug of steam, a pocket of steam.

Q See, I have trouble visualizing a slug of steam which is going up the cold leg, against the flow of the HPI. That is turbulent.

How do you get a slug of steam going up through --

A You may not want to visualize it as a slug of steam, but rather, as bubbles, steam bubbles.

Q Let's break it up into steam bubbles. Where do you go from there?

A Well, as the steam bubbles collect in the cold leg, they have to obviously displace water.

Q Why would they collect? Why wouldn't they be

j-25-7

condensed?

A Well, some are, but what we are saying is that the steam, as it goes into the cold leg, the HPI water flowing in is of sufficient temperature that it will condense some of the steam, but not all of it.

In other words, as the steam goes in --

Q Have you done a thermodynamic analysis to see whether or not the amount of the steam that goes out of the vents as opposed to the steam going up the hot leg is sufficient to give you --

A There is no steam going up in the hot leg. There is no flow.

Q All right. But that is because the pressure up at the top is sufficient to hold it down; okay?

A No. There is no flow, because there is no condensing surface. There is nothing to force that flow into the steam generator. There is a level in the steam generator, and in the vessel, and in the hot leg, and that steam has no place to go. It is just like a pressure cooker.

Q It still hasn't any place to go, in my opinion. Because you open the vents, and you say it goes up the hot leg --

A No.

Q The cold leg, rather.

j-25-8

A Goes into the cold leg. All of the HPI going in condenses as much of that steam that it is capable of condensing. Remember, as the steam condenses, that heater evaporization raises the temperature of that incoming HPI water.

Q And it, therefore, will increase the -- wait a minute, now. That will tend to increase the rate at which the water level in the reactor goes down, or it will increase the rapidity of boiling, at least, because you are putting hot water in the bottom?

A No, because there is no flow.

Q If there is no flow, you are going to be going down rapidly as though the HPI is not coming in at all.

A No, you won't go dowr rapidly, because HPI is coming in. I agree, there is some water coming in, but it is being raised to saturation.

The whole vessel is saturated.

Q You told me this morning that the whole vessel is saturated, yes, but not the steam generators.

A Right. Because that water is not --

Q That is cold?

A Yes.

Q All right. But what I'm asking you, have you done thermodynamic analyses to see whether the amount of

j-25-9

steam that you are shoving out is so much that it will not be condensed before it gets to the top of the steam generator?

A If you are asking whether I've done a hand calculation to second-guess RELAP, the answer is, no.

Q Have you asked RELAP about this? Have you asked EG&G about this?

A No, I haven't questioned them on it, because without having checked it, it does make physical sense that one cannot condense --

Q I don't see that it does make physical sense, because you've got a huge amount of water here that is below saturation.

A The only water that is below saturation is the water in the steam generator.

Q Through which the bubble has to go?

A No. It doesn't. That water -- you can look at it as being effectively insulated from the rest of the system. It's sitting on the side.

Q How does that water get pushed up, then?

A The steam, as it travels through the vent valve into the cold leg, some of it accumulates, because it is not all condensed by the HPI water. Like I say, the HPI water, as it enters the cold leg, is raised to saturation by condensing some of the steam, but not all of

j-25-10

it.

The steam that cannot be condensed because there is insufficient HPI water to condense all of it remains in the cold leg.

That water -- I'm sorry. That steam that remains in the cold leg occupies volume. It pushes warm water away from it.

That is one way to look at it. That warmer water acts like a piston pushing the colder water in front of it up through the steam generator.

So the steam generator -- the cold water in the steam generator never really sees a steam bubble, if that is one way to describe it.

Q You are telling me that a slug of water can go up, say, through the center of the steam generator, through some of the tubes, and still be uncondensed, or still be heated?

A The cold water in the steam generator?

Q I don't care how far up, but if you've got water in the primary part of the steam generator, you are saying that part of that water is now going to be pushed out to the top of the steam generator, expanded there, fill up the tubes from the top of the steam generator, and fall down, the ones that aren't being pushed up, and still have enough volume to go up and over the hot leg?

j-25-11

A No.

Q Well, sure it is.

A What I'm saying is that as the cold water that sits in the steam generator is pushed backwards, you might say --

Q Well, to me, that means up.

A Okay. Up. It's pushed up. It is not pushing up in one tube. It's pushing up in all tubes. There is a column of water in all the tubes, and that entire column in every tube is coming up slowly.

As it comes up, there is steam above it. There is a thermal layer, and then there is the steam.

Q All right. Fine.

Do you know practically what is going to happen? Do you guarantee that the level in every one of these steam generator tubes is the same, or will not be pushed up a little bit ahead of another one?

A Of course not. Some will be slightly different from others.

Q Normally, when you blow one tube clean, you are going to blow --

A I'm not blowing any tubes clean here.

Q What I'm saying is, I think you may, by the time you --

A I think what you are hitting on is perhaps one

of the uncertainties we are trying to get our handle on.

Q I can't get out of you whether you've got any calculations on this at all. I cannot see the amount of steam coming out of there and going through the cold leg into a body of unsaturated water, and not being condensed.

A The steam is not going into the subcooled water.

Q All right. How big a bubble are you going to form? Are you going to fill the lower leg out through the pump section, out to the bottom of the generator? Are you going to fill that with gas?

A I don't have the detailed calculations to know how much --

Q What I want to know is, the volume of that tube, how much that represents the volume of the steam generator?

A I really don't know the answer to that question in terms of the volumes.

Q In other words, you have done no check on this whatsoever. You haven't asked questions about the physical possibility of this code at all, of EG&G?

A Well, certainly when EG&G does a calculation, and we do ask them what happens --

j-25-13

Q Well, have you?

A Well, yes. We got a description of the physical process which the code calculated, and which EG&G --

Q Look, I know this. I know you got what the code calculated.

What I'm asking you is, have you checked it out for a physical possibility using exact volumes, temperatures, and so on, to see what really happens when the bubble expands beyond the lower leg, for example?

A No, because I don't know whether that bubble expands beyond the lower leg.

j-26-1

Q If it does, how far up will the steam generator water be pushed, then?

A It probably doesn't have to go very far before it starts really condensing some steam and creates that pressure sink --

Q How is it going to condense steam any more than it did before? You mean, steam at the top of the steam generator?

A Yes. As you are pushing it up, you are basically putting this cold water in contact with more steam.

Q In the primary? The only steam it sees is what comes down the top of the primary tubes.

A I understand, but there is a turbulence, too, in there, I think, the way the code calculates the mixture.

I think what you are hitting on, Dr. Buck, is one of the problems that we have said in our testimony, and the like, and that is that there are a lot of uncertainties with respect to the way the systems perform.

I'm not saying that the EG&G calculation is any better than another calculation. As to whether the phenomena which RELAP has calculated is accurate or physically reliable, it makes sense.

From the standpoint of the calculation that B&W has done, that, too, makes sense.

j-26-2

Q I have no problem with the physical possibility of the B&W model, as I see it. I can see this as being physically possible. Whether it is absolutely correct or not, I don't know.

At least, I can see it as being physically possible.

But in looking at the stretcher of the steam generator, the length of the tube at the bottom, the total volume of the steam generator, the amount of water that would have to be moved to chug it over the top to have any effect and so on --

A I'm not pushing this column of water completely up into the top of the U-bend, and then over.

Q You are pushing it up to the bottom of the vent, at least?

A I'm just pushing it up enough such that that colder water gets a chance -- again, it may be anomaly of the computer code to thermally mix and create a heat sink, condense the steam above it, by condensing the steam above it, which may be well into the length of the generator, you create a pressure sink at that location, which is going to suck more steam over and essentially cause this chugging flow over the top in a positive direction.

Q See, you are getting a lot of heat transfer here, and this steam generator still has the water in the

j-26-3

primary tubes, and this is what you have been telling us you can't do.

With the condenser boiler you've got to have water on the outside that is above the primary level so that you have an opportunity to get condensation.

Now, what you are telling me now is that by shoving some water up the inside of the primary tubes, and getting it closer to the top, you are going to get a lot more condensation. This seems to be contradictory to me.

A I think we said that it was not a matter that the secondary level had to be above the primary level in order to get heat transfer. In other words, the only way you remove heat is not just by condensation and steam.

Q No, but the major part is the heat transfer to make the condenser-boiler method operational, as I understood it --

A Boiler-condenser, I agree.

Q Okay.

A But we did not see boiler-condenser --

Q I'm saying that you are saying that the boiler-condenser will not work, or has a lesser chance of working unless the secondary is well above the primary water, so that you have a surface for condensing the water.

j-26-4

A Right.

Q Correct?

A Correct.

Q Now, what you are telling me, however, is that by simply shoving the primary water up into the tubes, you say, well, this is going to get closer to the top, you will get some turbulence, and we will condense this thing, and so you will get a pass through your hot leg. But to me, this is a contradictory situation from what you were telling me before, that you do not get much more condensation -- you don't get much condensation, just on the water on the tops of the tubes, but you've got to have water on the outside to give a condensing surface.

A I think the condensation that we are talking about, it is the primary cloud that is coming back up through the generator and condensing steam directly above it.

Q I know that is what you are talking about. What I'm saying is that in the condenser-boiler method, you were saying, okay, we want to get the level of the primary water higher, so that it flows over; you have to get the water level high enough so that it flows over.

A Correct.

Q And you are saying that the only way that we can

j-26-5

get fast enough condensation, or the best way in order to get fast enough condensation to do this, is to have a secondary level, which is much higher than the primary, so that we have a large surface for condensation, which is the inside of the tubes.

A Okay.

Q Okay. Now, what you are telling me is that this method of EG&G, all it does is move the primary water up higher, and you would say that gives a better opportunity for it to condense.

Now, to me, that sounds contradictory to what you are talking about being able to get out of the condenser-boiler.

Mr. Jensen, have you got an idea on this?

A (WITNESS JENSEN) I have a few ideas. I don't know whether it will help or not, but in the EG&G calculation, there was about twice as much water remaining above the core than in the B&W calculation.

This may result from the fact that the power level was more, and more ECC water was being added because it was plant specific for TMI-1. So I suspect that there was much less steam in the top of the candy canes than in the B&W case, and it was my understanding that as this column of water was pushed up, cold water was pushed up through the steam generator tubes, that it condensed the

bubble at the top of the candy canes, which was acting to block natural circulation, and then momentarily, permitted single-phase natural circulation to occur for a short time.

Q I don't see the difference in why this water has been condensed with steam than it could in the boiler-condenser mode.

A I guess what I was trying to say is that there was less steam in the loops and more water in this calculation than in the B&W calculations. The fact that natural circulation was lost, after it was lost, it didn't take much to restore it again.

And so it was kind of a time when natural circulation perhaps was almost lost, and then not very much condensation had to occur to get it back again.

Finally, it was lost --

Q Well, I must say that I just don't understand the logic in this EG&G calculation when I compare it to what I see as being the physical situation in that condenser, particularly, the volumes of the cold leg compared to the volume of the steam generator, the amount -- therefore, the amount at which that water can be raised, and then looking at the calculations and so on for condensation on the boiler-condenser mode.

To me, the two don't match up, particularly

when you are having to shove that steam through a fairly large flow of HPI.

A I did make a comparison between the HPI flow and the steam that would be produced by the core, and the core would produce more steam than could be condensed in the HPI water.

Now, finally, if you will look at this EG&G procedure curve, at about 3000 seconds, the primary system pressure remains --

MS. WEISS: Can you tell us what curve you are looking at?

WITNESS JENSEN: Wait. Wait, excuse me. This is Figure 7-1. And finally, the reactor system pressure remains relatively constant, indicating that all of the heat -- all of the core heat is being removed by the break and by condensation in the water, condensation in the ECC water.

So, early on, there was not enough ECC water to condense all the steam, but as the decay heat decreased, then less steam was produced, and finally it could be condensed in the ECC water and removed from the break.

BY JUDGE BUCK:

Q Well, I just wonder whether their interpretation of their curves is correct. That's all.

That's all I have.

JUDGE EDLES: Dr. Gotchy.

XX BY DR. GOTCHY:

Q I just have a couple of questions along that same line, now.

Correct me if I'm wrong, but the pressure has to be higher above the core than it does in the downcomer area in order for the internal vents to open; is that correct?

A (WITNESS JENSEN) Yes, that would be the case. They would be higher above the core because of the steam production, and it would take a very small amount to open the vent, just a a fraction of a pound per square inch opens these vents.

Now, the pressure around the location of the injection nozzles would tend to be lower because of steam condensation.

Q It just seems strange to us, I guess, that you would have this large mass of water in the primary size of the steam generator that is heavy and another volume of water in the core which is heated and is less dense, that it would be easier to push the more dense cold water up by pushing water back through the cold leg than by pushing water around the hot leg.

A There must be a lot of water in the hot leg, too. Probably a small bubble at the top of the candy cane.

So it is a fairly delicate balance, perhaps.

JUDGE BUCK: Again, it seems to me that what you are saying is that the EG&G calculation almost depends upon the water -- there being water in the hot leg over by the steam generator, which is just lapping against the top of the U-bend.

WITNESS JENSEN: I'm not sure exactly where the level is, but I do know there is about twice as much as predicted by the B&W calculation.

XX BY JUDGE BUCK:

Q For the TMI case specifically?

A (WITNESS JENSEN) The B&W case was the generic case which had the higher power level, and the ECC flow, where the EG&G case was the power level -- the ECC water was specifically for Three Mile Island Unit 1. So the conditions were somewhat better, and I'm not surprised there was more water in the EG&G case.

Q You are talking about HPI injection now?

A More HPI injection in the EG&G case.

Q What was the HPI injection that EG&G calculated, or estimated was coming in here? Or what was their input for it? Let's put it that way. Was it low?

A The EG&G case had a fairly high HPI flow. It was based on the numbers from the restart report which were given to EG&G from GPU.

j-26-10

The B&W calculation had a lower ECC flow. Both of the flow rates are a function of pressure, where you would get -- whereas, if the pressure increases, you would get a lower ECC flow.

Q When you say you had water in the hot leg above the steam generator, is this just a slug of water that is trapped there?

A I don't know. I speculate there was water in the hot leg, and so that the bubble in the top of the U-bend was relatively small, and I feel that because, again, there was a lot more water in the EG&G case. So I suspect there was some water in the hot leg.

Q. Then you are assuming that this steam generator is full, the primary side is full?

A. It was probably fairly full except for the location around the top of the U-bends, which would blcok natural circulation.

Q. You are saying, then, that the only gap -- the whole steam generator above the primary tubes is full of water?

A. A condition to block natural circulation would be if the hot leg were completely full of water up to the -- from the vessel to the top of the U-bend, and if then there were a condition of steam between the top of the U-bend down to the top of the steam generator tubes. That much would probably block natural circulation, because there would not be a sufficient gravity head to push the water up over the hot leg U-bend, and I don't know exactly how much water there was in the EG&G case.

Q. What I don't understand is how you can have water on the steam generator side of the hot leg and not have it in the top of the steam generator.

A. Well, the hot leg goes up for, from the vessel, it rises in the air about 50 or 70 feet or so, and then there is a U-bend, and it then goes down before it ever gets any -- before it reaches the steam generator.

Q. I know that. It goes down into the steam

generator.

A. In this downpath, which is 10 feet or so, if steam would form in this location, this would be what would block natural circulation.

Q. What I'm asking is, the steam generator water is below the top of the steam generator tubes; okay? How can you have water in the hot lets, in the steam generator side of the hot leg?

MR. CUTCHIN: Dr. Buck, would it be helpful if we could look back at the figure that was put into the record yesterday, showing the relative elevations? I'm not sure that would help, but it may help.

JUDGE BUCK: I've got a figure here which I think is fairly accurate. My memory is, speaking only about the hot leg, you go up over the U-bend, and you drop directly down into the top of the steam generator; is that correct?

WITNESS JENSEN: Down into the steam generator, but you don't hit the tubes for several feet. I don't remember the exact number.

BY JUDGE BUCK:

Q. That's right. There is a plenum in there before you get to the top of the steam generator tubes; right?

A. (WITNESS JENSEN) Right.

Q. Now, what I'm asking is, if, say, the water in the steam generator, the top of the water in the steam generator is at the top of the tubes, the steam generat . tubes, how can you then have water in the steam generator side of the hot leg?

A. The steam generator side of the hot leg?

Q. Yes.

JUDGE GOTCHY: Could I ask a question?

JUDGE BUCK: Sure. Go ahead.

JUDGE GOTCHY: If I understand what you are trying to say, there is part of the hot leg coming from the reactor vessel a body of water, a slug of water trapped in that hot leg. It does not go all the way up to the candy cane. There is steam on both sides of that slug, in the top of the reactor, and there is steam on the primary side of the hot leg; is that right?

WITNESS JENSEN: Possibly that could be the case.

BY JUDGE GOTCHY:

Q. How else do you get steam into the internal vent valves in the top of the reactor, into the downcomer area? There has to be steam in the head of the vessel?

A. (WITNESS JENSEN) Yes.

Q. And you are saying there is steam on the steam generator side of the candy cane. If the vent valves are working correctly, as I understand this design, the level

in the primary side of the steam generator should be approximately the same as the level in the reactor vessel; is that right?

A. The level on the primary side of the steam generator -- yes, and the only difference should be the difference in gravitational head, because the water in the steam generator would be denser than the water in the core and the hot leg. So with those gravitational heads taken into account, the vent valves should equalize the pressure between the cold leg and the reactor vessel upper plenum.

Condition for which natural circulation would be lost would be if the sum of the gravitational terms between the bottom of the steam generator up to the top of the hot leg, including cold water in the steam generator, and including a bubble that might be trapped in the back side, I call it the back side of the candy cane, if that were equal to the elevation head of hot water, in the hot let, plus the core, including any bubbles that would be trapped in the hot leg or up above the water in the hot leg, if these two balance, then there wouldn't be a natural circulation flow.

JUDGE BUCK: That's all right. I'm going to give up on this thing and let it go.

As I understand it, I just do not understand how this whole thing is physically possible.

BY JUDGE GOTCHY:

Q. I have just a few questions left.

Let's go back to page 6 for a minute, where you talk in the middle of the page there -- I just want to make sure I understand everything you are saying.

You say the system must eventually drain down and the steam condensing surface in the steam generator would be exposed before the core could begin to uncover.

Once the steam condensing surfaces are uncovered, boiler-condenser circulation would commence, and the pressurizer system would increase the HPI, flow would result in a net inventory increase in the primary system before the core could begin to uncover.

The question I have here is, after you have exposed the steam condensing surface, would the subsequent depressurization and inventory recovery from increase to HPI injection eventually lead to a loss of condensing surface in the steam generator as the primary system is refilled?

A. (WITNESS SHERON) The answer is we are not sure.

Q. Okay.

A. That was one of the concerns I think that was in the document which Ms. Weiss passed out earlier, which was a letter that was from Mr. Eisenhut to -- who was it?

MS. WEISS: Mattimoe.

WITNESS SHERON: One of the concerns was the long-term hydraulic stability, is there such an animal.

BY JUDGE GOTCHY:

Q. I see. What we were speculating on here was whether you wouldn't get kind of a cycling with a kind of dampening function with the system becoming more stable through each one of these cycles until you reach a stable situation?

A. (WITNESS SHERON) That was exactly the concern that was pointed out in that memo.

Q. I guess the bottom line is, are you convinced that if such a thing did occur, that at the worst, if you got this condenser-boiler cooling, that you would have a neg gain in cooling, not a net loss?

A. I think if you looked at the Board Notification back last summer where we attached the memorandum to Henry Meyer, our explanation at that point was that we tried to bound the scenario by assuming the steam did not condense at all as you refilled the system, covering the condensing surface.

Obviously as you are refilling the system, if all of the steam above it condensed at 100 percent efficiency, you would quickly restore natural circulation and everything would be fine.

Q. Single phase, right?

A. Yes. If the steam had a very, very slow rate of condensation, and then the limit didn't condense, which is really not possible, but for this scenario we could assume that, what would happen would be you would refill the system, you would cover the condensing surface, but because of this steam bubble trapped at the candy cane, which for some reason wasn't condensing, would not allow restoration of single-phase natural circulation. And as I say, you would create a situation where you would lose your heat sink, system would repressurize, leak would increase, the level would drop down, you would reestablish a condensing surface, you drop the pressure. Theoretically it would just continue to cycle indefinitely.

Q. There would have to be dampening some way, because decay heat --

A. Well, decay heat is dropping off. Each time you did it, you would obviously condense some steam, if not all. So there would be a continual condensation and there would probably be some sort of a damped oscillation or what might happen is that you would achieve some sort of an equilibrium situation where you just maintained an inventory in the system necessary -- you know, it would be a very, very slight oscillation. Again, we don't know exactly how the scenario would evolve.

Q. Okay. On page 8 of your testimony, starting at

top paragraph, the top of that paragraph, I guess what you are saying here is that -- doesn't this depend, at least for number 2, that you have a condensing surface, and that the steam generator is, say, at 95 percent of the operating range, or can you do this at 50 percent?

A. Yes. This assumes that either the secondary level has been raised to the 95 percent elevation, or that one has spray going in.

Q. Thank you.

MS. WEISS: Mr. Chairman, could we go off the record for one second?

JUDGE EDLES: Let's go off the record.

(Discussion off the record.)

JUDGE EDLES: Back on the record.

BY JUDGE GOTCHY:

Q. On page 17, where you refer to figure 7-5 and 7-6, I guess this runs out to about 30 minutes before you get emergency feedwater initiated, and with one motor-driven emergency feedwater pump started, wouldn't the steam generators be totally dry at that time?

A. Yes. They were totally dry.

Q. With RELAP, how do you get this depressurization that you show on 7-5 if you don't get -- I'm trying to figure out how you are getting cooling there. I guess the only way that the RELAP gets cooling is when you get

some pool boiling on the secondary side of the steam generator.

Do you assume that none of this evaporates; that it all immediately goes to the bottom of the steam treader, so you start to get pool boiling immediately?

A. (WITNESS JENSEN) I think RELAP calculated that all of it evaporated up at the top of the steam generator, and calculated that none of it fell and formed a pool during this time.

Q. I thought RELAP didn't take into consideration the effects of the spray, the emergency feedwater spray.

A. Yes, sir, it does.

But it calculates how much of the tube surface is wetted and it calculates the heat transfer coefficient.

Q. Okay. On page 20 -- I remember that yesterday Mr. Jones was talking about 115,000 cubic feet. Was that a condensing surface, and was that different from the heat transfer surface you have of 236,000 square feet? There is a factor of two differences there.

I'm trying to figure out what the difference is between those two values.

A. I think both of us were talking about the total heat transfer surface of the steam generator, of which we were going to calculate what fraction was available. And my calculation were both steam generators,

27a10

whereas Mr. Jones was just for one generator. So mine is about twice as big as his.

Q. He's nodding his head yes. So I guess the answer is yes. Thank you.

JUDGE EDLES: We will consider that nod under oath.

JUDGE GOTCHY: I guess that is all I have.

JUDGE EDLES: Okay. We will take a ten-minute recess, and I'll have our office contact Dr. Ornstein.

(Recess.)

JUDGE EDLES: Please be seated.

Thank you.

Any further questions for these witnesses, Mr. Cutchin?

MR. CUTCHIN: None from the Staff, sir.

JUDGE EDLES: Any further questions?

MS. WEISS: Mr. Pollard just had one question to explore the scenario a little bit further.

JUDGE EDLES: If it is only one question, okay.

XX BY MR. POLLARD:

Q Dr. Sheron, when you were discussing with Dr. Gotchy this phenomenon where, as the boiler-condenser mode was working, that would cause depressurization, increasing HPI flow, covering the condensing surface and so on, and I think you said you didn't really know that scenario exactly. Is it not possible, then, that you don't know whether in this course of losing the condensing surface, repressurizing and gradually refilling the system you might not at some point wind up in the feed and bleed cooling mode?

Perhaps I can explain why I think that might occur.

As I understood your discussion with Dr. Gotchy, as these oscillations would be dampening out, you would be slowly refilling the system. At some point, now, we've got

the water level up so that it is practically full of liquid again, and I just thought, isn't it a possibility that at that point, you might wind up in feed and bleed, rather than reinitiating the boiler-condenser mode?

A (WITNESS SHERON: I don t think so, becuase, as the system repressurizes, you still have your hole in the system, though the leak flow is going to exceed the HPI flow, which is mostly liquid, which is the case you are referring to. So you would probably, as you repressurize, you would start to lose inventory rather quickly during this repressurization process. And then you would drain down and establish the condensing surface.

Again, we don't have any calculations to substantiate this oscillation, or potential oscillations. So, again, you know, I'm speculating on that whole end of the scenario.

JUDGE EDLES: Thank you very much.

Dr. Sheron, Mr. Jensen, thank you very much for your testimony. You are excused.

Would you please ask Dr. Ornstein to come in, please. He's seated outside.

Dr. Ornstein, when you get settled, you can come forward and take your place at the witness table, please.

If you will remain standing for one minute,

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let me swear you in.

Whereupon,

HAROLD L. ORNSTEIN,

called as a witness on behalf of the Intervenor, being first duly sworn, was examined and testified as follows:

JUDGE EDLES: Let me thank you very much for your patience over the last week or ten days. The Board appreciates that very much.

DIRECT EXAMINATION

XXX

BY MS. WEISS:

Q Mr. Ornstein, I'm going to show you a copy of a document, one page, labeled "Professional Qualifications of Harold L. Ornstein."

I've given the reporter a copy. Was that prepared by you?

A Yes, it was.

Q Is it a correct statement of your qualifications?

A Yes, it is the same as what I submitted, yes, it is.

Q Would you read it over and check and make sure it is.

A (Witness complied)

That is correct.

Q Thank you.

May we have that bound into the record,

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Mr. Chairman.

JUDGE EDLES: In the absence of objections.

XXX (The document referred to, Professional Qualifications of Harold L. Ornstein, follows.)

PROFESSIONAL QUALIFICATIONS OF

HAROLD L. ORNSTEIN

I am a Lead Systems Engineer at the Nuclear Regulatory Commission Office for Analysis and Evaluation of Operational Data (AEOD). I am currently in charge of reviewing event reports and other information relating to nuclear power plants of the Babcock and Wilcox design.

I received a BME degree at City College of New York (CCNY) in January 1961, a MSME degree from Rensselaer Polytechnic Institute (RPI) in February 1966, and a PhD in mechanical engineering from the University of Connecticut in June 1971.

I am a Registered Professional Engineer (New York State).

I have been employed at NRC since 1975. My assignments have included assessing the safety margins which were available during the Browns Ferry fire and preparing testimony on the fire for the Joint Committee on Atomic Energy. I also served on the NRC's Special Inquiry Group on the Three Mile Island Accident (Rogovin Report).

Prior to employment at the NRC, I served as a reactor engineer for the Atomic Energy Commission's Fast Flux Test Facility project (1971-1975).

Previous employment (1961-1971) included Senior Analytical Engineer at Pratt and Whitney Aircraft; Research Specialist and Instructor at the University of Connecticut; and Assistant Director at the New England Research Application Center (NERAC).

BY MS. WEISS:

Q Mr. Ornstein, you have been asked to appear here today to give the views of AEOD on the efficacy of boiler-condenser, feed and bleed, among other things.

Would you describe for us, please, what AEOD's mission is in NRC.

A Sure.

JUDGE EDLES: Dr. Ornstein, could I ask you to sit a little closer to the mike. Sometimes it is hard to remember that, but it makes it a little easier for us.

THE WITNESS: Essentially, the Office for Analysis and Evaluation of Operational Data was established by the Nuclear Regulatory Commission in order to try and review operational data, experiences, associated within nuclear power plants, and to see whether or not there are certain indications that are available from the operational data which will help us to improve the safety of the plants.

BY MS. WEISS:

Q Was the office established after the TMI-2 accident?

A The office was originally established subsequent to the TMI-2 accident. It took quite a few months from the time of the accident until it was fully established with a

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permanent director. However, it was in operation sort of with a temporary, or acting director, originally. But that is correct.

Q Could you describe for us the link between the TMI-2 accident and the establishment of your office.

A Well, the office, as I said, was put together subsequent to the TMI-2 event, and it was recognized by many people that there were previous events that occurred at nuclear power plants, which were not examined in any great deptch or detail to give us the outlook or enable us to determine that certain modifications could be made to the operation of the plant, or the design of the plant in order to enhance the safety of the plant.

Essentially, there was a licensee event reporting system which was available, and still is available, in which there were somewhere in the area of approximately 3,000 licensee event reports, that were submitted to the agency, and prior to the establishment of my office, there was no systemized method of going ahead and looking at this data and being able to feed it back into the operation of the plants.

I guess I am remiss in not emphasizing the fact that as part of our office's mission, is to go ahead and try to go through -- not try to, we do go through all

these licensee event reports, which are now probably going to be pushing 4,000 per year as times goes on, as we get more plants coming in. But basically, that is what we have been doing, and that is what our function is.

We are presently looking at ways of changing the method in which LER's are written, what they contain, how they are cataloged, how they are retrieved, and, of course, we hope that the idea will be to enhance reactor safety.

JUDGE EDLES: Dr. Ornstein, can I ask you again to push the microphone up. This is a tough forum here. Sometimes it is difficult.

Thank you very much.

THE WITNESS: Okay.

BY MS. WEISS:

Q I'm sure that you must have a copy of the memorandum dated June 2, 1982, from C. J. Heltemes, Jr., Deputy Director, Office for Analysis and Evaluation of Operational Data, for Gerry Mazetis, Section Leader, Section C, Reactor Systems Branch.

A Yes.

Q June 10, 1982.

A Yes.

MS. WEISS: I would ask that that be marked for identification UCS 53, please.

XXX

(The document referred to was marked as UCS Exhibit No. 53 for identification.)

BY MS. WEISS:

Q Are you the author of that memo, Dr. Ornstein?

A Yes, I am.

Q I want to begin by directing your attention to page 2.

A Can you hold on a minute, and let me get my copy.

Q Yes. If you can't find it, I have extras.

A Okay.

Q On page 2 of the memo, Item No. 4, "We believe that the conclusion 'If the feed and bleed process discussed above was insufficient to remove decay heat, natural circulation would be established in the boiler/condenser mode,' is not a certainty, especially in the absence of experimental data for B&W plants. In the event that, for any reason, natural circulation cannot be established and the primary coolant pumps are not available, the 'feed and bleed' mode of decay heat removal would have to be used."

My question is, if you, please, would summarize for us all of the concerns that AEOD has with regard to reliance by NRC on boiler-condenser mode for mitigating

Small-Break LOCAS.

A I think the answer to that question is, partially, or maybe entirely, listed on Item No. 7 on the same page.

Essentially, what is behind this statement is one in which we say, hey, we have seen a lot of analyses which seem to have a very important or high degree of sensitivity to the input parameters. If you had gone ahead and analyzed a break of one-inch pipe, you get one thing; if you've got a two-inch pipe, you've got something different. On a square-footage basis, you are talking about .005 square feet versus .01 square feet. You have a great deal of sensitivity associated with the amount of fluid in the steam generators, the amount of high pressure injection pumps you have, your flow rates, starting conditions, temperatures; we get pressures, we get decay heat. There is a great deal, or a large number of parameters which are varying, and you go ahead and do an analysis of a particular point, and a particular code tells you one answer, and then I guess at the time in which we had received the original draft memo to comment on, there were some things that were fresh in our mind; namely, the fact that there were some analyses done where there was difficulty in trying to eliminate the steam void in the candy canes.

I guess it was Los Alamos had done some work, and some of the things that we were told is that, well, the core will still remain cool, even though we cannot re-establish natural circulation, but one of the reasons why this is happening is because we have two high-pressure injection pumps instead of one high-pressure injection pump going.

Rather than rambling on, the point that I'm trying to get to is the fact that in theory, we could understand what is being postulated here on how the steam would have to go this way and that way, and how the introduction of liquid into the steam would cause condensation, and then a depressurization. But we are a bit uncomfortable from the standpoint that we had not really in front of us seen a demonstration that would say, this will happen.

But even if we do have a demonstration of one particular case, with one given set of parameters, that doesn't tell us that we know it will happen if we had a break twice the size, or half the size.

There is a very large spectrum of tests that one can do. We are saying that we think we understand what you are telling us; we think you should not say immediately that we can, or at least give the impression that we can always establish this kind of cooling, and the

bottom line to our memo which, unfortunately, I get the impression you have only seen the final report that the Staff produced, and the comments, but the original memo was what we were looking at, and the final memo that was put out by Mr. Denton, or which was given to Mr. Denton by Dr. Mazetis, did indeed incorporate many things that we happen to have been very strong advocates of.

In particular, there was a recommendation for future work which was pushing towards getting data, experimental data, to try and help us. Again, we have codes. The codes tell us some things.

We look at the tests as assisting in the code verification, and there are many other aspects of experimentation. But basically, we were saying that, you know, seeing is believing.

Q. Why are you concerned with having confidence about how the plant will behave over the spectrum of small breaks?

A. Well, first of all, can you give me more of a lead into what you are trying to ask? I think that question is very broad and I can give you many hours of an answer.

Q. I was trying to pick up on what I thought I heard you saying in your first answer, which was that there is a substantial spectrum of breaks involved, lots of different input parameters, lots of different computer codes, which have been run on one or two breaks, and you get different results, and that you were concerned because you can't really tell from this agglomeration of computer analyses which use different codes how the plant will in fact behave over the spectrum of Small-Break LOCAS.

Is that correct? I don't mean to say that that summarizes everything that you have said, but is that a correct summary of at least part of your answer?

A. Part, I would agree.

Q. My question to you was, why is it important to know how the plant behaves in the view of AEOD?

A. Well, let me try and clarify AEOD's role in this particular issue.

AEOD is not in the licensing arena. AEOD is evaluating information that is available.

Now, we had been asked -- or at least Dr. Mattson had been asked to obtain AEOD's views on the issue of feed and bleed cooling at TMI-1 as it was being handled in a restart hearing.

If you recall, you and Bob and myself met with Mr. Michaelson, Mr. Denton, Mr. Cunningham, who I believe is the head of OCS, OC, and Dr. Meyers, who works for Morris Udall, and we sat down in front of Dr. Meyers about a year plus ago and we were talking about the same issue, and the issue was raised, I believe, by you and Dr. Meyers. And you people were of the impression that UCS was not getting a fair shake by the Board with regard to how feed and bleed cooling was established.

Now, Mr. Denton, I guess, was very much impacted -- I shouldn't say impacted -- very much impressed by this particular hearing that we had, a formal hearing, and as a direct result, he went back to his staff and said, hey, I want you to tell me what is going on; and when you do so factor in AEOD's views.

Now, normally, AEOD does not get involved in this kind of thing, but because of those circumstances, we did.

Q. Okay. I understand that AEOD takes no opinion on licenseability --

A. Let me clarify that. AEOD may have an opinion,

but AEOD does not grant licenses. We do not rubber-stamp things that other offices do and vice-versa. We are supposed to be an independent office within the agency.

Q. Right.

A. Whether we are a gadfly or whether we are a pain or whether we make good sense, that is up to the individual to decide.

Q. And we are interested in AEOD's technical views here, and I will not be pressing you for any opinion on licenseability. I don't think it is particularly relevant, anyway.

A. Well, the thing I believe, you understand, is that licenseability is not our bag.

Q. Exactly.

A. Okay.

Q. And I don't want to ask you about that.

A. And my opinion is not what you have asked for. You have asked for AEOD's opinion, collectively, or whatever, and I have had discussions with our former director, our present director, and our branch chief, and I can say that the opinion of the office, if you call it such, seems to be invariant between the time when this memo that I drafted that Mr. Heltemes signed to present remains unchanged.

Q. Okay.

The question that I asked is for AEOD's views on why it is important to have confidence for the spectrum of Small-Break LOCAs that we understand what is happening in the plant system.

A. Well, I'm trying to think of a simple analogy that might help you in answering that question. That is, you have a typewriter and you have as many words come out of the typewriter as you can hypothesize small breaks coming out of the nuclear power plant. If you know the mechanics of the typewriter and you know the ground rules under which it is going to work, you can pretty well bracket what you expect to come out of it. And I think on small breaks and big breaks we have a similar analogy where, if you think that you understand the physical phenomena and you think you have bracketed it from the standpoint of what may be the worst situation, you don't have to go ahead and type out every word, and you don't have to analyze every single potential break that there is. And the name of the game is to understand better than we might presently understand.

That is not to say that we are ignorant. We have a great deal of analysis. We have a lot of single-effect tests that have been performed which help us to understand what happens, and we have again different codes, different noding, different alot of things. And if we can put all the stuff in and keep on getting something out that is

understandable and meaningful, and the results are favorable, then we are in a fairly good position. And basically that is about as close as an analogy, for example, I think I can give you to try and get you to understand what the answer to that question may be and how we fit into it.

Q. I kind of envision it as an interdependence between the codes and our understanding of the physical behavior of the plant; that if one -- if the codes predict behavior in the plant, which makes sense, because as compared with results of tests that we have done, or observations in actual plants, or just plain physical sense, then the codes begin to confirm themselves.

A. Well, you see you have a problem here. You can take the same problem, use five different codes, and get five different answers.

Q. Exactly.

A. And the thing is if all the answers keep on telling you it's okay, that is a lot different than if two say it's bad and three say it is good.

Q. What if one of the codes predicts, in the course of predicting thermal hydraulic responses which get us to core cooling eventually, it predicts plant behavior which has never been observed and is inconsistent with the plant behavior predicted by the other codes?

Can that code's results be used to confirm the results of the other codes which are predicting entirely different plant behavior?

A. Well, for the hypothetical case that you have given, the first thing that we would do would be to look at the results of the outlier and see if there is a reason for it, whether someone put in an input decimal point in the wrong place, as I have seen many times, whether or not there is some phenomena that this particular code is taking into account that the others aren't, or vice-versa.

It is a question of going ahead and doing a quality assurance check on it, and doing a thorough elevation to see if you can spot the difference. I mean, four codes can be wrong if the fifth code models it right.

For example, the pre-TMI work, I guess there weren't too many PWR codes that took boiling into account in the core, and if you went to the simulator down in Lynchburg and you tried to run the TMI accident, you got a surprise. It didn't work out the way it happened.

Q. Until that sort of quality assurance detailed evaluation was done, and one comes up with some explanation for why the difference in plant behavior has been predicted, until that is done, do you think that this outlier can be used to confirm the results of the other codes?

A. Well, until you can account for your outliers being good or bad, you have to treat it with respect.

JUDGE EDLES: Dr. Ornstein, I don't think I understand what you mean by "treating it with respect."

THE WITNESS: You can't throw it away as being useless, and you can't say everything else is all wrong because that one is right.

BY MS. WEISS:

Q. You just don't know?

A. You have to think about it some more and you have to look a little bit further to see what the anomaly is.

Q. Can I direct you to item number 7 on page 2 of the Heltemes memorandum that has been marked UCS 53 for identification.

A. Sure.

Q. You are talking about the section of the report which includes the recommendations for the future.

You say, "We agree with the need for obtaining experimental verification of the analytical code predictions. We believe that this section of the report should be expanded to clarify the items for which verification is considered appropriate or necessary. In this regard, consideration should be given to (a) natural circulation in B&W plants, including establishment of boiler/condenser operation and elimination of steam formations in the hot

legs; and (b) the ability of existing PORV and safety valves to perform reliably in a 'feed and bleed' mode."

Can you tell me if the changes were made that you recommended?

A. Well, I can take a look at that particualr section and see what it says and see what the first one said. But if my recollection serves me right, they did say that additional verification, additional experimentation should be done. I don't believe the entire gamut of these items and many others that I discussed with Gerry Mazetis on the phone, and Walt Jensen when we were talking about it, were all included. But let me check.

(Pause)

The intent of the comment seems to have been cut, and there were some changes here. As I said before, we found that the final document served the purpose of going ahead and explaining what the story is, and even though it did not get into a six-page treatise on the details necessary, the fooling was that it was pretty well-captioned here.

Q Could you tell us, please, what are the specific items which AEOD believed verification was appropriate or necessary?

A I don't know about the word "necessary," and necessary for what. Once again, remember, we are not saying anything about what is necessary for licensing.

We are saying in order to understand the phenomena, and to be able to predict how things will happen over the wide range of possibilities, we should understand what we have.

Now, we wanted to understand more about the stoppage of natural circulation; we wanted to know more about the re-establishment of circulation; we wanted to know more about how the operators would be able to determine where they were and what they had to do.

Now, as you are aware, there are many issues in the licensing arena that involve this, as well. We

were just looking at it from understanding the machine and resolve any postulated event in the system.

Essentially, what I'm saying is, a better understanding of what is happening, a better understanding of the physical principals and hypotheses that we had of how things are going to condense and how things are going to expand, this kind of thing, and when the flow is going to go up to a hot leg and go down to a cold leg.

Q Okay.

With respect to the B portion of that item No. 7, where you are discussing the need for obtaining experimental verification of the analytical code prediction --

A Wait a minute. B section says --

Q No. I'm still at 7.

A Yes. B in mine says "the ability of existing PORV and safety valves to perform reliably in a feed and bleed mode."

Maybe the court reporter can read back what you said.

Q I read verbatim from the first sentence in the paragraph. "The need for obtaining experimental verification for analytical code predictions" -- is that the first sentence in the paragraph?

A Right. I was looking at B, right at the bottom.

Not looking at the top of that same paragraph.

Q Okay. And we just discussed how that relates to the first issue, which is natural circulation, boiler-condenser. The second issue, you are right, B, the ability of the existing PORV and safety valves to perform reliably in a feed and bleed mode.

Now, what experimental verification were you thinking of relating to the ability of existing PORV and safety valves to perform reliably in a feed and bleed mode?

A Well, in accordance with NUREG-0737 and in accordance with maybe other specific documents that the Commission has published, we felt, and I believe the Commission felt, that some data should become available, or should be available, to tell us about these things that we use during feed and bleed.

And at that point in time, the EPRI test program was either gearing up, or was actually ongoing, and again, we are giving an extra push saying, hey, we think that, you know, we need this kind of data.

We did not specifically say, you have to do something more than EPRI tests, but just said something should be done, and something was being done.

Q Is it AEOD's view that the ability of existing PORV and safety valves to perform reliably in a feed and

and bleed mode has been established?

A I cannot answer that question for two reasons. First of all, I've got some peripheral exposure to the EPRI tests. I have been looking at PORV's and safety valves in operation with liquid from a different standpoint back in 1977 or so, when I was looking at the ATWS.

Under those conditions, the first question you had is how these valves perform when you have liquid going through them.

As you heard very well, the way I did yesterday, or maybe it was last week -- I'm a little fussy, Mr. Lanese, and the other gentleman from GPU had talked about those tests. The important thing with the safety valves that we knew, and I believe some B&W Licensees have submitted to us in the past, was the fact that they were not designed for the flow of single-phase water through them, and the manufacturer, Dresser, said point-blank that they will not guarantee those things for water operation under any conditions.

So, with that in mind, it is very difficult to say that, hey, everything is going to be great, we are going to use a particular flow Delta P calculation, and it is going to work.

We just, you know, said, there is more to it than that, and as far as we are concerned, testing would be

needed to verify something that the manufacturer was not going to verify.

Now, I have not been following all the EPRI work. I've heard bits and pieces the way you have. I have seen volumes. And I've heard different people come up with different assessments, but I cannot come up with any firm conclusion other than the fact that the experts in this area seem to feel that, if you use the valve in a particular situation, and you make whatever modifications may be necessary on the upstream piping, and if you go ahead and set your settings properly, you stand a good chance that the will work okay, as has been established on some tests.

Q When you refer to the experts, are you referring to Mr. Correa?

A I don't know Mr. Correa. In my office, there is another person who is very much involved on the mechanical tests, mechanical equipment. In the agency, there is Frank Churney, who, I believe, is in charge of it, or other people.

As I say, I'm only one person in a small office, and I look at certain things. I looked at the valves and said, hey, that is a problem. That, I recognize.

I also recognize that we have experts who are involved. You mentioned the name of one person in GPU.

I mentioned the name of a couple of people at NRC. These people, as well as those who were down at Huntsville, and down at, I guess, Duke, who are doing work, are the ones who are getting us the data.

I'm a mechanical engineer, but I'm no valve seat expert, as some of these other people may be.

Q Well, would you agree that -- strike that.

As of the 10th of June, at a-y rate --

A Of 1982.

Q Of 1982, which is the last 10th of June there was, was it AEOD's view that there was a need for obtaining the experimental verification of the ability of the PROV and safety valves to perform reliably in feed and bleed?

A Well, I would have to temper that a bit.

I think I did say "and/or." I could be wrong. But essentially, there is some question as to whether it may be a safety, or it may be a PORV, or it may be both.

Q You said "and," but if you want to change it, that's okay.

A Well, that is for clarification, anyway.

Q And my question simply is, is that your position, AEOD's position today, so far as you know?

A I could honestly say that AEOD and people in AEOD have not gone ahead and evaluated the results of all the

EPRI test s to come up with any conclusions. The statement that we made back in June said work should be done. We think it is necessary. I don't know that we have come up with a conclusion. I don't know that we have been asked to.

The think is, I got the impression that this is a very large ongoing problem. But the important thing that I should mention about AEOD, which you may be missing, not because of any fault of your own, but it is a fact that we try in my office to look at the things that most people aren't looking at.

In other words, if everyone is looking at these valve tests, and we think we have the right expertise working on it, we will go ahead and we will look for something else that may get by that other people will not even take into account. And we will probably get much better return on the investment.

Q Well, as a taxpayer, I appreciate that.

Can you tell me if AEOD has any other concerns about feed and bleed, other than the ability of the PORV and/or safety valves to perform reliably in that mode?

A I think the memo that Jack Heltemes had signed pretty well outlined the concerns. As I say, I cannot think of anything that we might have omitted on that.

Q Well, it is not self-evident from a reading of the memo exactly what you mean by some of these sections, so I thought you might just summarize for me today whether there are any concerns with feed and bleed other than the questions about performance of the PORV or safety valve.

A I don't think so.

I would like to raise one point that I did mention in the memo, on the subject of feed and bleed, which this might be very appropriate.

Again, I think in a way we went out of our way, and that is, Item 2 on this particular memo, where we talk about feed and bleed. I would like to read this and enter into the record one of our comments about the report was "Some of the scenarios discussed in the report assumed multiple failure events, safety grade systems. Usually, the Staff considers multiple act of failures of safety grade systems not to be sufficiently credible, but such failures need to be considered in the plant's design basis.

"Consequently, the reason for considering the complete failure of the auxiliary feedwater system, or the high pressure injection system should be presented in the report. That is, some discussion is warranted on NUREG-0737, Item I.C.1 - Guidance for the Evaluation and

Development of Procedures for Transients and Accidents, which requires guideline and procedural development to consider occurrences of multiple and consequential failures."

What we were saying is the regulations, as we understand them, don't require feed and bleed, but we ought to tell the people who are reading this memo why the Staff is going into it.

Q Isn't it AEOD's position with respect to the paragraph that you just read that emergency feedwater is such an important system, and it's availability is so crucial, that the current requirements in the standard review plan may be insufficient to ensure the appropriate level of reliability for that system?

A I'll have to back off on that.

You have a lot of questions in there. Maybe you can rephrase it. Maybe you can say it again, so I can answer it one at a time rather than a whole chunk at once.

Q Is it AEOD's position that the emergency feedwater is such an important system that it's availability is so crucial that current requirements of the standard review plan do not ensure a sufficient level of reliability.

MR. BAXTER: Objection, Mr. Chairman. It is my understanding from reading ALAB-715 that this witness was subpoenaed to present AEOD's views on feed and bleed,

liquid natural circulation, and boiler-condenser operations, and I didn't understand we were exploring emergency feedwater reliability, or the requirements for that system.

JUDGE BUCK: We are puzzled by the question, because this has already been treated here, except for the one thing that we didn't reat, of course, that you have objected to. But we have looked at reliability of the emergency feed and bleed.

MS. WEISS: Well, I asked the question, Dr. Buck, because we are exploring AEOD's position here. And I understand the witness' reason in directing me to Item No. 2, what he was saying was perhaps, in some respects, the Staff is being overconservative.

Now, bearing in mind that emergency feedwater is needed for boiler-condenser, since the witness volunteered it, I wanted to ask him if it is not in fact AEOD's position that it is not overconvservative to assume multiple failures in emergency feedwater.

JUDGE BUCK: Now, I believe you are getting into whether their opinion as far as licensing is concerned is an opinion with regard to licensing, and my understanding is that AEOD does not take positions on requirements or licensing.

MS. WEISS: I've handed the witness and the parties a document dated February 16, 1983, from

Carlyle Michelson, Director, Office for Analysis and Evaluation of Operational Data, to Harold R. Denton, Director of the Office of Nuclear Reactor Regulation.

BY MS. WEISS:

Q I would simply direct your attention to page 3. This is under the heading "Conclusions."

The paragraph begins, "The AFW system, in my opinion, is probably the most versatile and vital of the plant safety systems. It is typically used during normal plant operation, i.e., startup and shutdown, as well as in the mitigation of postulated events such as" --

JUDGE BUCK: Where are you reading?

MS. WEISS: Right under "Conclusions," page 3.

BY MS. WEISS:

Q " . . . main steamline break, small break loss of coolant accident, loss of feedwater, stem generator tube rupture, and loss of offsite power."

Continuing: "So crucial is the availability of this system during a loss of offsite power that it is required by the staff to have at least two full-capacity independent systems powered by diverse sources and is the only safety system designed to function during a total loss of AC, loss of offsite power and failure of the redundant onsite emergency AC power. Further, it is the only safety system for which a reliability analysis must

be performed demonstrating an unreliability in the range of 10 to the minus 4 to 10 to the minus 5 per demand."

Now, that is the opinion of Carlyle Michelson.

JUDGE BUCK: I don't understand, Ms. Weiss, what is the significance?

MS. WEISS: I think it can be taken that that represents the AEOD opinion. That description of the importance in the role of emergency feedwater.

MR. BAXTER: I do not accept that.

MS. WEISS: If one, then, goes to the cover page of this memo, where AEOD is analyzing the Fort Calhoun event -- I mean, the Fort Calhoun feedwater pump arrangement, Mr. Michelson says that this raises the question, in the second line of the cover sheet, as to whether these requirements are adequate and suggests that the present review plan be reviewed to determine if a additional guidance should be provided.

It is hard to summarize the whole document, but what this AEOD document does is, essentially, find that Fort Calhoun meets all the requirements but may still not be sufficiently reliable given its importance.

MR. BAXTER: Mr. Chairman, I don't know if we are ever going to get to a question here. We have left now emergency feedwater, which I had previously objected to, we have left TMI-1, and gone to Fort Calhoun,

which this paper is about. And on its very face, it says they have only done a limited survey of a couple of -- I can't imagine how we can get much further afield from the subject of this reopened proceeding.

MS. WEISS: The question was, whether it is AEOD's opinion that emergency feedwater is such -- the availability of emergency feedwater is so crucial to safety that compliance with a stancard review plan may be insufficient as a guarantor of its reliability for safety purpose, and I introduced this document only because the question was raised about whether AEOD had such an opinion, and whether they looked at these questions at all.

JUDGE EDLES: I guess I'm not clear how that relates exactly to the four questions that we are dealing with in the reopened hearing.

BY MS. WEISS:

Q Does the reliability of emergency feedwater enter into AEOD's views on the viability of boiler-condenser?

A Let me reiterate what I said before, and actually, add something else.

If you are talking reliability number, you've got the wrong person here. I can't tell you that 10 to the minus this is okay, and 10 to the minus that is not. As far as the reliability goes, we have several things that we

have to look at. Not only is there a question of losing it, there is also a question of how long it takes you to regain it.

There is a difference between not having auxiliary feedwater at the onset of an event, and then being able to re-establish it by some manual operations within a certain period of time, and in fact, for certain plants, you have certain amounts of time, depending upon the accident scenario.

Just to say that I have a 99 point whatever percent reliability and availability is only a small portion of the big picture.

As I said before, in Item 2 of Jack Heltemes' memo, we talk about the fact that we generally, or the Staff generally does not consider failures of reliable systems, and you have got to go ahead and make up your mind as to what is okay and what isn't.

Now, I have to go one step further and tell you that I have not read this section of the standard review plan that you referred to in the recent past. It has been quite a while since I looked at it, and besides that, I don't remember all the details. It would take me some time to go ahead and refresh my memory on it and read it to go ahead and answer a question.

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Q. The last question didn't ask you about the standard review plan. It simply asks you whether you make some assumptions about the reliability of emergency feedwater when you evaluate whether the boiler-condenser mode is a valid mode of core cooling.

A. Can you rephrase the question, please?

A. Oh, gee, what part of it bothers you?

A. Nothing bothers me. I just don't understand it.

Q. Assume for the moment that you are asked to make a judgment about whether NRC should place reliance upon the boiler-condenser mode to mitigate Small-Break LOCAS, and that is your judgment to make. This purely is a question of safety.

A. Yes.

Q. Does it matter to you in making that judgment how reliable emergency feedwater is?

A. May I ask you a couple of questions?

Am I able to depressurize the secondary system to bring in some other water system to give me feed?

Q. No.

A. Why not?

Q. Because I say so.

JUDGE EDLES: Counsel, are you just asking him whether in making his computations he assumes that the emergency feedwater is reliable?

MS. WEISS: What assumptions does he make about emergency feedwater reliability in evaluating the reliability of boiler-condenser.

JUDGE EDLES: Can you answer that question reasonably simply?

THE WITNESS: I may make it so simple that the answer is meaningless.

JUDGE EDLES: Well, don't do that, but try hard to make it simple so that even I can understand it.

THE WITNESS: Well, I have difficulty with the question as to reliable enough.

MS. WEISS: No, no, no. I didn't ask that question. Maybe we will get to that next.

MR. CUTCHIN: Is she badgering her own witness, Mr. Chairman?

MS. WEISS: I'm trying to make sure he understands what I'm asking.

BY MS. WEISS:

Q. Do you make some assumptions about emergency feedwater reliability if you are attempting to reach a judgment about whether boiler-condenser is a suitably reliable mode of cooling for TMI?

JUDGE BUCK: Wait a minute, Ms. Weiss. I'm not at all sure that AEOD makes a judgment on whether or not the boiler-condenser mode is sufficiently good or not good

for licensing.

As I understand AEOD -- and the witness can confirm this one way or the other -- what they do is to look at it and make judgments on how it works, whether it would work, how well it would work; but they do not then come along and say, on this basis it is good enough for licensing the plant or not good enough.

Isn't that correct?

THE WITNESS: That is true.

JUDGE BUCK: And I'm afraid the question that you are posing is asking him basically is this good enough for licensing.

MS. WEISS: I didn't mean to.

BY MS. WEISS:

Q. Are you ever asked by NLR to make recommendations on safety questions?

You were in this case, weren't you?

A. I'm not sure of the safety question per se.

In a broad sense I might say yes.

Q. Let's assume as a hypothetical that you got a memorandum from Harold Denton that said AEOD, I would like you to review for us the question of whether boiler-condenser coolinjg at TMI-1, using safety grade systems, is suitably reliable. That is your task.

Now, would you consider -- and forget about

licensing -- he doesn't ask you should we license it. He asks you, how do you feel about that from the safety standpoint? When you begin to answer that question, don't you make some assumptions about emergency feedwater reliability?

A. As I said to you before, you wouldn't allow me the ability to look at additional ways to introduce cooling water on the secondary side, and I would have to look at my defense in depth on the auxiliary feedwater side as well as my defense in depth on the primary system side.

Now, again, it is not just will the machine break. The whole way plants are built and analyzed and operators are taught to operate their plants is based on the assumption that something will go wrong; and we go ahead and we look to backups, and backups, more backups. And in answering the question that you posed hypothetically, I would have to look at what other things are available to the operator besides the main frame systems that you are talking about, the procedures that he has, the training that he has received, and the alternates that he has, and then going beyond that, the next question is, what can he do in the event that all hell broke loose and things made a mess; what could he do to protect the general public.

Q. Fine. I never meant to ask you whether that was your sole consideration. I simply was asking you whether

that was a relevant consideration.

A. It is one of many.

Q. Mr. Ornstein, at page 5 of your memo -- I mean, page 2, item 5 of your memo --

A. Jack Heltemes' memo.

Q. I thought you wrote it.

A. I didn't sign it on the page that you have.

Q. But you wrote it?

A. At least once.

JUDGE EDLES: The memorandum in question is the one you are talking about?

BY MS. WEISS:

Q. Item 5 on page 2.

A. Right.

Q. Would you read that over and summarize for me what your point was. That is, what AEOD's point was.

A. I'll read it.

"It is our understanding that the emergency guidelines (or emergency procedures) discussed in this section are not presently in place. Thus, it is important to provide a sense of timing regarding what is in place and available now (in terms of equipment, procedures, and training) and what is likely to be available at some specified time in the future."

I'll have to go back to the original on page 11

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that I was commenting on, and then compare it with what you finally have.

JUDGE EDLES: Is it possible, Dr. Ornstein, that the page 11 reference is to the earlier draft memo?

THE WITNESS: That is exactly what I'm looking at. Now I'm comparing it with the new one to see what kind of variations have taken place and then try to explain it a little bit better.

BY MS. WEISS:

Q. I just want to know what your point was, at least for this question, just with reference to the draft.

What was the point that you were making?

A. Well, you have asked me something and I wanted to see what I was talking about. I was not talking about the final report that you have. I was talking about an original draft.

Q. Right.

A. And I wanted to see exactly what the words were in that.

Q. Please do look at the draft.

All I'm saying, Dr. Ornstein, is: My question is, what was your point with respect to the draft? I'm not asking you right now whether the changes were made and whether they satisfied you. Just what was your point?

A. As I said, I wanted to look at the draft and

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then compare it.

Q. Please do.

A. Fine.

The point is -- well, if I recall correctly, and if you will give me another second here --

Q. Please take all the time you need.

A. Thank you.

Okay. Without going to the present form, it said in the draft, "All PWRs have in their emergency guidelines methods for use," et cetera, et cetera.

Now, it was our understanding that all plants did not have emergency guidelines at the time that this particular draft came about. All plants had emergency procedures. What we are saying is, if you go ahead and say there are procedures which can be used, that is a lot different than there will be procedures that will be available. And that at the day that we looked at it, we felt that the procedures were not in place at the plant of interest, and we cautioned Mr. Denton -- actually not Mr. Denton -- Dr. Mattson and Gerry Mazetis -- that we should look at the time frame in which we are dealing with with regard to this particular memo, and procedures and guidelines, anticipated transient, operator guidelines, and all that kind of thing.

Q. We don't have that draft, and my question, I

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think, was more simple than how you interpreted it. I'm just trying to learn to begin with, what was the issue involved? You know, what were they talking about and what was your difference, or what was your comment?

A. Well, what I said was that they used the present tense in what we think should be the future tense.

Q. What were the procedures, or what was the event being analyzed at this point? Was it boiler-condenser, or what?

A. I'll check.

MR. BAXTER: In either case, Mr. Chairman, I have to point out that I didn't think procedures, again, were to be explored here. The Board had ruled with regard to feed and bleed and other removal forms that they weren't interested in evidence in any further procedure.

JUDGE EDLES: I don't think we are at that point yet, Mr. Baxter.

THE WITNESS: Essentially we are talking about feed and bleed information, and also we are talking about alternative sources of secondary site cooling water if main or auxiliary cooling water are unavailable. At least, that is the section in the particualr draft that we are talking about.

BY MS. WEISS:

Q. And were the tenses changed in the final?

Now please look at the final.

A. Okay. Now I'm allowed.

I think they were. Very much so. It was changed to say all three PWR suppliers are developing emergency procedure guidance to Licensees on how to use equipment, et cetera, to perform feed and bleed operations as a back-up method of heat removal if all measures for feeding steam generators are lost.

So, essentially, rather than the original draft that came out positive, definite, we have it, we said, hey, that is not quite right, and they accommodated whatever observation we had made.

Q. So far as you are aware, it is still correct -- the sentence as read by you in the final report employs the correct tenses as of today?

A. Well, I would have to say that probably -- well, again I'll have to plead ignorance. I suspect there may be one plant out there that has operating guidelines that have been okayed.

I would suspect that most of them are working on it.

MS. WEISS: We have no further questions.

JUDGE EDLES: Is there any cross-examination?

I think we will begin with Mr. Baxter.

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CROSS-EXAMINATION

ON BEHALF OF THE LICENSEE

BY MR. BAXTER:

Q. Dr. Ornstein, just on that last exchange, when you said there may be one plant out there with operating guidelines, for what purpose? The record in this proceeding has emergency operator procedures from TMI-1 on inadequate core cooling, or Small-Break LOCAS, complete loss of feed to the steam generators. I'm puzzled by your comment.

A. Well, I didn't mean to puzzle you, but basically what I thought I was being asked is, do plants have the anticipated transient operating guidelines in effect today.

Q. I see.

A. And I do not know of any particular plant that does.

However, I do not find it beyond my comprehension that there are plants in that position today.

Q. Okay. Thank you.

I have just one other question, to quibble with one point that you made on direct.

I think when you were discussing the TMI-2 event you made the comment, if I understood it correctly, that prior to the TMI-2 accident, none of the vendor LOCA ECCS codes predicted boiling in the core.

We have in the record here, in the B&W ECCS

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evaluations from prior to the TMI-2 accident, and they show saturation for the operation in the core.

Have you examined those codes, or did I misunderstand your testimony?

A. Well, I guess I took a rather liberal, poetic license, let's put it this way: People aren't doing too much with what they were finding. Particularly the thing I have in mind is the simulator at Lynchburg and the codes that went into that. But most operators, if you talk to them about a PWR, and talk about boiling taking place in there, they look at you like you were crazy.

Q. But you haven't looked at the actual ECCS evaluation models?

A. I have seen ECCS evaluations for other plants in the past. However, that wasn't the issue that I was trying to raise here.

MR. BAXTER: I see. Thank you. That's all I have.

JUDGE EDLES: Mr. Cutchin, any cross-examination?

MR. CUTCHIN: Perhaps just one question, Mr. Chairman.

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CROSS-EXAMINATION

ON BEHALF OF THE REGULATORY STAFF

BY MR. CUTCHIN:

Q. Dr. Ornstein, at the time you submitted your

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affidavit to this Board on the 24th of February, you made a statement to the effect that it was your view that in the areas of common interest to both the AEOD and the NRR Staff, that there were no significant differences in their views as to whether the plant would successfully go into boiler-condenser feed and bleed or liquid natural circiulation modes.

Is that still your view today?

A. Yes, sir.

MR. CUTCHIN: Thank you.

JUDGE EDLES: Mr. Adler, any questions?

MR. ADLER: No. We have no questions for the witness.

I do have a question regarding the status of UCS-53. Was that going to be moved into evidence?

MS. WEISS: Yes. I was going to move the admission of UCS-53.

MR. CUTCHIN: Is that the Michelson memorandum?

MS. WEISS: Heltemes.

MR. BAXTER: I would object to it without having the draft and final reports on which it comments.

MS. WEISS: Well, we have the final, but we don't have the draft. I'll be happy to provide the final.

Perhaps Mr. -- Dr. Ornstein can provide the draft if the Board feels it is necessary.

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MR. BAXTER: I would comment that I think most of what you want from that document has been discussed with the witness. I just think it is going to be confusing having an exhibit that comments upon nothing.

MS. WEISS: I think you are right that most of it has been discussed, but on the contrary, it would be more confusing not to have it.

JUDGE EDLES: What is the method of getting the other one? I don't know whether there are any concerns that your office would have about releasing the original draft of the memorandum. We obviously have a copy of the final draft.

Is there any problem on that score?

MR. CUTCHIN: I think it would be up to the office, Mr. Chairman. Normally we do not make publicly available draft documents. We only make available draft documents, and that is part of the problem here.

JUDGE EDLES: I appreciate that. I'll take the exhibit in, and I would ask the Staff to make inquiries as to whether the underlying draft document can be released and placed in the record. If it cannot for some reason, advise us of that, and then we will have to do the best we can with UCS-53.

MR. CUTCHIN: Would it be appropriate to ask that that be directed to the office of -- it is their

determination, their office and their office alone would determine whether it is released.

THE WITNESS: Excuse me. I don't think that is correct. Because it is the draft that we received from NRR. Actually it is called a redraft, dated 5-28, and then there is another draft -- I'm sorry, 5-24, and then 5-28.

MR. CUTCHIN: I would undertake to determine that we will identify the correct draft, and then I will ask whether or not we have any problem.

JUDGE BUCK: Excuse me. I think you are beyond the office of this situation. I think you are looking at the Commission's policy in releasing drafts and everything else. I think you have to look at that very carefully.

JUDGE EDLES: However, I would just comment that it would be useful to the Board, and in presenting that matter to your colleagues or supervisors, you alert them to the fact that it will be a useful document, and report back to us one way or the other.

MR. CUTCHIN: I will do so, sir.

JUDGE BUCK: I have no questions.

JUDGE EDLES: Is there any redirect, Ms. Weiss?

MS. WEISS: Just one question.

(The document previously marked as UCS Exhibit No. 53 was received.)

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REDIRECT EXAMINATION

BY MS. WEISS:

Q. Mr. Cutchin read a sentence from your affidavit.

With respect to that sentence, would you tell me what are the areas of common interest between AEOD and NRR?

A. Sure. Let me pull out my affidavit again.

Basically we looked at the postulated events and we looked at the physical phenomenon associated with them, and we understand exactly where they are coming from and where they are going. It does not appear as though they are making water go uphill. There seems to be a reasonable set of assumptions behind what is being done, and we conclude that you have a handle on it and that now we have to get to a point where we get more information; and a very important aspect of the NRR document was a stipulation about getting the data that will enhance our ability to understand above and beyond what we already know, or think we understand.

Q. Your sentence was, in the areas of common interest there is no significant difference between the AEOD position and the NRR Staff's position?

A. That is correct.

Q Could you tell me what are the areas of common interest? What is the meaning of your qualifier?

A What I am saying is, they are interested in licensing; we are not.

We looked at the physical phenomena about the need for data, and we conclude this.

We are not saying we agree on everything with them. We are saying in the areas where we do have a mutual concern and interest, and basically marching orders, we are in agreement.

Q Is it possible for you to state what are the areas in which you have these common marching orders?

I'm sorry. I just don't catch the drift of what is the meaning of the qualifier.

A Let me read it again to see the qualifier.

Q In the area of common interest.

A Okay. We are not looking at the specific nodes, we are not looking at the number of nodes. We are not looking at whether this equation is being used properly or improperly. We understand that heat goes from hot to cold. We understand that if you have a high pressure here and a low pressure there, something is going to happen. The physical phenomenon, the big picture is understandable. They seem to agree with us, and we agree

with them with regard to the fact that the operators are very important, and they have to know what they are doing, and you have to give them as much information as you can.

You have to go ahead and look at alternative and backup systems in the event that the top line item doesn't work.

You have to go ahead and look at the big picture here, the fact that you are not asking for something to happen which is physically impossible. We seem to have agreement and understanding of what the phenomenon is, and basically, that is where I'm coming from.

Q Do you include the EG&G RELAP5 analysis of the .01 square foot break within your statement that you understand the physical principles involved?

A Let me see if I have the right EG&G item. This is RELAP5 that we are talking about?

Q Yes. It is a calculation that showed what is described as a chugging phenomenon.

A Okay. There is an example, I guess of an outlier like I was talking about before, where we have to try and get down to the nitty-gritty and understand better as to what is happening.

I mean, there have been a lot of cursory explanations and people looking into it more.

Q You said that both offices agree that it is very important tnat the operators understand what is going on and take the right action.

When you say there is no significant difference between the AEOD position and the NRR Staff's position, do you mean to say that AEOD has reached any judgment about whether for TMI-1 we can have confidence that the operators would understand what was going on and would take the correct action?

MR. BAXTER: Objection, Mr. Chairman.

JUDGE EDLES: I'll sustain the objection.

MS. WEISS: No further questions.

JUDGE EDLES: Any recross?

MR. CUTCHIN: No, sir.

JUDGE EDLES: If there isn't any, Dr. Ornstein, thank you very much. You are dismissed.

THE WITNESS: Thank you.

JUDGE EDLES: I think the only item remaining is the establishing of the brief date, if I'm right. We had originally figured that there would be more or less 20 days from the time the hearing got started. If we use the same frame of reference and assume that it got started yesterday, the briefs would be due on April 5th.

Does that pose a problem for counsel?

MS. WEISS: Yes, Mr. Chairman. I am committed for the better part of next week to be faculty on a conference. So we would request an additional week.

JUDGE EDLES: That would be the 12th?

MS. WEISS: Yes, Mr. Chairman.

JUDGE EDLES: Any comment from other counsel?

MR. BAXTER: Only that I have a lot of other work to do, too, Mr. Chairman. I'm willing to accommodate the Board, if they are interested in expediting the decision making. I'll basically look to you in terms of what your needs are.

We can certainly meet April 5, and we prefer to get on with it.

JUDGE EDLES: We will set the brief date at April 12th.

Anything else?

MS. WEISS: No, sir.

JUDGE EDLES: If not, let me personally thank counsel, Mr. Pollard, Mr. Dornsife, for your cooperation and courtesy over the last two days, and also last week. I appreciate that very, very much.

At this point, we stand adjourned, and we will await the briefs on the 12th of April.

(Whereupon, at 6:10, p.m., the hearing in the above-entitled matter was adjourned.)

NUCLEAR REGULATORY COMMISSION

This is to certify that the attached proceedings before the Atomic Safety and Licensing Appeal Board, in the matter of: Metropolitan Edison Company, et al., (Three Mile Island Nuclear Station, Unit 1)

Date of Proceeding: March 17, 1983

Docket Number: 50-289 (Restart)

Place of Proceeding: Bethesda, Maryland

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

Frank G. Tayloe
Official Reporter (Typed)

Frank G. Tayloe
Official Reporter (Signature)