UNITED STATES DISTRICT COURT
SOUTHERN DISTRICT OF NEW YORK

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GENERAL PUBLIC UTILITIES CORPORATION, JERSEY CENTRAL POWER & LIGHT COMPANY, METROPOLITAN EDISON COMPANY and PENNSYLVANIA ELECTRIC COMPANY,

Plaintiffs,

v. 80 Civil 1683 (RO)

THE BABCOCK & WILCOX COMPANY and J. RAY McDERMOTT & CO., INC.,

Defendants.

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January 14, 1983

10:00 a.m.

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(Trial resumed.)

G R A H A M B. W A L L I S, resumed.

THE CLERK: You are still sworn, sir.

DIRECT EXAMINATION (CONTINUED)

BY MR. FISKE:

Q. Dr. Wallis, when we left off yesterday we were at about 6 o'clock on the morning of March 28, 1979. I would just ask you to pick up from there, if you could summarize for the Court what methods were available as of 6 o'clock to effectively keep the core cooled.

A. The most straightforward method would have been

to run HPI. Closing the block valve followed by running HPI has essentially the same effect.

At 6 o'clock there was still the opportunity to feed the steam generators, and so proceed to successful cooling.

Q. By "steam generators," you are referring to both the A and the B generators?

A. Both steam generators.

Q. That is all as you testified yesterday, right?

A. That is so.

Q. In his testimony in this case, Dr. Lahey at page 4775 said, "At around 6:19 you could expect clad ballooning and some rupture."

Assuming for the moment that that is correct and that as of 6:19 what you would expect was clad ballooning and some rupture out the PORV, what does your analysis show as to whether or not if high pressure injection had been put on at 6:20 after the block valve was closed, the core would have been effectively cooled?

A. I believe it would.

Q. You testified yesterday, Dr. Wallis, about the effect of auxiliary feedwater on producing a reduction in pressure and temperature and in effect providing heat removal.

A. Yes, I did.

Q. I think you testified that in the B & W 177 plants the auxiliary feedwater is sprayed in on the tubes at the top of the steam generator and then the water falls down to the bottom.

A. That is correct.

Q. Are you familiar with how the auxiliary feedwater enters the steam generators in the B & W 205 design?

A. It enters lower down.

Q. And it fills up from the bottom?

A. It fills up essentially from the bottom.

Q. In your analysis, Dr. Wallis, is there any significance in terms of providing heat removal by reason of the fact that in the 177 plants the spray comes in at the top, whereas in the 205's the feedwater comes in from the bottom?

A. The auxiliary feedwater being introduced at the top, which was the plant at Three Mile Island -- I am simply saying that because I don't remember exactly the number --

THE COURT: 177.

A. -- had the greatest single effect of any mode of cooling during the period from the time HPI was turned off until 6 o'clock.

Q. What is the relative ability or impact of the

spray coming in at the top as opposed to the feedwater coming in from the bottom in terms of heat removal?

A. It makes it possible when the pumps are shut off for steam to be condensed in the upper part of the steam generator, even though there is no circulation in the primary.

Q. How does that happen?

A. The tubes -- there are 15,000 tubes, and the outer part of the tubes are wet by the spray. There is a spray, there are a number of holes around that spray water onto these tubes. The water runs down the tubes.

The steam inside the tubes condenses on the wall of the tubes and the heat is transferred through the tube to this water which is sprayed onto the tubes.

Q. And by spraying in the water at the top of the generator as opposed to having it come in at the bottom, how does that enhance --

A. If the water came in at the bottom, there would not be this mode of cooling.

Q. I'd like to read you from portions of Dr. Lahey's testimony in this case, reading from page 5163 on the same subject:

"Q. Isn't it correct that the effect of having the auxiliary feedwater spray directly on those tubes at the top itself produces a condensing effect which prevents

the pressure from going up?"

This is Dr. Lahey's answer: "Very little. In fact, that's what B & W used to think until they ran experiments in their Alliance Research Center, and they found out something I suppose they should have known all along, that spray only impinges on about 10 percent of those outer tubes, and the amount of energy it removes is really very small."

First of all, are you aware of the Alliance Research Center experiments that Dr. Lahey is referring to?

A. Yes, I am.

Q. What do they in fact show with respect to what portion of the tubes is hit by the spray?

A. They show that, depending upon the flow rate, a percentage of the tubes is continually wet, and that percentage is small. Dr. Lahey quoted 10 percent. I would not disagree with that number.

Q. So you wouldn't disagree with Dr. Lahey's statement that the Alliance Research Center experiments showed that the spray only hits about 10 percent or less of the tubes?

A. I would not disagree with that statement.

Q. Would you agree or disagree with Dr. Lahey's statement that as a result of that the amount of the energy it removes is really very small and that the effect of the

spray has very little effect on pressure?

A. I would disagree entirely with that part of his statement.

Q. I believe you introduced yesterday an exhibit which showed -- a curve which showed the rate at which decay heat is generated following a trip?

A. Yes, I did.

Q. This is Exhibit 4055, is that correct?

A. I don't have the number, but it is this figure.

Q. It is 4055. I believe you testified yesterday, Dr. Wallis, as to what the amount of decay heat was that was being generated at about 4:45?

A. Yes, I did.

Q. Just one more time, that was how much?

A. That is less than 2 percent of what was being generated when the reactor was running.

Q. In your analysis, is the spray coming in on approximately 10 percent of the tubes sufficient to provide heat removal for that 2 percent of decay heat?

A. It is sufficient to remove that heat, and more.

Q. I believe you already testified yesterday, Dr. Wallis, on the effect of auxiliary feedwater spray in producing a drop in pressure during the period 5:40 to 6:05.

A. Yes, I did.

Q. How much did pressure go down during that period,

roughly?

A. Maybe I should refer to this diagram here. These pressures are about 50 PSI. The period we are talking about is the period between here where the pressure as indicated on the strip chart was 930 and the period down here where the pressure as indicated on this strip chart is 700. It is a drop of roughly 200 pounds per square inch.

Q. Was there any other point prior to the accident where the spray of the auxiliary feedwater on the top of the steam generators' tubes had an impact on either temperature or pressure that you can demonstrate to the Court?

A. Every time that the spray was on it had an impact on temperature and pressure.

Q. When was the first --

A. The most noticeable time was at 8 minutes when it first came on. Let me refer to figure A-1, the first figure in the reactimeter data, which I think the Court has. At 8 minutes there is a spike. The temperature goes up -- the temperature is going up before 8 minutes because the AUX feed is not on. When the AUX feed comes on the temperature falls rapidly and it falls rapidly from 595 degrees down to 555 degrees by about 20 minutes.

Q. Is that during the period of time when the AUX feed is being sprayed on the top of the generator tubes?

A. That is so.

(Continued on next page.)

Q. Let me direct your attention, Dr. Wallis, to an answer that Dr. Lahey gave on page 5168, referring specifically to the period of time shown by the pressure chart around 5:40 to 6:05.

"Q. This pressure chart shows, does it not, a significant decrease in pressure from about 5:40 to 6:05?

"A. It shows a continuing decrease, that's correct. Because of the --

"Q. Well, it shows a decrease of a total of about 200 PSIG during that period, does it not?

"A. Something like that.

"Q. And isn't it a fact that it was during that period of time that auxiliary feedwater was being sprayed directly into the steam generators until the operators turned off the second set of reactor coolant pumps?

"A. It had very little to do with this fact that the pressure came down.

"Q. Isn't it a fact that it was during that period of time that the spray was going into the steam generators?

"A. The spray was going in, but it had very little to do with the fact that the pressure came down."

Now, do you agree with that testimony of Dr. Lahey?

A. I do not.

Well, let me qualify. I agree with his statement that the pressure was coming down. I do not agree with his statement that aux feed had nothing to do with it.

Q. Now, one last area.

Yesterday you described by reference to GPU 186 an analysis which had been made by GPUSC of pressurizer performance during the April 23 transient, do you remember that?

A. Yes, I do.

Q. And you also testified with respect to the log entries in the shift test engineer's log relating to the hot functional testing incident in September 1977?

A. Yes.

Q. Now, can you tell the court whether or not there is any relationship between the concept discussed in Exhibit 186 and the concept discussed in the shift test engineer's log relating to the September 77 event?

A. The concept that is being demonstrated is the same in each case.

Q. What is that concept?

A. The concept is that if there is steam in the primary loop, which is colloquially referred to as a bubble, the level in the pressurizer will be higher than it would

be if the bubble were not there.

Q. Now, directing your attention specifically to the entry from the shift test engineer's log in the hot functional testing incident, the entry of September 8th, 1977, which is tab 11, you referred to an entry on the third page yesterday, the page relating to September 8th, 1977, which reads "Pressurizer level unexpectingly increased when when venting the pressurizer and decreased pressure from 500 PSIG to 460 PSIG. Pressurizer level increased approximately 150 inches during the evolution."

Could you describe to the court the dynamics of why with a steam bubble in the primary system that situation that's described in the shift test engineer's log would occur?

A. If there is a steam bubble in the primary system and if the pressurizer is vented, then the effect of the venting of the pressurizer is to release steam from the top of the pressurizer. This has the effect of lowering the pressure on the entire system and the steam bubble will expand. The expansion of that steam bubble raises the level.

THE COURT: This is the steam bubble elsewhere?

THE WITNESS: Elsewhere. The steam bubble elsewhere.

Q. Now, I believe you testified yesterday and a

just a few minutes ago, Dr. Wallis, with respect to the concept as you have just described it that is reflected in the discussion of pressurizer performance in both the April 23, 1978, analysis and in the shift test engineer's log for September 1977, correct?

A. Yes.

Q. Now, does your testimony or your explanation of the extent to which this concept that you just described, namely, steam in the primary system causing pressurizer level to be higher than it would be otherwise, does your testimony of the recognition of that concept in the April 23 analysis depend in any way on whether or not, in fact, it turned out that there was steam in the reactor coolant system?

A. No.

THE COURT: I don't follow that. Read that back please.

(Record read)

MR. FISKE: I will back off and start again, your Honor.

Q. Your testimony yesterday was directed at the analysis that's contained on page 25 and page 26 of Exhibit 186, correct?

A. Yes.

MR. FISKE: Which is in the book, your Honor, as

tab two.

Q. And I believe yesterday you went through an explanation of the language on pages 25 and 26 and explained to the court how that analysis or in that analysis GPUSC had concluded that the temperature dropped and the system was such that looking just at the temperature you would have expected that the volume in the pressurizer would have shrunk to the point where the pressurizer emptied, but that according to this analysis it was concluded that the pressurizer did not empty because a flashing in the reactor vessel upper head which had held the pressurizer level higher than it would have been otherwise.

A. That's a good description.

Q. And your testimony yesterday was a description of that analysis by Met Ed, right?

A. Yes.

Q. Or GPU.

Now, are you aware that B & W also made an independent analysis in this case of whether or not the steam bubble had formed in the reactor coolant system?

A. Yes.

Q. And are you aware that B & W down at Lynchburg concluded that a --

MR. KLINGSBERG: I object to the leading, your

Honor. I think he ought to ask the witness what does the B & W analysis show. Not --

THE COURT: I don't think there is any dispute about this in the documents. It is a question of whether the witness has an awareness of it.

MR. KLINGSBERG: It goes to the witness' credibility as to whether he can answer the questions without Mr. Fiske making a long description and the witness just saying yes.

MR. FISKE: If Mr. Klingsberg strenuously objects to this, I can proceed --

THE COURT: Go ahead. We have been through this earlier. That's why it seems to me this is just refreshing the situation so the court has some appreciation of the answer.

MR. KLINGSBERG: We haven't been through this, your Honor. The B & W analysis is raised for the first time at this point.

MR. FISKE: I think that -- I thought this had been gone into at length with various other witnesses.

MR. KLINGSBERG: I'm talking about this examination.

Q. Are you aware, Dr. Wallis, or were you aware before you testified that B & W had made an analysis of the same event to determine, among other things, by their

analysis whether a bubble had formed in the reactor vessel?

A. I'm not sure when I first saw this.

Q. But you are aware of the --

A. But I would like to return to your first question.

The idea --

MR. KLINGSBERG: The first question is not on the record, your Honor.

Q. The question is, Dr. Wallis, are you aware as you sit there on the witness stand that sometime after this April 23 event B & W made its own analysis of whether or not a bubble had formed in the reactor vessel?

A. I am aware of that.

Q. And are you aware of what B & W's conclusion was?

A. B & W concluded there was no bubble.

Q. Now, does the fact that B & W in its analysis concluded that there was no bubble in the reactor system in any way effect your testimony as to the recognition by GPU as reflected in Exhibit 186 of the concept that the formation of steam in the reactor coolant system can cause pressurizer level to be higher than it was --

A. It makes no difference.

MR. KLINGSBERG: I object, your Honor. I don't see how --

THE COURT: There is nothing to object to.

There doesn't seem to me to be an objection.

What's the basis for your objection?

THE WITNESS: It makes no --

MR. KLINGSBERG: Please, Mr. Wallis.

The basis for the objection, your Honor, is I don't see how this witness can testify in regard to a leading question from Mr. Fiske that GPU when it received an analysis from the vendor with all the things that the vendor knows reached a conclusion conceptually. How could he possibly know that?

THE COURT: The problem is your objection is based upon a question that wasn't asked.

The question that was asked, if you take pages 25 and 26 of exhibit 186 -- Mr. Fiske, you correct me if I am wrong -- if you take those two pages that states a concept by GPU of the fact that if there is a bubble in the candy cane, I gather, the most likely spot, correct, is at the top of the reactor hot leg?

THE WITNESS: No, I wouldn't personally say it is the most likely place but it could be anywhere.

THE COURT: But if there is a bubble in the reactor coolant system outside of the pressurizer, that could, in this case, have caused the pressurizer not to empty even though mathematically you would conclude it had emptied on that analysis. That was what GPU concluded.

That they believed that it had not emptied because of the bubble elsewhere, which kept water in the pressurizer.

Now, all that Mr. Fiske is asking is whether the fact that GPU made that analysis as a conceptual matter is in any way derogated by the fact that B & W concluded that there was no bubble elsewhere and therefore that phenomenon had not occurred.

All he's asking is whether that determination of fact had any effect upon GPU's conceptual analysis of the situation to which he answered it did not.

Now, do you still have an objection?

MR. KLINGSBERG: Yes, I object, your Honor, on the grounds that I don't see how this witness sitting up in New Hampshire can make a determination of what GPU in Parsippany was deciding --

THE COURT: GPU did decide that at pages 25 and 26 and the question is whether that's a valid concept given the factual assumptions they made.

MR. KLINGSBERG: The question is what did they decide after they had B & W's, certainly, more expert analysis based on their computer codes and so forth which this witness, I assume, knows nothing about.

THE COURT: You and I are talking about apples and oranges and I have a feeling that I have assessed correctly what the questions and answers are. I will

overrule the objection.

Let's go forward.

MR. FISKE: Just so there is no question. My point is the issue, as far as Dr. Wallis' questions are concerned, is not whether in fact there was a bubble or wasn't a bubble --

THE COURT: But conceptually --

MR. FISKE: -- but whether GPU knew conceptually if steam forms in the reactor coolant system that could cause the pressure to increase.

THE COURT: I understand that testimony.

MR. FISKE: I have no further questions.

THE COURT: You may cross-examine.

CROSS-EXAMINATION

BY MR. KLINGSBERG:

Q. Professor Wallis, have you had any prior experience with transient analysis in nuclear plants?

A. Yes.

Q. Have you had prior experience in drawing lessons learned from transient analysis?

A. Yes.

Q. Have you had prior experience in the incorporation and training of operators into procedures or guidelines that are practicable for operators to use during transients of such lessons?

A. No, I have not.

Q. Have you ever been in the control room of a nuclear plant during operations?

A. Yes, I have.

Q. Have you ever been in the control room of a nuclear plant during a transient?

A. I was not aware that a transient was occurring when I was there.

Q. There was just one occasion that you were in the control room of a nuclear plant?

A. Yes.

Q. When was that?

A. This was in Vermont.

Q. And a transient was occurring?

A. There was no way I could determine what was occurring.

Q. Why is that?

A. I was a part of a visiting group that was being shown around and it was not explained to the group what was happening.

Q. And that was the only occasion when you were ever in the control room of a nuclear plant?

A. That is right.

Q. Have you ever been employed other than as a consultant by a company which either designed or used

Nuclear Steam Supply Systems?

A. Yes.

Q. Yes?

A. Yes. The answer is yes.

Q. What employment was that?

A. Before I was a professor I worked briefly, but as a student -- the true answer is, yes, I did work on vacations for General Electric and Westinghouse.

Q. But other than as a student, I take it, you have not?

A. That is correct.

Q. Where were you on March 28, 1979?

A. I believe that I was at home.

Q. On that date did you receive any telephone calls from Babcock & Wilcox?

A. I received a telephone call from Three Mile Island. The speaker was not identified. I believe it was on that day.

It might have been -- it was a very mysterious occasion because I was standing there shivering in the middle of the night by a telephone. And I didn't have the wit to take proper notes of what occurred. But somebody asked me if he should put water into some pipe and that's about as much as I can remember.

Q. And you don't know who it was?

A. I never found out who it was.

Q. You don't know if it was a representative of B & W or someone else?

A. No idea whatsoever.

THE COURT: You were in Hanover New Hampshire?

THE WITNESS: I told --

MR. FISKE: Do you want to hear what he told them?

THE WITNESS: Briefly, I tried to get a description, not being familiar with the plant, of what was going on and what the question was.

Q. Do you know what time it was?

A. Well, I was going to bed and it must have been about 11 o'clock at night.

THE COURT: Mr. Klingsberg, could I ask what in the deuce this is all about?

MR. KLINGSBERG: I have finished with this, your Honor.

THE COURT: So my curiosity is never to be satisfied, I take it.

All right. Go ahead.

THE WITNESS: I didn't intend this ever to be said in public this story. Since it has come out, it has come out.

Q. Let's turn to the April 23rd event.

On that event the steam safety valves failed open, is that correct?

A. Let me look -- to refresh my memory, I would like to look at my exhibit.

That is right.

Q. And is that what might be termed a small steamline break?

A. In my analysis of this accident I have not found it useful to categorize events in that way. That is something that is done for the purpose of licensing. So all I would -- my only reaction to this is that there was excessive steam flow and that caused the subsequent events. Whether or not you wish to call it a steamline break is not important.

Q. Are you aware of the fact that on the day of the accident the Three Mile Island operators suspected a small steamline break?

A. I have read something to that effect in reports of the accident.

Q. And does what you have read as to what was suspected put that type of break in more or less the same category as the steam safety valves failing open on April 23rd?

MR. FISKE: I object to this.

This is way outside, first of all, the scope of

the direct and, secondly, the scope of Dr. Wallis' expertise. He's not here to testify about what the operators thought or didn't think.

MR. KLINGSBERG: I didn't ask him what the operators thought.

I am trying to characterize the type of event that started on April 23rd and the witness has compared the April 23rd event with the Three Mile Island accident and came to the conclusion that there were certain similarities and I'm establishing that he knows from his own --

THE COURT: I didn't understand that from his testimony at all. In fact he testified there were dissimilarities.

MR. KLINGSBERG: He testified to both.

THE COURT: No. He testified to dissimilarities. I'm looking at Exhibit 4059. I thought that was the thrust of his testimony, that there was dissimilarity and not the similarity.

MR. FISKE: Once again, your Honor, I think Mr. Klingsberg has totally misstated the operators' testimony.

THE COURT: Let's go forward.

Obviously, you want to go into this area but let's go forward without reference to operators' testimony on March 28, 1979, because we did not get into that.

MR. KLINGSBERG: Your Honor, the witness has

reviewed that as part of his testimony here. He said he reviewed a great deal of material. I put witnesses on the stand such as Dr. Lahey who didn't talk about operators' testimony and Mr. Fiske never stopped quoting from the testimony of Mr. Zewe and Mr. Frederick. I don't think that I should be precluded, as your Honor has noted, even on the issue of credibility in asking -- in mentioning even operators' testimony.

THE COURT: Let me hear the question

(Record read)

(Continued on next page)

MR. FISKE: I don't know what he means, your Honor, by more or less the same category --

MR. KLINGSBERG: I don't think Mr. Fiske should make a speech while the witness is here.

THE COURT: All right, sir, step through the door, would you, please?

(The witness left the courtroom.)

THE COURT: Mr. Klingsberg, the unfortunate coincidence is that I had exactly the same reaction to that question. I haven't the slightest idea when you are asking the witness what does more or less mean with regard to this type of area of inquiry. Where are we going?

You are entitled to legitimate inquiry into all areas, and I have utterly no intention whatever of limiting you. But that question doesn't give the Court the slightest idea that this is going to something that is a proper area of cross examination of this witness.

Tell me where it is that you want to go. The witness isn't here. We have no problem.

MR. KLINGSBERG: On this particular event, your Honor, it will be indicated, which I haven't developed yet, that there were certain similarities, although it has been pointed out that there are certain differences which we will also explore, there were certain similarities between this event and the events on the day of the accident.

THE COURT: Why don't you ask the question in that form and you are golden, you are golden. You get off into questions of what do operators think, what did operators testify to, and that takes us off into an area that is questionable. If you say to him, "What are the similarities that you see between April 23 and March 28," that's perfectly fine.

MR. KLINGSBERG: That I will do in time, your Honor.

THE COURT: No, I am not going to get off into these other byways that have problems associated with them.

MR. KLINGSBERG: I am asking him his interpretation of a bit of testimony which he says he has read as to whether or not the steam line break which, in the testimony he read, was suspected by the operators is the same type of break as actually occurred on 4/23.

THE COURT: Then where do you go from there?

MR. KLINGSBERG: It is a very simple question which I am sure the witness can give an answer to, and I am sure the answer will be it is the same type of break. If he doesn't know the answer, then we go on to other things.

MR. FISKE: The problem with this, your Honor, is exactly what I mentioned a minute ago. The operators' testimony is that nobody even thought there was a steam line break, nobody thought there was a leak, until 5:15;

and they thought there was a leak from a steam generator, and that's why they isolated it.

What Dr. Wallis has talked about is a comparison of the first 10 minutes of these two, three or four events. Even the operators' testimony didn't say anything about steam valves sticking open. One operator thought that at 5:15 there might be a leak.

What that has to do with Dr. Wallis' testimony about the first 10 minutes of the accident is beyond me, but, in any event, if we are getting into this, I don't see why we have to reference it to operators' testimony. Let Mr. Klingsberg develop whatever he wants to in terms of the relationships or similarities of different events during the course of those two days. Dr. Wallis will be prepared to answer that in terms of system response, which is his area of expertise. I don't know why we have to fuzz it up by what I believe are misleading and inaccurate quotations from operators' testimony.

THE COURT: I think it is probably so that Mr. Klingsberg is endeavoring, whether he can succeed or not is another question, but he is endeavoring, and I think it is proper for him to endeavor, to show that certain indications that appeared on March 28 had similarity to things that appeared on April 23, 1978, and therefore to argue from that to me that operator conduct was proper,

given those indications. I think he is entitled to do that.

But we have got to do it in a way that gets at it without getting into areas that raise an objection because of time differences, that raise an objection because of questions that perhaps are not as pointedly phrased as they ought to be phrased.

Let's get the witness back and make it perfectly clear that we are talking about something that happened -- what was the Zewe testimony? Was it in the 5 o'clock area that he first had such a concern?

MR. FISKE: Yes, sir, about 5:15.

THE COURT: And not in the first 10 minutes.

(The witness entered the courtroom.)

BY MR. KLINGSBERG:

Q. Mr. Wallace, the 4/23 event involved a secondary side problem, did it not?

A. That was the origin of it, yes.

Q. It did not involve a loss of coolant accident?

A. That is correct.

Q. And what we have called the day of the accident, the March 28, 1979 event, was a loss of coolant accident and not a secondary side problem?

A. That is not entirely correct. It was both.

Q. Right. Temperature average, what we have called T ave, dropped in March '79 at one point, did it not?

A. T ave dropped in March '79 at one point, yes.

Q. If you look after the 10 minutes that you have put on your chart, there came a time, did there not, on March 28, 1979 when T ave dropped about 40 degrees?

A. T ave went up and down many times after 10 minutes.

Q. You are aware of the fact, are you not, that there was a delay of about 8 minutes in the auxiliary feedwater coming on on March 28, 1979?

A. Yes, I am.

Q. And after the auxiliary feedwater came on, the temperature dropped approximately 40 degrees, did it not?

A. The temperature dropped. If you want me to confirm the 40 degrees, I would have to look it up.

Q. Figure A-1 in your Exhibit 4058.

A. It dropped 40 degrees, or thereabouts.

Q. Approximately what time was that?

A. It dropped between 8 minutes and 20 minutes.

Q. In the November '78 and the December '78 event, how much did T ave drop?

A. You are now talking about another event, and we are talking about T ave dropping at an entirely different time. What we see for December '78 is that T ave dropped by 60 degrees.

Q. And in November '78?

A. T ave -- we are talking about a drop in temperature over a period of time displayed in the graph?

Q. Yes.

A. How much it depends on -- it drops there by 70 degrees.

Q. How much was the T ave drop in the April 23 event?

A. I'd like the record to show that this is a completely different time period --

Q. No, just answer my questions, Mr. Wallis.

A. No, we have to be specific --

MR. FISKE: Your Honor, can he --

MR. KLINGSBERG: Your Honor, I object to the witness --

THE COURT: If you would just answer his question, which is -- you are all the time thinking about the interrelationship, but all he has asked you is what is the figure as shown by the graph, I take it, on 4059. That's really what he is asking you. Just answer the question.

A. Then that is the answer. As shown by the graph, the drop is 70 degrees -- whatever I said it was.

Q. What is the drop in the April 23 event?

A. In that case you have to be specific about the time period you are talking about.

Q. The time period shown on your chart.

A. In that case, I am looking at B & W 4059. The drop in temperature is, as I testified befcre, over a hundred degrees.

Q. What is it that in these three overcooling events causes one to have a drop of 60 degrees, another to have a drop of 70 degrees and another to have a drop of 100 degrees?

A. There are various different initial conditions, there are interactions between the initial power level, the performance of the steam generators, the exact time at which HPI comes on. There are interacting things, and each one of these events, if you look at the total temperature drop, there are different causes. The result of that temperature drop, as I testified, is independent of what the cause may be.

Q. Is the temperature drop where you have, for example, as you had on 4/23, a break on the secondary side, influenced by the size of the break?

A. It may be; it may not be. It depends how far the temperature drops.

Q. Just looking at T ave, is the fact that there was a drop of 40 degrees on March 28, 1979 as compared with a drop of 100 degrees on April 23, 1978 necessarily indicative of whether there is an overcooling or a loss of

coolant accident? Just focusing on T ave.

A. Now, you are asking me a question about a generic loss of coolant accident, and I am not sure that I am prepared to state categorically what T ave does during any kind of a loss of coolant accident.

Q. The answer to my question is --

A. An overcooling I am prepared to say is characterized by a drop in temperature sufficient to initiate HPI. If you just talk about a loss of coolant accident, there are so many different kinds of loss of coolant accidents that I have difficulty being sure in my mind what T ave would do.

Q. Looking at the next parameter which you analyzed on April 23, which is pressurizer level, when the pressurizer level gauge showed the level was falling, that indicated accurately that the reactor coolant system water volume was decreasing, is that correct?

A. Yes.

Q. When the pressurizer level gauge showed the rising pressurizer level, that adequately indicated that the reactor coolant system water volume was increasing, is that correct?

A. Now, we have to be clear what you mean by that. It does mean that there was an inflow of water into the pressurizer.

Q. And the gauge showed that the level was increasing, is that correct?

A. It is increasing not because the water volume is increasing, unless you mean by that that you are taking account of HPI.

Q. If you were looking at the gauge of pressurizer level on April 23, pressurizer level was increasing?

A. Yes.

Q. At the same time HPI was coming into the system, is that correct?

A. Yes.

Q. It is a fact, is it not, that the only suspected effect of the void in the documents you reviewed was to keep the level from going down further and at the bottom of the pressurizer in the surge line?

A. I am not clear what the suspected effect was. There was a question about whether or not the level went down and out into the surge line. It would have been possible for the analysis to predict that the level rose if the bubble were big enough.

Q. There is nothing like that in the analysis you saw, is there? It didn't say that, did it?

A. If the analysis -- the analysis could have concluded that.

Q. I didn't ask you what it could have. Just

answer me yes or no. Did the analysis conclude that there was a bubble big enough to send pressurizer level up when it was falling down?

A. Wait a minute. It can't be going up when it is falling down. We have to be specific about the question and then I am very happy to answer it.

Q. Isn't it a fact that in the analysis that you saw, the GPU analysis, the void didn't turn the drop in pressurizer level into a rise in pressurizer level that you could see on the readable scale?

A. The analysis did not show that.

Q. In that event, HPI was turned on automatically, was it not?

A. Which event are you talking about?

Q. We are talking about the April 23.

A. Yes, it was.

Q. It came on at 1 minute and 11 seconds, right?

A. It came on at the set point, which is at about that time.

Q. Even before that, at about 43 seconds, a second makeup pump was put on, is that right?

A. I do not recall what was done with the second makeup pump.

Q. So that the rise shown in the middle graph of pressurizer level is due to the fact that there is HPI

filling up the system, is that correct?

A. That is correct.

Q. And that's just like what you said, filling up a glass of water?

A. And spilling over into an overflow tank.

Q. Right. In your graph D in B & W 246, that shows the event going out a little bit further, does it not?

A. I have to find the reference.

MR. KLINGSBERG: I don't have the tabs.

MR. FISKE: Tab 1.

THE WITNESS: Tab 1 in the big book?

MR. FISKE: Yes.

THE WITNESS: The reference is graph D? Yes, I think I have it now. This is from -- let me just check the reference. This is correct. I have now got B & W 246, graph D.

Q. That goes out to 12 minutes, does it not?

A. Yes, it does.

Q. It shows pressurizer level going to about how many inches?

A. Pressurizer level is going to around 280 inches.

Q. 218, did you say?

A. 280. It is above the scale marked on the left, but all I have done is to continue that scale and I get 280 inches.

Q. There comes a point, does there not, at around 225 inches, or so, when the level rise flattens out?

A. It doesn't flatten out.

Q. It is not as steep?

A. The rate of increase is decreasing at that time, yes.

Q. That indicates, does it not, that HPI is being throttled?

A. That is a possible explanation.

Q. You are aware of the fact, are you not, that there came a time in this event when the HPI was shut off?

A. Usually there is a time like that.

Q. When HPI was shut off in that event, pressurizer level didn't continue to rise, did it?

A. I have not got any record in front of me to show what happened.

Q. You didn't analyze this event past the time when HPI was shut off?

A. No, I did not.

Q. What do you think would happen?

A. HPI is going to be shut off?

Q. Yes.

A. And we have a subcooled system and we have a pressurizer level of a certain amount and there is some heat additional removal from the system and the makeup

pumps are doing various things. The effect of heating up the system would be to cause the coolant to swell into the pressurizer.

If the letdown and makeup pumps were set sufficiently -- they have a range of operation too. So increases and decreases in pressurizer level -- slow increases and decreases in pressurizer level can be accounted for by what is happening to makeup and letdown.

Q. You wouldn't attribute any effect at that point to the fact that there had been saturation in the system, would you?

MR. FISKE: I don't understand, your Honor. Who --

MR. KLINGSBERG: It is for the witness to understand, your Honor, not Mr. Fiske. He knows what I am --

A. In order to predict -- you are asking me about a part of the event which I have not studied. You are not showing me enough information for me to assess it.

Q. I believe you said in your last answer that in this event after the HPI is effectively shut off you are operating on what they call the makeup mode.

A. Yes.

Q. And you said that the level in the pressurizer at that point would depend on whether you are having more makeup or less makeup.

A. And on what's happening to T ave.

Q. Despite the fact that there had been at some point earlier saturation in the system, as had been assessed in the GPU document, once you got to the point where pressurizer level rose and HPI was throttled and then turned off, you wouldn't see any more increase in level as a result of the saturation that had existed, would you?

A. Not of the saturation that existed at some prior time, but if one achieves saturation again, then the same thing applies again.

Q. But in this event, the HPI would have eliminated the bubble, would it not?

A. Well, I recall in one of these events, and I don't know if this is the one you are referring to --

Q. I am talking about the April 23. That's all I am talking about, if you can't answer --

A. You are asking a general question about whether something would have done something. I imagine that applies to any event, which is why I am --

Q. No, I am asking you about the April 23 event.

A. You are saying something would have happened?

Q. I am asking you whether or not under what you have read in the GPU analysis the HPI would have eliminated this supposed bubble.

A. It would be likely to eliminate the bubble at this time. That does not preclude the arrival of another

bubble at a later time, if the operating conditions are right.

Q. The fact of the matter is that there is nothing in your review of the GPU document or the material in your boxes to indicate that the level of pressurizer went off scale high after the HPI was turned off in the April 23 event, is that correct?

A. There is nothing in the documents in front of me now to indicate that, that is correct.

Q. Are you aware of the fact that the reactimeter data which you said you reviewed in Exhibit 186 shows that pressurizer level stayed between 275 and 280 inches up to 30 minutes?

A. My review of this accident -- this incident was concentrated on the period as indicated here, the first 10 minutes. I am not prepared to testify about what happened at 30 minutes.

Q. Would you look at B & W 186, pages 0655 to 0656. This chart has the automatically recorded data that you said was the most important thing to look at when you are analyzing a transient, is that correct?

A. That is the information I found most useful for reconstructing what happened.

Q. And in point of fact, you used this data which is contained in this part of the exhibit in order to

construct your chart, did you not?

A. The chart was constructed, that is correct, from reactimeter data.

Q. This shows, does it not, that from 12 minutes to 30 minutes pressurizer level stayed between 275 and 280 inches?

A. Could I have the times, please, read back?

Q. 12 minutes to 30 minutes into the event.

A. I believe that statement is correct.

Q. So in point of fact, once the HPI went into the makeup mode, the pressurizer level did not have any significant rise, is that correct?

A. It is essentially stabilized around 270, 280 inches.

Q. And the pressurizer level in this event after the HPI went into the makeup mode did not go off scale high, did it?

A. It did not.

Q. And in March 1979 the pressurizer level did go off scale high, did it not?

A. Yes, it did.

Q. And that was a misleading indication, was it not?

MR. FISKE: I object.

A. Who is being misled?

THE COURT: I sustain that objection.

Q. When the level went off scale high in March 1979, the March 28, 1979 event, that did not indicate, did it, that the reactor coolant system was in fact full of water?

A. It did not.

Q. Mr. Fiske asked you this morning about the Babcock & Wilcox analysis of this event. Are you familiar with that?

A. You are back on the April 23 event?

Q. I am still on the April 23 event.

A. Yes.

Q. Babcock & Wilcox concluded, did it not, that there was no bubble in the reactor coolant system on that day?

A. That's what it states in their report.

Q. What are the reasons why Babcock & Wilcox reached that conclusion?

A. I was not involved in their analysis.

Q. You reviewed Exhibit 186, did you not?

A. Which is 186?

THE COURT: The GPU exhibit.

MR. FISKE: Number 2.

THE COURT: Number 2 in your tab book.

Q. Are you familiar with attachment 4, 0680 at the bottom?

A. Yes, this is an analysis by B & W.

Q. You reviewed that document in preparation for your testimony, did you not?

A. Yes, I did.

Q. You are familiar with the fact that B & W's conclusions with regard to voiding at the top of the pressurizer were "there are four observations or calculations which can be drawn to ascertain whether or not the pressurizer surge line emptied during the transient. Each of these suggests that in fact no steam bubble was drawn into the reactor coolant system proper from the pressurizer or formed spontaneously during the depressurization"?

A. That was their conclusion.

Q. Could you explain the first reason for that conclusion as stated in this document?

A. Would you please draw my attention to the statement here?

(Pause.)

A. What is being discussed here by B & W is that the same thing that --

THE COURT: Doctor, you are at the bottom paragraph on page 1 --

THE WITNESS: "Calculations were based on."

THE COURT: Go ahead.

A. B & W rightly points out that there are a

variety of influences upon this situation, such as what is happening with the makeup system and what is happening with -- what are the effects of temperature measurement errors, flashing, and so on.

So what they are describing here are the various influences which they considered, and they state that they may use conservative estimates.

Q. It is a fact, is it not, that B & W concluded in substance as one reason why there was no bubble that the reactor coolant system shrinkage was not enough to draw the pressurizer bubble into the hot leg?

A. That is --

Q. Is that correct?

A. That is correct.

Q. And B & W also concluded, did they not, that previous calculations showed that drawing the bubble into the hot leg should have produced a flat spot in the depressurization as the fluid in the hot leg flashed and in fact the depressurization was smooth in this particular case?

A. Where does that appear?

Q. Didn't you review this document in preparation for your testimony, Dr. Wallis?

A. The only thing that was important to me in this document --

Q. Just answer yes or no. Did you review this document or not?

A. I looked at the beginning of it to find out what was being discussed, what the subject addressed was, and I read the conclusion on the last page. It made no difference whatever to my thoughts about the problem.

Q. Then I will give you the opportunity to review it as we go through it. Look at page 2, the top paragraph.

(Pause.)

A. If there were -- this is not an unreasonable technical approach, that if there were flashing in the hot legs, that this would show up in the response of the system by means of pressure, temperature and level. In some cases there is a flat spot, in some cases the pressure may fall more rapidly.

Q. In point of fact, B & W concluded that there was no flashing or bubble because the depressurization was smooth, and that if there was a bubble drawn into the hot leg from the pressurizer it would have been flat, there would have been a flat spot?

A. That is not true. The pressure can go --

Q. I am not asking you if it is true. I am asking you if that is your technical interpretation of what Babcock & Wilcox says in this paragraph.

A. So you are asking me to say whether I understand

what Babcock & Wilcox is saying and not whether I believe this is true?

Q. That's correct.

A. What they are saying is that they have run some codes and those codes have shown that there should be a flattening in the pressure trace if there is flashing in the hot leg, and this did not occur in that incident.

Q. And on that basis they concluded that there was no bubble drawn into the hot leg?

A. Not into the hot leg. They are using this argument as a supporting argument for their conclusion that there is no bubble in the hot leg.

Q. Have you reviewed those codes, the track codes?

A. Not at all.

Q. The third reason why Babcock & Wilcox concludes there was no bubble drawn into the hot legs is stated in the next paragraph which says, "The third indication that no bubble was drawn in the reactor coolant system is that the hotter of the two reactor coolant system hot legs, loop A, never got within 20 degrees fahrenheit of saturation temperature as the reactor coolant system pressure fell." Do you see that?

A. I see that.

Q. Can you explain how that leads to the conclusion that there was no bubble formed?

A. The fluid is circulating in the hot leg at this time and therefore the temperature measurement is a reasonable indication of the temperature throughout the hot leg, and if a steam bubble were to form in the hot leg or to be -- it would not form in the hot leg.

If a steam bubble were to be introduced into that hot leg from the pressurizer, it would collapse in that cold water. So this is a reasonable technical statement.

Q. What was the fourth reason why Babcock & Wilcox concluded there was no bubble drawn into the hot leg?

A. This is a long one.

Q. Can you summarize it in a couple of sentences?

A. This is a much more difficult conclusion to assess because it is referring to a variety of things happening on-site which I have not studied.

Q. I am not asking you to assess it. I am just asking you to explain the basic conclusion for the record.

(Pause.)

A. The conclusion, if we look at the bottom of the paragraph, the penultimate sentence, "The conclusion from this line of reasoning" which is very qualitative and full of a lot of assumptions -- that's my adjectorial comment -- "is that pressurizer level could not have dropped very far below the lower level tap when HPI turned the level

decrease around."

Q. Basically, does that mean that from their analysis of the reactimeter data, B & W concluded that the pressurizer level recovered too quickly in order to have emptied?

A. They conclude that the pressurizer level did not fall very far below the lower level tap.

Q. And therefore B & W concludes, does it not, that the lack of any pronounced effect on pressurizer level in this situation indicates that there was no saturation?

A. That is not -- what the pressurizer level does is a complicated function of the flow rates and the presence or not presence of a bubble.

Q. You are giving us your answer or are you interpreting the B & W document?

A. It is impossible without spending a long time to look at this fourth paragraph, which is full of many statements, many qualitative statements, many references to evidence here and there, it is impossible to really tell -- to really follow the line of reasoning. The line of reasoning in general terms has to do with how much water is going into the system and what its effect would be on pressurizer level.

Q. Turning over to page 3, it states, "Based on the arguments and observations outlined above, B & W's

conclusion is that the pressurizer was never emptied. It appears that only the operators' timely initiation of high pressure injection prevented this from occurring, but the data seems to support our contention that the pressurizer was never entirely drained."

. Can you explain that paragraph?

A. They are concluding that the pressurizer never emptied and they are saying "the data seems to support our contention," which is a way of saying "we think we are right," that the pressurizer was never entirely drained.

Q. They are saying also, are they not, B & W is --

A. They talk about operators' timely initiation of HPI preventing this from occurring.

Q. Essentially B & W is saying that the behavior of the pressurizer level was influenced by the high pressure injection, is that not so?

A. That is correct.

Q. Are you familiar with the fact from your review of the GPU analysis that that was based on what was called the RETRAN computer model?

A. I am aware that GPU uses RETRAN and I believe that is true.

Q. Are you further aware of the fact that this was one of the first attempts in order to utilize the RETRAN in connection with review of transients?

A. I have no basis for answering that question.

Q. Are you familiar with the way in which GPU reached the conclusion from its RETRAN that there might have been a void?

A. I am not familiar with how GPU used RETRAN.

Q. You can't tell from the documents you read?

A. What I see as the result of their use of RETRAN is a dashed curve on the figure page 29 of this document, which is a prediction by RETRAN compared with a prediction of plant later. Excuse me. Let me correct that. Compared with a record of plant data. So they are comparing their theory with what happened.

Q. In other words, they are trying to fit what happened into their model?

A. You said that.

Q. I am asking you.

A. I have no idea what they were trying to do. They were basically comparing a model with experience. What they were trying to fit I have no idea.

Q. They were comparing the model with experience and trying to see if the experience could be explained by the model, is that correct?

A. That is a correct statement.

Q. That requires a number of assumptions of things that are not recorded, like HPI flows?

A. That does require assumptions about things that are not recorded.

Q. And those assumptions can affect the results, can they not?

A. They can.

Q. I want to turn to this chart which you have just referred to, we happen to have a colored version of it which is a little clearer, which we have used from time to time in this examination. It is GPU Exhibit 2053, which is the same as the attachment to Mr. Rogers' letter, part of B & W 186, to which the witness just referred in his answer.

Do you see the reference in this document where it says "HPI throttled"?

A. Yes.

Q. Do you recall on page 2 of Mr. Rogers' letter, which you have just been reviewing -- do you still have that before you?

A. Let me go back to find that.

THE COURT: Go ahead.

Q. B & W concludes on page 2 in the third paragraph, in about the middle, "at T equals 2.5 minutes the operators throttled down HPI flow." Do you see that sentence?

A. How do they know that?

Q. I just asked you if you see the sentence?

A. I see the sentence. I am sorry.

Q. Babcock & Wilcox says that in its report to GPU, does it not?

A. Yes. I read the sentence. It is stated here.

Q. At that point in time pressure was falling, was it not?

A. I am looking now at your exhibit GPU 2053 --

Q. Which is the same as the exhibit attached to Mr. Rogers' letter.

A. I am assuming that it is the same as the ones I have and everything is consistent. The pressure is falling at that time.

Q. It indicates that HPI was throttled at a time pressure was falling both in the chart and in the paragraph of the letter to GPU from B & W which you have just reviewed, is that correct?

A. That's right.

Q. In all the material that you read, including this document and the report from B & W to GPU on this transient, did you ever see any criticism from B & W on throttling HPI when pressure was going down?

A. I am not familiar with this enough to -- I do not recall seeing such a statement.

Q. You are aware, are you not, from reading these documents, both the B & W and the GPU, that the principal concern in inquiring into this transient was the

pressurizer emptying and the losing of the steam bubble into the reactor coolant system?

A. That is a major concern in these documents.

Q. Are you aware of the fact from just having been in the industry that in or about the period late 1977 and 1978 that pressurizer emptying and losing the steam bubble into the reactor coolant system was a concern relating to B & W units in general?

A. I was not familiar with that at that time.

(Continued on next page.)

Q. Are you familiar with that now?

A. I am still not familiar with it.

Q. Have you ever heard of any concern with the speed with which the B & W pressurizer empties during transients?

A. In a very -- I have heard about it. This is very much sixth or seventh-hand. I have heard it mentioned.

Q. In the course of your review of materials did you look at any material or have you heard about the November 1977 transient at Davis-Besse?

A. I have heard about that transient.

Q. And that was an overcooling event, was it not?

A. I have not studied the Davis-Besse transient.

Q. Do you know that that November 77 transient dealt with the question of pressurizer level emptying?

MR. FISKE: I am going to object. We are getting very far afield here. We are talking about a transient that Dr. Wallis said he didn't know very much about and didn't review.

MR. KLINGSBERG: I have covered that. I am going onto other things. It has been asked and answered.

Q. Did you learn in the course of your work in the industry or in the course of your preparation for this testimony that there was concern with the size of the pressurizer in the B & W unit which might cause level to --

the pressurizer level to totally empty?

MR. FISKE: I object for the same reason.

THE COURT: Sustained.

Q. Have you heard about concern with pressurizer level emptying in relation to the capacity of the steam generators of the B & W unit?

MR. FISKE: Same objection

THE COURT: Let me hear that again.

(Record read)

THE COURT: I don't understand what you mean by has he heard about concern.

MR. KLINGSBERG: Has he heard about it in the course of his preparation or otherwise of the work he has done in the industry.

THE COURT: I know. But what does the word "concern" mean? The question gets us nowhere. I will sustain the objection.

Q. I'd like to show you exhibits 83 and 84, CPU exhibits, and I direct your attention to Exhibit 83 which says: "Attached is a copy of a letter dated January 31, 1979, from J foster of the NRC to J.H. Taylor," who is the head of licensing at B & W, "which requests a meeting with us", in connection with his investigation regarding the evaluation of loss of pressurizer level indication at the Davis-Besse unit.

Exhibit 84 for identification is a memorandum concerning a meeting attended by, among other people, Kane, Faist, Bert Dunn of Babcock & Wilcox in February 1979. There are also representatives of utilities there, Toledo Edison, Metropolitan Edison, SMUD and Arkansas. Do you see that?

A. I see that.

Q. And those companies, you know, all have B & W units of a similar type, nuclear plant.

A. I do not know that.

Q. You don't know that?

A. No, I don't know that.

Q. You know that Metropolitan Edison and Toledo Edison have B & W 177 units?

A. In my study of this accident I took no steps to find out what B & W plants utilities might have. I'm not able to answer this question.

Q. On the second page of this document which would be the third paragraph, it states: "Mr. Hilbish" -- who is from Metropolitan Edison -- "said that TMI had two events 4/23 and 11/11/78 both of which were reported to the NRC and both of these events were thoroughly evaluated."

Now, the events which you have talked about are April 23rd and November 7, 78, events, are they not?

A. That is so.

Q. Those are the overcooling events where there was reference to the possibility of the pressurizer emptying, is that correct?

A. That is so.

Q. Then it says in the last paragraph on the page and it is repeated in similar words in the last paragraph of the document on the last page which I'll read:

"Mr. Foster" -- who is from the NRC -- "summarized the day's meeting by stating that he believed B & W had been exonerated from the charge that they had not responded in a timely manner, that the loss of pressurizer level indication was only an operational convenience and that the loss of pressurizer level was not a safety concern."

Do you see that?

A. I do.

Q. Now, in point of fact, is it your conclusion that the loss of pressurizer level in the events which occurred on May 23rd and November 7, 1978, did raise a safety concern?

THE COURT: April 23rd.

Q. April 23rd and November 7, 78, did raise a safety concern?

A. What is or is not a safety concern is defined by the NRC. It is like balls and strikes in a baseball game. Until the umpire says what it is we don't know what it is.

All I understand from this is the NRC calling to their methods and said it is not a safety concern.

I have no expertise in deciding whether something is or is not a safety concern.

Q. Now, have you heard of Bert Dunn in the course of your work in preparation for this case?

A. Yes, I have.

Q. And you have reviewed, I take it, the two Dunn memoranda?

A. I have read at least one Dunn memorandum.

Q. And that's the February 79 memorandum -- 78 memorandum giving certain instructions on the operation of high pressure injection?

A. I read a Dunn memorandum. That's all that I remember.

Q. Let me show you our --

THE COURT: Why don't we take a recess at this point for about ten minutes.

MR. KLINGSBERG: I have about a minute to finish this subject, your Honor.

THE COURT: All right, go ahead.

Well, you just sort of got into it. You haven't even showed him the document. Why don't you show him the document? You asked him if he saw this, he said he saw a Dunn memorandum, give him the two and then we'll take our

recess.

MR. KLINGSBERG: Okay, your Honor.

THE COURT: Does that work any prejudice to you?

MR. KLINGSBERG: No, it doesn't work any prejudice at all, your Honor.

THE COURT: Let's do it. That is the Dunn memorandum. That's one of them. There are two. You are giving him 78 and 79?

MR. SELTZER: Yes.

THE COURT: We'll take our recess.

(Recess)

(Open court)

CROSS-EXAMINATION (Cont'd)

BY MR. KLINGSBERG:

Q. Professor Wallis, have you had a chance to look at the two Dunn memos, Exhibit 78 and 79?

A. I have had a chance to look at them.

Q. Have you seen both of those in preparation for your testimony?

A. Yes.

Q. Now, do you recollect we were talking before the break about the February 1979 meeting which Mr. Dunn and others attended at which the April 23rd and November 78 events were discussed from the point of view of whether they raised a safety problem?

I want to read you from Mr. Dunn's testimony before the President's Commission, so-called Kemeny Commission. You are familiar, I assume, with Dr. Kemeny who is the head of your university, I believe?

THE COURT: You are objecting?

MR. FISKE: Yes, your Honor. I don't know where we are going with all of this.

THE COURT: I don't understand how this is cross-examination.

MR. KLINGSBERG: What, your Honor?

THE COURT: What you are getting into.

MR. KLINGSBERG: Well, I haven't read the question and answer.

THE COURT: I understand, but what item of direct examination is this addressed to?

MR. KLINGSBERG: We're talking about these events, the April and November events and their significance.

MR. FISKE: So far, your Honor, all that's happened is that Mr. Klingsberg has showed Dr. Wallis some minutes of the meeting at B & W that --

MR. KLINGSBERG: The reference to Kemeny was just a humorous remark. Strike it from the record.

THE COURT: But you would like to read testimony from another proceeding and I don't understand how it bears

on the direct examination.

MR. KLINGSBERG: Well, I haven't read it yet.

MR. FISKE: The point is I am perfectly willing to let Mr. Klingsberg read it if he wants to read it to your Honor, but it is totally irrelevant to any direct examination.

Mr. Klingsberg has showed him minutes of a meeting of B & W in February 1979 that clearly Dr. Wallis wasn't there. There is no showing that Dr. Wallis ever looked at these minutes, knows anything about these minutes and now we're going even further afield by reading Mr. Dunn's testimony at the Kemeny Commission.

What has that got to do with anything that the doctor is testifying about?

THE COURT: Mr. Klingsberg says we haven't given him a chance to pose his question so let's hear the question.

Q. Reading:

"Q. At the time of the February 9, 1979, meeting did you bring up to the group at the preparation meeting the concerns you had about pressurizer level with respect to the other Davis-Besse transient in the fall of 1977, namely, the September transient?

"A. No. It was my understanding at the time that these discussions were relative to the pressurizer

level going low during an overcooling transient and were not really related to loss of coolant accident and I was merely participating as a knowledgeable thermal dynamic engineer rather than as an ECCS representative."

Now, sir, is it your testimony that the matters relating to the November and the April 23rd, 78, event which were pressurizer level going low during an overcooling transient are related to loss of coolant accident?

MR. FISKE: Your Honor, I object to this completely.

THE COURT: I am going to sustain that.

I don't see where this bears on this at all.

MR. KLINGSBERG: Well, it bears, your Honor, because this witness has come here and tried to draw conclusions from these April and November transients that there was something in the analysis of these transients which should have put people on the alert concerning what happens in loss of coolant accidents and here is Mr. Dunn who has authored his memo in February 1978 concerning what happens during loss of coolant accidents when you have saturation and pressurizer level misleading and he goes to a meeting in February 1979 just before the accident in regard to a discussion of these very events that this witness is talking about and he says, Dunn says one thing

has nothing to do with the other.

THE COURT: Let me see what you are reading.

MR. KLINGSBERG: I want to know if this witness is contending something different. If this witness is saying, yes, these are related, then that's fine. I say that Mr. Dunn should have told us about it. If he says they aren't related, then I don't know why we are having testimony about it in this case.

MR. FISKE: Your Honor, this is totally out of context. Mr. Klingsberg is talking about something totally different and Mr. Dunn is going to be here next week and Mr. Klingsberg will have ample opportunity to ask him, as I'm sure he will, all about this meeting and then you'll hear the context under which that meeting was held. Mr. Dunn will explain to you what he understood the purpose of that meeting was.

THE COURT: I don't see how this answer -- it may be that there is something behind this answer that lifts it into some relevance to our situation, but I don't see how this answer has anything to do whatever with the examination of this witness.

He says: "These discussions were relative to the pressurizer level going low during an overcooling transient." That's what is in here, in exhibits 4059 and so forth.

He says these discussions were not related to a loss of coolant accident.

Now, "I was merely participating as a knowledgeable engineer rather than as an ECCS representative."

What does that have to do with any issue on cross-examination of this witness? What does that answer have to do with it?

Q. Let me ask the witness.

Dr. Wallis, is it your testimony that the 4/23 transient --

THE COURT: You are now going onto another question. You are conceding that this answer doesn't thrust up any great concept to thrust in the witness' face?

I will sustain an objection to that question.

If you want to put a new question, you can go forward to a new question.

MR. KLINGSBERG: Yes, sir.

Q. Professor Wallis, is it your testimony that the April 23rd and November 7 events, even though they related to overcooling and even though they related to a question of loss of pressurizer low, have some relevance to loss of coolant accidents?

MR. FISKE: I object to that, your Honor, as to whether Dr. Wallis is saying that one has relevance to the

other.

He has specifically said he doesn't come here as an expert on how people should react, how the operators should have reacted --

THE COURT: I'll sustain an objection to the form of the question, specifically to the use of the word "relevance".

Q. Professor Wallis, is it your testimony that the April 23rd and the November 7 events, even though they are overcooling events and pertain to a loss of pressurizer low, teach some lesson which is of interest from the point of view of nuclear safety in regard to loss of coolant accidents?

MR. FISKE: I object to that.

THE COURT: Sustained.

Q. Professor Wallis, is it your testimony that the April 23rd and the November 7 events which you have testified about reveals some conclusions which are useful or of some interest in regard to loss of coolant accidents?

MR. FISKE: I object to that. This is exactly what is beyond the scope --

THE COURT: Would you go through the door again, please, sir?

(Witness excused)

THE COURT: Mr. Klingsberg, what are you getting

at?

MR. KLINGSBERG: What I am getting at is this witness has testified for a day and a half about three overcooling events. We don't have an overcooling event here. We have a loss of coolant accident.

THE COURT: He said that.

MR. KLINGSBERG: I want to know why he thinks something has to do with the other.

THE COURT: I understood what he was suggesting to me. If his testimony is to be credited, that they are to be distinguishable by the graphing of them. They are distinguishable, that's what I gathered from him. Perhaps I'm wrong in this. Perhaps something will later develop that corrects that. But that's what I understood this witness to be saying. That they are distinguishable.

MR. KLINGSBERG: I understood the witness to be saying, and your Honor even asked the witness a direct question about it, that the witness thought there was some lesson to be drawn from these events in regard to whether pressurizer level is inaccurate or a misleading indication of system volume.

THE COURT: That he did with regard to the GPU Exhibit 180 -- what?

MR. FISKE: 186.

MR. KLINGSBERG: 186.

THE COURT: And that was the basis of your objection about an hour ago which I had gathered you really didn't appreciate Mr. Fiske's question at the time and what I got from that, again, I'm listening to this case, direct and cross-examination, but what I got from his testimony in regard to 186 was that GPU was unaware of a theory under which a bubble in the reactor coolant system would cause the pressurizer level to stay up even though there were voids in the rest of the system.

That's what I learned from that and that has to do with only that exhibit which flows from chart number 2 of B & W 4059.

Now, that's all I took away from that. That was the lesson that I took away from that.

MR. KLINGSBERG: The witness didn't say that pressurizer level would go up. He said that pressurizer level would not empty out of the pressurizer if there was a bubble.

THE COURT: He said reading the GPU analysis at pages 25 and 26 they had concluded that the pressurizer had not emptied because of a steam formation elsewhere in the reactor coolant system.

MR. KLINGSBERG: Right. And I am saying that -- excuse me.

THE COURT: And that's all I take it that he

said one was to learn from this particular matter.

MR. KLINGSBERG: That's right.

And I am saying that here is an event which was analyzed by B & W as well as by GPU and, as a matter of fact, we had showed your Honor earlier Exhibit 366 which is the same as the document we were previously reviewing by Rogers which was countersigned by Wandling and Scott and Phinney and all these people who got the Dunn memo.

THE COURT: Get to the point, Mr. Klingsberg.

MR. KLINGSBERG: Here is Mr. Dunn who goes to a meeting in February 1979 on these very events and has written his memo and knowing all about the concern of misleading pressurizer level, Mr. Dunn does not take this occasion to tell Metropolitan Edison who reports on these events at this meeting with the NRC present, hey, you know this has something to do -- this fact of whether the pressurizer level emptied or not and whether there is a bubble in the pressurizer which keeps it from emptying and all these things which have to do with the April and November events which B & W analyzed as well as GPU -- Dunn doesn't say, as this witness purports to say, hey, you know, this has something to do with producing misleading levels of pressurizer indication in the event of a loss of coolant accident.

Dunn says this has nothing to do with loss of

coolant accident and he doesn't say a word about it.

Now, I want to know why does this witness say and spend a day and a half on the stand saying that this has something to do with loss of coolant accidents? Either he disagrees with Dunn or he agrees with Dunn.

If he disagrees and thinks it is important, then Dunn should have told us.

THE COURT: All right. I see what you are saying now, but you have gone around Robin Hood's barn to get there and what you are saying is that Dunn -- what you are saying is that if you accept GPU's analysis of this and if you make the connection to a stuck open PORV, code safety or otherwise at the top of the pressurizer, then there is a relationship here to a loss of coolant, correct?

MR. KLINGSBERG: That's what the witness might have said in answer to my question.

THE COURT: No, that's what you are saying.

MR. KLINGSBERG: No. That's what I am trying to find out from this witness. He might say that or he might not.

THE COURT: That's what you believe you can get the witness to say if you put the proper questions to him, correct?

MR. KLINGSBERG: Actually the witness might say if you accept the GPU analysis and the concept that -- as

Dunn seems to think -- that it has nothing to do with holes in the top of the pressurizer. When you have holes in the top of pressurizer, you have a misleading indication and the pressurizer level scoots over scale high even though the high pressure injection is off and in these events --

THE COURT: I see what you are saying.

On the other hand in Dunn's testimony at page 208 of this testimony he doesn't say it either. He doesn't see any connection here to a loss of coolant. And this witness doesn't do more than state that the author of Exhibit 186 had an awareness of this concept which could have applicability to a pressurizer break at the top.

Am I correct in that, Mr. Fiske, essentially?

MR. FISKE: Yes. I have just two points --

MR. KLINGSBERG: We say it has no applicability. We say, as Dunn says, it is a totally different situation. But if it does have applicability, then this was the perfect opportunity to tell us about it.

MR. FISKE: We have two basic points here and it is very important with respect to the scope of Dr. Wallis' testimony. He made it very clear and we outlined it right from the very beginning. That he is here as an expert witness on how the system reacts.

All he has purported to do in his testimony and Mr. Klingsberg misconceives the function of an expert

witness. We have had expert witnesses who came in here as advocates and said "I contend this" or "I contend that", and Dr. Wallis isn't here for that purpose.

He is here as an expert to analyze how the system reacts. He shows you how it reacts on one occasion and he shows you how it reacts on another.

We will make the arguments as to whether we think there is a significance from that and Mr. Klingsberg can make the arguments as to whether he thinks there is a significance in terms of what conclusions operators should have drawn from these two or three or four events.

That's the whole purpose or end purpose of this testimony.

We will make arguments as to what the operators should have concluded.

Dr. Wallis isn't here for that purpose. He's made it clear that he's not an expert on that.

Mr. Klingsberg is at liberty to ask him as much as he wants in terms of how the system reacts but it is unfair for Dr. Wallis to say that. Is it your contention that one of these things is related to another in terms of how the operators should have analyzed it. That's objection number one.

Objection number 2 is that there is no basis for leap frogging even from that improper hypothesis to go to

some meeting in B & W in 1979 and start asking the witness questions about that when we don't know yet, and we will from Mr. Dunn, what the background of that meeting was, what the purpose of the meeting was, what was said during the meeting, what the context of the meeting was and whether that meeting had anything to do with anything that we have been talking about here and how you can put the question in the abstract to a witness who isn't here to express ultimate conclusions or make contentions in the first place is really beyond me.

(Continued on next page)

MR. KLINGSBERG: I would say two things in response very briefly. One, I don't think things can be sliced that thin. This witness is experienced with CREARE, which does nuclear safety analysis, he has consulted with the NRC. I don't think I can be precluded when they bring this witness in from asking questions about nuclear safety and just ask questions about temperatures and pressures. These plants don't operate in a vacuum. They are operated by people.

THE COURT: But he didn't purport to be a safety expert. I think it is not appropriate to cross examine him about safety matters.

MR. KLINGSBERG: Secondly, Dr. Lahey came here and also talked about thermodynamic --

THE COURT: Dr. Lahey was tendered as a general witness. What you tendered him for he can be cross examined on. This witness was not tendered --

MR. KLINGSBERG: He was not allowed to testify as much as I would like him to.

THE COURT: I am not going back over what Lahey did or didn't do. Bring the witness in. In any event, you put a new question. I am going to sustain the objection to the use of the Dunn testimony being read to him and him commenting on it.

(The witness entered the courtroom.)

BY MR. KLINGSBERG:

Q. Dr. Wallis, in this April 23 event you testified, I believe, that pressure early on, about 1 minute and some seconds, hit 1640 PSI, is that correct?

A. That's right.

Q. And the primary system was shrinking?

A. That's right.

Q. And pressurizer level was dropping?

A. That's about the time it went off scale.

Q. And pressure was coming down?

A. Pressure was coming down, yes.

Q. At the point where pressurizer level hit below the readable scale the HPI hit the 1640 mark, is that correct?

A. I don't know what you mean by HPI hitting a 1640 mark.

Q. The pressure hit the 1640, which was the HPI actuation?

A. Pressure hit 1640 about that time, yes.

Q. At about the time when the pressurizer level went below the readable scale?

A. Went off scale, yes.

Q. Then, according to your chart, the pressurizer appears to be empty, does it not?

A. The level is below the zero point.

Q. In point of fact, did it either empty or come very close to emptying, the pressurizer?

A. I have not made an assessment of whether the pressurizer was empty or not.

Q. How much gallonage maximum would have been left in the pressurizer below the readable scale if there was anything in there?

A. I can only give you an assessment.

Q. Yes.

A. I believe it is something less than 1,000 gallons.

Q. Are you aware of how many gallons are in the pressurizer? It is about 11,200 gallons, is it not?

A. I think in terms of cubic feet, it is 1500 cubic feet. That sounds about right.

Q. HPI comes in at 1,000 gallons a minute, is that correct?

A. It depends upon the pressure, but at this low pressure that's a reasonable estimate.

Q. If you let HPI run for 10 minutes, that would put in 10,000 gallons of water, would it not?

A. That is correct.

Q. So if you let HPI run for 10 minutes at 1,000 gallons a minute and you put in 10,000 gallons, your pressurizer has a capacity of 11,200 gallons, approximately,

and you had only about 1,000 gallons, I think you said, below the readable scale, you wouldn't fill the pressurizer, would you?

A. That depends on which gallons you are thinking of. As the HPI comes in and warms up, it gets bigger, so you might fill the pressurizer, depending on what T ave is doing during this period.

Q. What if T ave is doing what it was doing on April 23?

A. T ave during this time was decreasing somewhat, so there was some shrinkage which would have to be taken into account. On the 10,000 gallons coming in, it would grow to a larger volume because the water is heated up and it grows. So the question you ask puts enough doubt in my mind.

I say maybe it would and maybe it wouldn't. It is something I would have to calculate, but it is a reasonable calculation to make. It is a reasonable -- if you ask me did it fill, I could not rule out that it filled.

Q. It could be calculated easily?

A. It could be calculated fairly straightforwardly, yes.

Q. Now I'd like to turn to the next event about which you testified, which is the March 29, 1978. In that event the PORV opened because of a lack of power and a

problem in the wiring, is that correct?

A. There was an electrical problem. There was loss of power to a bus.

Q. The PORV failed to close because there was no electric power?

A. That is my understanding.

Q. The PORV did not stick on that occasion as it did on March 29?

A. It did not stick, no. It was a loss of power which led to this PORV staying open.

Q. And you are aware of the fact, are you not, that the absence of electric power affected numerous panels and instruments during that transient?

A. I understand that some panels and instruments were affected.

Q. When electric power was returned at about 4 minutes, the PORV closed by itself, did it not?

A. I believe that is correct.

Q. And the block valve was not closed?

A. I do not believe the block valve was closed.

Q. To your knowledge, in the descriptions there was no, during this four minutes, diagnosis of the open PORV which led somebody to close the block valve or do something else?

A. Let me answer the first part of the question. I

do not believe there is a diagnosis of the open PORV which led to somebody closing the block valve.

Q. Saturation did not form in the reactor coolant system during this event, did it?

A. What I am doing is I am looking at temperature and pressure. No, it did not. Not in -- let me be clear about this. Saturation can occur locally at hot spots. I am not able to assess that. It did not occur throughout the system. I can tell that from the temperature and pressure.

Q. Looking at the temperature and pressure gauge, the system was not saturated?

A. The entire system was not saturated.

Q. And in comparison on the March 1979 event, the so-called day of the accident, we know from the reactimeter data and the post accident analysis that the system became saturated at about 6 minutes, is that correct?

A. Yes, that is correct.

Q. Again turning back to the March '78 transient, it is a fact, is it not, that the reactor coolant system was always more than about 42 degrees subcooled?

A. The exact number escapes me, but one characteristic of that time was that the system was much more subcooled than it was on the day of the accident.

Q. You said on the day of the accident the system

became saturated?

A. This is very clearly seen because the temperature on March 29, 1978 is around 525 degrees or a little above, whereas on the day of the accident it was around 50 degrees higher.

Q. So that when the transient ended at 4 minutes, the reactor coolant system in March '78 was quite a ways from saturation, was it not?

A. I believe that to be the case.

Q. It is a fact, is it not, that during the March 1978 event the pressurizer level at all times would have been an accurate indicator of reactor coolant volume, liquid volume?

A. I believe that's a reasonable deduction.

Q. And since there was no power, there was no indication of pressurizer level, was there?

A. I have thought about that --

Q. What?

A. I have thought about that, and I am not sure because there is this uncompensated Delta P which I used in my calculation which I believe is available.

Q. But the pressurizer level indicator was not available?

A. The final display of pressurizer level was not available. It is reasonable to conclude that there could

have been another indication which is easily interpreted.

Q. My question is, the pressurizer level indicator was not available?

A. I believe that's a correct statement.

Q. From your review of this event, there came a time when high pressure injection came on, is that correct?

A. That is so.

Q. And the high pressure injection was not terminated during the 4 minutes, or so, which the event lasted, was it?

A. It may have been terminated towards the end.

Q. Before the block valve was closed?

A. The block valve never --

Q. Before the PORV closed by itself?

A. It is possible that the HPI was terminated before it closed.

Q. You are saying that, looking at the chart?

A. Depending upon the status of the makeup system. I am looking at the pressurizer level. I am saying it started to go up rapidly. Something happened to slow down the rate of rise before the PORV was closed.

Q. You are saying it may have been throttled, HPI?

A. Exactly.

Q. You are looking at the time when the slope changes a little bit between 3 and 4 minutes?

A. The rate of rise slows after the first -- after 3 minutes.

Q. As it is approaching 200 inches?

A. That's right.

Q. The pressurizer level increased in this event because the HPI was on, is that not so?

A. That is correct.

Q. And the pressurizer level in this event did not increase because of saturation in the reactor coolant system or steam voids?

A. That is correct.

Q. Pressurizer level in this event did not rise above scale, as it did in March 1979 or the day of the accident?

A. That's correct.

Q. There came a time, did there not, when pressurizer level stopped rising in this event?

A. Yes.

Q. That was at about between 4 and 5 minutes?

A. The rate of level rise is very slow after that period of time.

Q. That would indicate, would it not, that the HPI was throttled back to the point of almost being turned off? It went into a makeup mode?

A. That would be the implication, yes.

Q. After the HPI was turned off, the pressurizer level in this event did not increase, did it?

A. It did slightly, but --

Q. It didn't rise looking anything like the March '79 event?

A. No, it did not, no.

Q. It didn't go off scale?

A. No, it did not.

Q. As a matter of fact, it never went above 200 inches?

A. That is correct.

Q. And 220 inches is the normal level, is that right?

A. There is choice in what one wishes to set the level at. It is usually set somewhere near the middle of the pressurizer.

Q. So therefore the pressurizer level here in this event always appears to have been an accurate indicator of reactor coolant system inventory, is that correct?

A. I believe that is a good assumption.

Q. When water was added by HPI the level went up, right?

A. That's right.

Q. When they stopped adding water with HPI, the level evened off, right?

A. I would put it the other way, that I deduce what was happening with HPI by looking at the level. I don't know exactly what was being done with HPI.

Q. And therefore there was no unusual, unexpected or seemingly unique response of pressurizer level going up or down due to the open PORV during this event, was there?

MR. FISKE: I object.

A. Yes, there was. I am --

THE COURT: There is no question pending before you.

THE WITNESS: He asked a question and I said I disagreed with the implied question. I disagree. He put it in a way that I want not to be equivocal. Can we go over that again? I want to be sure of what question I answered.

THE COURT: Read the question.

(Record read.)

A. May I explain my "yes, there was"? "Yes" to unusual. This was not usual. "No" to unexpected by me, knowing what happened.

Q. It appears from this event, does it not, that the operators handled HPI correctly in relation to the inventory being adequate or inadequate in the reactor coolant system?

A. It is very unclear to me why HPI was treated

this way if there was no knowledge of pressurizer level. So whether they operated correctly or not I am not able to assess, but I am puzzled by what happened.

Q. You know, do you not, that B & W reviewed this event as well?

A. I don't --

MR. FISKE: Your Honor, I am going to object to questions to Dr. Wallis as to whether the operators handled HPI correctly or not correctly. I don't think that is within the scope of his expertise. I have no objection to him describing what happened to HPI, what the conditions were. Mr. Klingsberg can argue from that whether it was proper or not proper. I don't think Dr. Wallis even knows what the procedures were that governed the operation of HPI.

THE COURT: Is there a pending question?

MR. KLINGSBERG: No, your Honor.

Q. During this event was there any indication that HPI was turned off in a way that would affect the safe cooling of the core?

A. This is impossible to assess because damage to a core, if it were to happen, would have happened a lot later. One has to go through the whole scenario. There is no way, looking at what happened in the first few minutes there, I can assess what might or might not have happened at a later time.

Q. Did you review the B & W report on this event?

A. Is that one of these reports here? I am confused about how many reports there were --

Q. I don't know whether it is in your book or not because I don't have a tabbed copy of that book, but do you know of your own knowledge if there is a B & W report of this event?

MR. FISKE: Your Honor, for the record, I am not sure there is a report. Does Mr. Klingsberg know if there is one?

MR. KLINGSBERG: Yes.

A. It doesn't occur to me at the moment. I have to say I don't know.

Q. You said that HPI may have been throttled between 3 and 4 minutes. Do you recall that?

A. Yes.

Q. At that time pressure was trending down sharply and was below 1640 PSI, was it not?

A. Yes.

Q. Did you see any documents in the things that you reviewed where B & W advised GPU that there was a mishandling of the HPI because the HPI was throttled while pressurizer level was going up and the pressure was going down and the PORV is open?

MR. FISKE: Your Honor, I am going to object.

There is no foundation for that question, unless Mr. Klingsberg shows us some document which shows that B & W reviewed this transient or was asked to review it by Met Ed and wrote a report on it.

THE COURT: I will sustain the objection.

Q. In this event, the plant was in the startup and test phase, was it not?

A. Yes.

Q. There was zero power?

A. I think it was less than 2 percent.

Q. That means that there is no heat source?

A. There is a very small heat source.

Q. And it means very little, if any, decay heat being generated?

A. Decay heat --

Q. After the event?

A. Because the reactor had not been running for a long time, there was little decay heat.

Q. And there was no reactor scram or trip and there was in March 1979, the day of the accident?

A. I wouldn't disagree with that statement.

Q. And the steam generators at this time in 1978 were not performing any function, were they?

A. They were probably performing some function.

Q. Very minor?

A. Minor function.

Q. You are aware of the fact, of course, that in March 1979 the unit was operating at close to full power?

A. Yes.

Q. So all these things, zero power, very little if any heat source, no decay heat, no reactor scram, steam generators performing minimal function, are all different from the full power operation on March 28, 1979?

A. Yes.

Q. If you are putting decay heat into the system, as you do when you have full power, then the heat can cause the water to expand and raise pressure, is that correct?

A. Yes.

Q. And then after that, as happened in March 1979, there was a reactor trip and a cooldown?

A. There was a cooldown for a period of time.

Q. Right. In March 1978 there was no high pressure reactor trip, was there?

A. There was no high pressure -- I believe that's a correct statement.

Q. And there was no cooldown which would occur following a high pressure reactor trip?

A. There was some cooling down between 2 and -- you can see the temperature did fall by a few degrees.

Q. Very minimal?

A. And probably that is associated with HPI injection.

Q. Focusing on T ave for a moment, you testified at 6533:

"Q. What happened to temperature in this transient," meaning March '78, "while the pressure was dropping as you just described?

"A. The temperature which is shown in the top of the three figures changed slightly by maybe three or four degrees, went down slightly and came up again.

"Q. Can you compare the relative drop in temperature, that is in terms of degrees, in the March '78 open PORV incident and the March '79 open PORV incident?

"A. They are the same order of magnitude, that close."

Do you remember that testimony?

A. I was speaking then about the temperature changes that occurred in the first few minutes, up to 4, 5 minutes.

Q. In point of fact, the temperature change in the March '78 event or the behavior of temperature in the March '78 event was principally due to the fact that the plant had been operating at zero power and was not producing any decay heat, so the temperature stayed more or less the same, except for the HPI coming in, is that correct?

A. I have not done careful analysis, and this is where we get into a tricky area because we are talking about low power, less than 2 percent, decay heat is of the order of 2 percent.

Unless you tell me clearly -- unless I really look at how big those heats are, I can't make an assessment. You should not compare the operating power with the decay heat because one is very much greater than the other, and in this case we have a reactor operating at low power. You are trying to compare it with decay heat in a different situation.

Q. So that comparing the relative drop in temperature in the March '78 event and the relative drop in temperature in the March '79 event is quite meaningless, is it not?

A. That is not so.

Q. Isn't it a fact that the movement of temperature during the March 1978 event was principally influenced by the fact that the reactor had been operating at zero power and there was no decay heat or very little decay heat?

A. My testimony yesterday referred to the influence of T ave on pressurizer level, and it makes no difference how T ave is achieved.

Q. I am not asking you about the influence of T ave on pressurizer level. I am asking you about the behavior

of T ave.

A. Yes.

Q. I am asking you if the factors influencing the behavior of T ave in March '79 were not very different from the factors influencing T ave in March '78?

A. That is a correct statement.

Q. That includes the fact that one time the plant was at full power and another time the plant was at zero power?

A. That has to be taken into consideration, yes.

Q. And another thing that has to be taken into consideration in assessing what happened to T ave in the first 8 or 10 minutes of the March '79 event was the delay in AUX feed coming on, isn't that true?

A. That is also correct.

Q. Is it also another factor to be considered that in March '78 there was no core burnup and in March '79 there had been core burnup?

A. That is also correct.

Q. In March 1978 initially there was no drop in pressurizer level, is that correct?

A. That is right.

Q. The reason for that is because there was no cooldown, the plant had been at zero power and there was no shrinkage of fluid, so you don't see the drop in

pressurizer level that you would see after a reactor trip?

A. That is substantially correct.

Q. And in March 1979 there had been a reactor trip at full power, is that not so?

A. Yes.

Q. And a reactor trip at full power causes a shrinkage, does it not?

A. If the result is that T ave drops, then there will be a shrinkage.

Q. When T ave drops, then you have pressurizer level come down, is that correct?

A. If nothing else is operating, that is true.

Q. In March 1979, again looking at the charts, the HPI was throttled after about 4 minutes, is that correct?

A. I believe that is correct.

Q. And yet after the throttling of HPI, the pressurizer level continued up and went off scale high?

A. That is correct.

Q. And in March 1978, as you have already testified, the HPI was off and they went into the makeup mode at around 4 minutes and the pressurizer level stopped any significant rise and stayed below normal levels, is that correct?

A. That is correct.

Q. Looking at pressure in March 1979 there was a

pressure drop, was there not?

A. The pressure decreased from shortly after the reactor trip until some time after 5 minutes.

Q. One contributing factor to the drop in pressure was the fact that there had been a reactor trip at full power, is that correct?

A. The main reason for the drop --

Q. No, I asked you, one contributing factor was whether there was a reactor trip at full power. Can you answer that question?

A. One of many factors.

Q. That's one factor which did not exist in March of 1978, reactor trip at full power?

A. But it is not an important factor. It did not exist in March '78.

MR. KLINGSBERG: I move to strike that, your Honor.

THE COURT: All right, strike it out.

MR. FISKE: I think if we are going to develop the factors, we ought to develop the ones that the Doctor thinks are important.

THE COURT: I will leave you to whatever redirect you deem appropriate.

Q. I'd now like you to look at the behavior of pressure in the March '78 and the March '79 events. In the

March '78 event at about 4 minutes the pressure is more or less on an even keel, maybe slightly rising, is that correct?

A. That is correct.

Q. And that is about the time when the PORV was closed when the electricity came back on?

A. That's right.

Q. In March 1979 at about a little bit past 5 minutes the pressure starts rising, does it not?

A. That is right.

Q. That was due to the delay in putting the auxiliary feedwater on, was it not?

A. That had an influence.

Q. You wouldn't disagree, would you, Dr. Wallis, that based on this review of the three parameters there are many respects in which these events were not parallel?

A. That is correct.

Q. In the course of your review of events, did you at all study or review the Davis-Besse event of September 1977?

A. I did not.

Q. You have no familiarity with that at all?

A. No, I do not.

Q. You made no attempt to compare that event with Three Mile Island?

A. No, I did not.

Q. Are you aware that in that event, Davis-Besse in September 1977, there was pressurizer level high without HPI being on?

MR. FISKE: Your Honor, I am going to object. He said he didn't review it.

THE COURT: Sustained. Would you step out a minute?

(The witness let the courtroom.)

(Continued on next page.)

THE COURT: Mr. Klingsberg, it occurs to me on thinking about this initially that that might be a proper question to ask him assuming there is a basis for factual underpinnings of it.

On the other hand, it seems to me on second thought with regard to it that while you may observed of this witness one factor that does not exist, there may be 20 other factors that account for the thing also and that's what troubles me about comparisons with Davis-Besse when this witness has made no effort to do it.

Are you in a position to say that everything at Davis-Besse was or was not comparable with Three Mile Island at the time of the HPI?

MR KLINGSBERG: I think I am in a position to say that Davis-Besse was in many vital respects far more comparable to Three Mile Island than any of the events this witness chose to discuss.

THE COURT: But it was at low power itself, was it not?

MR. KLINGSBERG: Nine percent. There was some power.

THE COURT: So that's really not at all comparable in that sense to it.

MR. KLINGSBERG: But in regard to the --

THE COURT: You see, the thing is this. It

seems to me you are entitled to say to somebody, well, I have a situation here where HPI was turned on and this and that happened, which is different than what this witness says happened here.

On the other hand, we're in -- as I am coming to learn, we are in a field where there are four or five or six different things, all of which have enormous impact and unless you have got them all lined up to select one and say that that is a factor and that no longer does that do injury to your theory without all of the others being included in the witness' ken before you ask him about it, seems to me to be inappropriate too.

MR. KLINGSBERG: I think what I was leading to, which I think is within this witness' ken, is that the Davis-Besse event, and he's read the Dunn memo which talks about it where you had pressurizer level go screaming up off scale after the HPI was turned off because of saturation and the things that Dunn analyzed, is far more analogous and teaches far more dramatic lessons as related to Three Mile Island 2 than either the March 78 event or the three overcooling events which he purported to analyze.

THE COURT: Well, I think as a matter of judicial discretion, given the fluidity of this entire area that I'm not going to permit this type of cross-examination on an incident that hasn't been studied because of tne

inability to meaningfully get before a witness all of the factors.

If you want to say that there are lessons to be learned from Davis-Besse, you, of course, can argue that to the court from the record that's already been made. You are not foreclosed from that event.

MR. KLINGSBERG: Well --

THE COURT: I'll adhere to my original ruling.

MR. KLINGSBERG: Before the witness comes back in, I would like to mark as Exhibit 361 an exhibit which we have prepared using the witness' own mode of analysis which is to take the temperature, the pressurizer level and the pressure in the first ten minutes. And essentially that is all the witness has done in regard to the events which he's testified to.

He has not purported to make an analysis of what the procedures say to do or what the operators did. Certainly, what the operators do has an enormous effect on how a plant behaves. This witness purports to take ten minutes of pressure, pressurizer level and temperature and draw conclusions. And I think he's smart enough to withstand examination based on these parameters as indicated in this exhibit and we're showing him the factors we wanted him to focus on.

MR. FISKE: Mr. Klingsberg is again

misconceiving the functions of an expert witness and particularly Dr. Wallis. He hasn't drawn any comparisons or conclusions. All he's done is show what the movements were in pressure and temperature and what he says accounted for it. We'll make the arguments from there.

If Mr. Klingsberg wants to make some argument later, and it wouldn't surprise me if he did, that he thinks that the Davis-Besse transient is more comparable to Three Mile Island than any of the prior incidents at Met Ed, he's perfectly free to make that argument and I'll argue the opposite. But why ask Dr. Wallis who knows nothing about the Davis-Besse event to now look at some chart that Mr. Klingsberg has prepared and express some ultimate conclusion as to whether that is more relevant to the Three Mile Island 2 accident than the prior transients.

That's what we object to.

MR. KLINGSBERG: Here is a question that Mr. Fiske asked at 6518.

"Q. From your analysis, Dr. Wallis, of what happened at the Three Mile Island accident in any part or any respect in the movement of system parameters that you studied with respect to the accident, did you find anything comparable to the phenomenon which you just described as reflected in the GPU analysis of the April 23rd event?"

Well, he's just looking at these three things

and he's drawing from patterns and it seems to me I can ask him questions in regard to what conclusions, if any, he draws from these patterns.

THE COURT: As I have observed earlier, there are so many things that can effect this; what the level of power was, what the various pumps were when they were on and when they were off and just to throw this chart in doesn't really tell us anything.

MR. KLINGSBERG: Well, I don't think he's taken those factors into consideration in the four or five events that he studied.

THE COURT: He has. He's done that with his exhibits to a great extent.

He has a familiarity with what happened behind each of these lines and these exhibits from 4059 on. He can tell you when the block valve was closed on 3/29/78 and that accounts for this and so on and so forth. But he doesn't know what happened at Davis-Besse behind these lines at all. And it is that that troubles me about this examination. I think your chart may be admissible under other circumstances or you would make an argument from it but I don't think it is appropriate to get into that with this witness on cross-examination because of all of the various factors in the background.

I think it is improper permissiveness of

cross-examination.

I'll sustain the objection.

Bring the witness back, please.

(Witness resumed)

CROSS-EXAMINATION (Cont'd)

BY MR. KLINGSBERG:

Q. Now, in terms of your booklet of patterns of movement of temperature, pressurizer level and pressure in these various events, B & W 4059, you have shown, have not, some overcooling transients where at times ther[illegible] decreasing level and decreasing pressure, have you n[illegible]

A. That is so.

Q. And some overcooling transients at sometimes when there was increasing level and increasing pressure?

A. That is correct.

Q. And in the April 23rd transient as indicated on the exhibit 2053, which is attached to the B & W report and should also be reflected, if you look closely at your charts, and this overcooling transient, there was a time, was there not, when pressure was going down and pressurizer level was going up?

A. That is correct.

Q. And it is also apparent from at least a portion of the time in your November 7 transient that there was a portion of time when there was increasing pressurizer level

and, more or less constant pressure?

A. To which part of this transient are you referring?

Q. I am referring to the period at around two minutes where pressurizer level starts up and pressurizer level is still more or less on a flat line?

MR. FISKE: You said pressurizer level twice.

Q. I mean where pressurizer level was up and pressure was more or less on a flat line?

A. You mean at two minutes on 11/7/78?

Q. Yes.

A. That's hard for me to say because at two minutes what I see is pressurizer level increasing and pressure increasing. That the kink is at the same place in both curves.

Q. That's a point, is there not, where pressurizer level is rising rather -- there is a point where pressurizer level is rising rather sharply and pressure is maybe a very slight incline but rather flat?

A. You are referring to the time around two minutes?

Q. Yes. In and around that time.

A. You have to be aware that we don't know exactly when this occurs and we're splitting hairs over a few seconds. I see at two minutes the rise being almost simultaneous in both curves.

Q. Now, in the first ten minutes on March 28, 1979, there was increasing pressure and increasing level for a time, was there not?

A. Would you please refer me to what part of this curve you are referring to?

Q. At around a little bit past five minutes.

A. At about 5:20?

Q. And also in the first few seconds?

A. Let us be clear here now.

What I see --

Q. My question is: Was there any point in time that you see on your charts on March 28, 1979, where pressure was increasing and pressurizer level was increasing at the same time?

A. There is a point fairly on after the reactor trip, that short spike at the beginning.

Q. And there is also a point in time, is there not, on March 28, 1979, where pressure is decreasing and pressurizer level is decreasing?

A. That is correct.

Q. And there is also a point in time, is there not, on March 28, 1979, where pressurizer level is increasing and pressure is more or less constant?

A. There is a point in time, yes.

Q. And there is also a point in time, is there not,

on March 28, 1979, where you have increasing pressurizer level and decreasing pressure?

A. That is so.

Q. So it is fair to say, is it not, that the trends in the three exhibits for the TMI-2 event go in many different directions during the first ten minutes?

MR. FISKE: I will object to that, your Honor, unless Mr. Klingsberg talks about what he means by a trend. I think a trend is defined for a duration of time.

MR. KLINGSBERG: I don't think the witness needs to be coached in that respect.

MR. FISKE: It is not a question of coaching a witness. It is a question of common sense in an unfair question.

THE COURT: Using the word, how do you define the word trend?

THE WITNESS: I define it it as being a continued variation in a certain direction for more than an instant of time. It would have to extend, let's say, over three of the dots on this graph to really say it was a trend.

THE COURT: Using trend as you understand it, can you answer the question?

THE WITNESS: I would need to have the question back.

THE COURT: You may have it back.

(Record read)

MR. FISKE: Your Honor, I'm sorry to interrupt, but --

THE COURT: It seems to me the answer is either yes or no.

MR. FISKE: If he means comparative trends, obviously, but one line is going in another direction and the other line is going in another direction. To that extent, the question is meaningless. I think what Mr. Klingsberg is getting at is the relationship between pressure and pressurizer --

MR. KLINGSBERG: I'm not getting at that. I think with all the answers by Mr. Fiske, the witness' answer won't be much help.

THE COURT: Mr. Fiske, I'll let the witness answer and his applying of the word trend.

THE WITNESS: I have trouble with the word many. There are movements in different directions.

Q. Now, if you have saturation and that creates steam voids in a reactor system, the pressure must drop, is that correct?

A. That is incorrect.

Q. It is incorrect?

A. Yes.

Q. That you can get to saturation without the pressure dropping?

A. You can get to saturation -- Mr. Klingsberg, throughout a long period of this accident conditions were at saturation and pressure and temperature were going up and down.

Q. But the pressure has to drop from its normal level of 2200 PSI which occurs during the course of a transient in order to get to a saturation point, does it not?

A. That's a different question.

Q. Okay.

A. Given that the temperature in the reactor system is not overly high, that is a correct statement.

Q. Now, and if the temperature and the pressure are at their normal levels of operation, in order to get to saturation, the pressure has to drop?

A. Or the temperature has to rise.

Q. And among the things that can cause a depressurization are an overcooling event?

A. Yes.

Q. Or a loss of coolant accident?

A. Yes.

Q. Can a spray valve failure cause a depressurization?

A. Yes.

Q. Now, if pressure is dropping from its normal level of 2200 to saturation point and temperature is dropping, as it would after a trip, you'll actuate HPI automatically, will you not?

A. HPI is normally set to actuate at 1650 PSI. It is necessary to reach the actuation point before it will actuate automatically.

Q. Now, if you have an overcooling event, such as on 4/23, you have a contraction, temperature comes down, pressure and level come down; is that correct?

A. That is correct.

Q. And the pressurizer level comes down about 220 inches below the readable scale in about a minute, is that right?

A. We're referring to this particular event not an event such as --

Q. The April 23rd event.

A. If it is a specific event, yes.

Q. And the steam void, if there was a steam void, didn't cause any large pressurizer level increase in that event, did it?

A. Would you be more specific?

Q. The steam void, if there was a steam void, did not produce any results in the pressurizer above the

readable scale?

A. I am unable to be sure about that. It may be that the level was higher than it would have been without the void if there had been one. There is no way in looking at the figure I could tell.

Q. Now, then HPI comes on at 1000 gallons per minute, is that right?

A. If two pumps are running and the pressure is low, that is a correct statement.

Q. And that's what happened on April 23rd; is that correct?

A. I don't know. HPI came on.

Q. You know that HPI came on?

A. Yes.

Q. And somebody looking at the pressurizer level gauge with the HPI coming on wouldn't be able to see any effect of any voids, would they?

A. I don't know what somebody might have been able to see.

Q. Isn't it a fact that the rise in pressurizer level from the HPI coming on full force would overcome any effect that might be seen with the visible eye from any saturation?

A. That is not a correct statement.

Q. On the April 23rd event?

A. The only way I can answer your question is to know more about whether there was or was not a bubble, how big it was. I have not researched that.

Q. And you can't tell that from reading the reports which you have read?

A. No, I cannot.

Q. Now, in fact, looking at the pressurizer level which you have studied on April 23rd, were you able to detect any effect of saturation or voids as recorded on the control room instruments?

A. I did not make an assessment of whether or not there were voids at that time.

Q. And just looking at the pressurizer level, you couldn't make any assessment as to whether there were or there weren't any?

A. Let's look at if that is hypothesized, that someone suggests there is a void, just looking at the level without knowing anything else, I could not immediately say. Because with any void it will influence the level in some way and it has to be determined.

Q. The fact that with the HPI on when there are bubbles, the effect of the HPI is to collapse the bubbles, is that correct?

A. If the HPI, which is cold, is able to contact the bubble and the HPI is going to a place where the bubble

is, then the likelihood is that the bubble will be collapsed.

Q. And isn't it a fact that the voids will slow the rate of HPI because the HPI has to repressurize the voids while it is refilling the pressurizer with water?

A. That in general is not always true.

Q. But it can be true?

A. I think of situations where it can be true.

Q. Would that have been true on April 23rd based on the GPU analysis?

A. I have not studied the details of the analysis. I have no idea whether it is correct or not.

Q. And you have already testified, I believe, that when pressurizer level hit the normal mid level point and HPI is throttled or turned off into the makeup mode, as it was on April 23rd, the level will not get above its normal level?

A. That's what normally would be expected.

Q. And the fact that you collapsed the bubbles with HPI, if that occurs in an event such as April 23rd, would not cause the level, the pressurizer level to come down after the voids are collapsed, would it?

A. It might.

Q. That's not what happened on April 23rd?

A. I don't know if there were any voids on April

23rd.

Q. How long would it take with full HPI of 1000 gallons per minute to collapse a bubble such as GPU estimated on April 23rd?

A. I don't know.

Q. Now, if you have a loss of coolant accident, let's take the example of what has been called a major rupture, guillotine break, pressurizer level and pressure come down rapidly, do they not?

A. I am not an expert on the so-called reference breaks or licensing breaks. I have not studied generic accidents.

Q. You don't know that if you have a guillotine break across a pipe in the hot legs your pressurizer level and pressure are going to come down?

A. I have not -- this is not my area of expertise. I would have to think about that because I'm not in the business of making general statements about all loss of coolant accidents.

Q. I'm not asking about all loss of coolant accidents. I'm asking about a major rupture, a guillotine break?

A. A major rupture -- all right, where is the major rupture?

Q. Have you ever heard the expression maximum

credible accident?

A. Indeed I have.

Q. During a maximum credible accident, loss of coolant accident, can you say that pressurizer level and pressure will come down rapidly?

THE WITNESS: Your Honor, this credible thing is redefined all the time by the government. It is not -- I prefer not to answer that question because what is credible or incredible depends upon who is believing it.

Q. And I take it if you can't answer my question in regard to a major rupture or a guillotine break, you can't answer it in regard to an intermediate size break above, say, .05 square feet or what Mr. Fiske calls a 007 James bond break or what we call a Michelson size break?

A. It depends -- I have not made a study of breaks of different sizes and different locations under different circumstances. That is not my area of expertise.

Q. And you can't say without making a study that in a large break loss of coolant accident pressurizer level and pressure are going to come down rapidly?

A. That is what -- you know, I prefer -- at this moment that is what I would expect, but I just have doubts about my expertise because this is not the area in which I claim to be knowledgeable about that general hypothesized break.

Q. And in the case of a large break where pressure comes down rapidly, you would expect the HPI to actuate, would you not?

A. Yes, I would.

Q. And do you know that in that size of a break saturation forms very quickly?

A. I do not. This has never occurred. All the scenarios are hypothetical.

Q. So you don't know whether it happens or not?

A. I don't.

Q. In the hypothetical scenarios after the Three Mile Island accident, does saturation form in such an event?

A. I have not studied hypothetical scenarios that were analyzed after the Three Mile Island break.

MR. KLINGSBERG: I don't know what your Honor your Honor's pleasure is. I won't be able to finish by 1:15 today.

THE COURT: How long will you require?

MR. KLINGSBERG: I'd say probably an hour and a half. Possibly two hours.

THE COURT: Can you return on Monday?

THE WITNESS: I can do what I can to get here on Monday. I don't have my calendar. I believe I can.

THE COURT: All right, we'll be in recess until Monday morning.

MR. KLINGSBERG: I haven't covered the scenarios that Mr. Fiske went through or the hot functicnal testing.

THE COURT: Is 10:15 --

THE WITNESS: I can get here by 10:15.

THE COURT: We'll be in recess until 10:15 Monday morning.

(Whereupon the evening recess was taken)

WITNESS INDEX