NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING APPEAL BOARD

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In the matter of: :

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

(Three Mile Island Nuclear Station, : (Restart)

Unit No. 1) :

- x

Nuclear Regulatory Commission

Fifth Floor Conference Room

4350 East-West Highway

Bethesda, Maryland

Wednesday, March 16, 1983

BEFORE:

GARY J. EDLES, Chairman

Administrative Judge

DR. JOHN H. BUCK

Administrative Judge

DR. REGINALD L. GOTCHY

Administrative Judge

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APPEARANCES:

For the Nuclear Regulatory Commission:

JAMES M. CUTCHIN IV, ESQ.

Nuclear Regulatory Commission

Washington, D.C.

APPEARANCES: (Continued)

For Metropolitan Edison:

THOMAS A. BAXTER, ESQ.

Shaw, Pittman, Potts & Trowbridge

1800 M Street, N.W.

Washington, D.C. 20036

For Commonwealth of Pennsylvania:

ROBERT W. ADLER, ESQ.

WILLIAM F. DORNSIFE

Department of Environmental Resources

Bureau of Regulatory Counsel

101 South Second Street

505 Executive House, P.O. Box 2357

Harrisburg, Pennsylvania 17120

For Union of Concerned Scientists:

ROBERT D. POLLARD

ELLYN R. WEISS, ESQ.

Harmon & Weiss

1725 I Street, N.W.

Suite 506

Washington, D.C. 20006

C O N T E N T S

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EXHIBITS:

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PROCEEDINGS

(9:00 a.m.)

JUDGE EDLES: Please be seated. Good morning.

This morning we will reconvene our reopened hearing.

Yesterday the Board granted the motion of the Licensee to present Mr. Correa for the limited purpose of introducing certain evidence and correcting certain issues from last week. But before Mr. Correa takes the stand, are there any matters that we need to take up in advance?

MS. WEISS: Yes, Mr. Chairman.

We would like to ask that Mr. Ornstein, who is scheduled to testify after the last Staff witness, be sequestered during the testimony of the witnesses on PORV condenser.

One of the purposes of having his testimony is to explore the differences between the Staff and AOD and I think it is important not to have him hear the questions and answers.

MR. CUTCHIN: I would object, Mr. Chairman, because I understood that the purpose for which Mr. Ornstein's testimony was requested was to explain any differences of opinion that the AOD may have had regarding the paper that was filed by Mr. Denton in

last July. His comments were made on that paper, and it was as a result of those comments that the questions were raised. So I think it would be totally inappropriate to exclude him from hearing --

JUDGE EDLES: What would be the prejudice to the Staff's position if Mr. Ornstein were sequestered?

MR. CUTCHIN: I don't see that there would be any prejudices, Mr. Chairman, but I think there ought to be some justification for sequestering before it is granted.

JUDGE EDLES: When you say it would be inappropriate, can you explain a little bit more other than the fact that we ordinarily would allow witnesses to sit and listen?

MR. CUTCHIN: I think, Mr. Chairman, if indeed he is to explain the differences in views that the office held at that point in time, I don't see how he would be influenced one way or the other by hearing this testimony. Therefore, I see no justification of having him excluded from hearing the testimony. I think it is just a bad precedent, to start sequestering witnesses with no justification.

JUDGE EDLES: Mr. Baxter, any observation?

MR. BAXTER: Does the request go to the Licensees, the presentation of Licensee's testimony, as well?

MS. WEISS: No.

MR. BAXTER: I have no position on the request other than to note that in this case the witnesses already presumably had access to the direct testimony, so I don't quite see the purpose of it.

JUDGE EDLES: Mr. Adler, any observations?

MR. ADLER: The Commonwealth would support the motion.

In response to Mr. Cutchin, I think, as Mr. Baxter pointed out, the witness has had ample opportunity to evaluate the Staff's position, and I wouldn't see the need for him to be present today to review the UCS cross-examination.

JUDGE EDLES: As I understood it, though, Ms. Weiss said she didn't object to him being here for the Staff presentation -- I'm sorry -- for the Licensee presentation, which we will undertake starting this morning.

Why don't I defer ruling on the motion, since we will be doing, I believe, only the Licensee's witnesses this morning and give you a ruling on it perhaps first thing this afternoon, or certainly before the Staff's presentation.

MS. WEISS: There is a precedent in this case, Mr. Chairman, as you consider for sequestering the

witnesses in various circumstances. UCS asked for sequestration; it was granted by the Licensing Board for the hearings.

JUDGE EDLES: In what context?

MS. WEISS: It's hard to recall -- what I recall the justification was, we intended to ask essentially the same questions of a group of witnesses, and it was important for us to see the differences, the honest differences in opinion --

JUDGE EDLES: Do you recall, Ms. Weiss, whether that was the management phase or the technical phase?

MS. WEISS: It was the technical phase.

JUDGE EDLES: Okay. I think we can defer ruling on the matter until later today.

Anything else?

MS. WEISS: Yes, Mr. Chairman.

We wanted to state for the record that the filing which was ordered by the Board to be served on all the parties by the Staff to respond to BN-8321 by close of business last Friday was not received by UCS until 10:00 a.m. Monday.

We, of course, believe that that has impeded our ability to be prepared as well as we might wish to be. We did not ask this Board for relief, because frankly our schedules are so tight next week that it would hurt us

more to have this hearing deferred than to go forward with it.

I wanted to add that it is also our view that the Staff's response is nonresponsive to the first issue raised in BN-8321. The issue raised with respect to Dr. Lahey's testimony was the undesirability of raising steam generator level to 95 percent for all cases of loss of forced circulation.

JUDGE EDLES: Ms. Weiss, let me ask you why that type of argument isn't better reserved for the briefs rather than at this stage?

MS. WEISS: Well, I certainly intend to make it on the briefs.

JUDGE EDLES: I have no objection to your noting it now for the record, but why shouldn't we just take it up in a detailed fashion as part of your presentation on the brief.

MS. WEISS: My only purpose for bringing it up here was in case the Board was interested in that issue that we might want to direct that the Staff's response address itself to that issue rather than wait until the end.

JUDGE EDLES: Thank you.

Anything further?

MS. WEISS: We have received from Mr. Cutchin, as of midday yesterday, and the Board, I assume, has also received, a letter -- I'm not quite sure of the status of it. What it seems to do is object -- renew an objection, or raise new grounds for an objection to the appearance of Mr. Ornstein as a subpoenaed witness for the Union of Concerned Citizens.

I don't know what the Board wants to do with that, although we would strongly object to him appearing as a witness for the Staff rather than as a witness for UCS.

And if you want to hear arguments on the merits of that letter at any point, we are prepared to do it.

JUDGE EDLES: I read the submission, and without getting into the merits of whether Cutchin on evidence or Edles on evidence is right, since neither one of us cited to any authority, it does seem to me that it doesn't make an awful lot of difference, unless you can explain to me why it does.

MS. WEISS: It seems to us, Mr. Chairman, to have some potentially serious significance, because the party under whose aegis Mr. Ornstein appears will determine the scope, at least in the first instance, of his testimony

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by virtue of the questions asked on direct, and we do not intend for him to be transformed into a Staff witness, and we have no idea what Mr. Cutchin might want to ask him.

You know, the fact is, we made a motion under the subpoena rule. You granted UCS's subpoena.

I don't think there were any grounds stated in that motion for transforming him from a subpoenaed UCS witness to a Staff witness.

JUDGE EDLES: I think I can certainly accommodate any need you might have to cross-examine more broadly than Mr. Cutchin's direct testimony might elicit, and I'm really not sure why at this stage, if that is the principal concern, why we ought to spend any time on what I think to be essentially an academic question, interesting though it may be.

MS. WEISS: Actually, my concern is quite the opposite, that he may be asked a series of questions much broader than those that we are prepared to ask him in a preemptive attempt to rehabilitate him or change the report of those documents; and we think that ought to clearly be on cross, and that we have the right to set the scope of direct, and they have a right to cross him.

JUDGE EDLES: All right.

Why don't I take that under advisement, as well, since we are not going to get to Mr. Ornstein this morning,

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anyhow.

MS. WEISS: Just one last question. In preparing for today's cross, we are unclear about the status of the document which was cited -- it was one of the documents that was cited in ALAB-708. It is the letter from Mr. Eisenhut to Mr. Mattimoe, B&W's owners' group, dated March 22, '82, and attachment entitled "Staff's Concern of the B&W Small Break Model."

It was also referenced by Mr. Jensen in his affidavit in response to the Board questions on this.

JUDGE EDLES: Was that a footnote reference?

MS. WEISS: Yes.

JUDGE EDLES: I remember it. But I don't remember exactly which footnote it was now.

Well, maybe you can just tell me what it is that is of concern.

MS. WEISS: We just wanted to sponsor it as a UCS exhibit to make sure it is on the record, since it has been cited, and it was in a real sense, kind of genesis on these issues on the adequacy of the B&W model during the small break loading.

JUDGE EDLES: Any problem, Mr. Baxter?

MR. BAXTER: I don't object to having it marked for identification, but we object to its admission. It is just another piece of correspondence in a complicated

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history that has been made available to the Appeal Board, and may have played some role in reopening the proceeding, but the contents of that letter have not been set forth as the Staff position raised in the reopened proceeding.

JUDGE EDLES: Again, I can't locate it in the opinion, although I do recall it being in a footnote, and I think that we intend to use it simply to take official notice of it for the purpose of reopening the record, although if it is not contained in the record, we wouldn't rely on it for evidentiary purpose.

Why don't we again wait for that until we --

MS. WEISS: Here it is. It's in footnote 39 on page 33 of ALAB-708.

Your order says March 25. I'm not sure which one of us has the date wrong. But it is certainly the same letter.

I'm sorry, Mr. Chairman. I think it is a different letter. We will have to look through it.

JUDGE EDLES: It may be the one you are referring to in footnote 40.

Again, if you want to doublecheck and get back to me at the afternoon session --

MS. WEISS: All right, Mr. Chairman.

JUDGE EDLES: Fine. If there is nothing else,

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we will put Mr. Correa on the stand.

MR. BAXTER: Licensee calls James H. Correa to the stand.

JUDGE EDLES: Just one quick question, Mr. Cutchin, if I might.

My copy of the Staff's report does not contain a service list, indicating when the document was actually served.

Do you know when it was served, how it was served?

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MR. CUTCHIN: The directed follow-up to 8320?

JUDGE EDLES: That's correct.

MR. CUTCHIN: Yes, sir, Mr. Chairman. The documents were picked up by the courier at a few minutes to 3:00 o'clock on Friday afternoon, with instructions to deliver them to the Board and to UCS, and Applicant's counsel, Licensee's counsel.

It is my understanding that there was some snafu between one courier and another, and as a result of his having duties to go someplace else, he did not arrive at the offices of either UCS or Mr. Baxter until sometime after 6:00. It was just a foul-up. It was set up to go right. It didn't.

MS. WEISS: Mr. Chairman, there was somebody in my office until well after 7:00 o'clock on Friday, and it never

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appeared.

MR. CUTCHIN: I cannot pin down the "well after 6:00," other than to say that it was sometime before 9:00, because that is the time he logged out, and the courier to whom I spoke said he was unable to say exactly what time after 6:00, but he had to say it was after 6:00.

JUDGE EDLES: Mr. Correa, would you stand, please.

Whereupon,

JAMES H. CORREA,

called as a witness by counsel for the Licensee, being first duly sworn by the Chairman, was examined and testified as follows:

DIRECT EXAMINATION

ON BEHALF OF THE LICENSEE

BY MR. BAXTER:

Q Would you please state your full name and your title and the name of your employer.

A Okay. My name is James H. Correa. I'm a mechanical components engineer for GPU Nuclear.

MR. BAXTER: I would note at this point that Mr. Correa's professional qualifications are already included in the record before the Licensing Board following transcript page 8746.

BY MR. BAXTER:

Q Mr. Correa, I want to ask you about --

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JUDGE EDLES: Mr. Baxter, I think your mike may not be on, or it is too far away.

Thank you.

BY MR. BAXTER:

Q. In the proceeding last week, Mr. Correa, Mr. Lanese testified at transcript page 145 that he believed the safety valve set pressure -- I'm sorry. I've forgotten one question. Let me go back.

First, would you tell us, for the record, please, Mr. Correa, the nature of your responsibilities with respect to the safety valves at TMI 1 and the EPRI safety and relief valve test program?

A. My main responsibilities for the safety valves as they relate to the TMI 1 valves include providing technical guidance for the ISI requirements for these valves.

Q. ISI is --

A. In-service Inspection Requirements. That includes the set point pressure testing at Wiley Labs, and the specification to perform that set point testing, and also to provide surveillance at Wiley Labs for the set point testing. And I also was involved in providing technical justification for the relocation of the safety valves from the loop seal to the pressurizer nozzle.

As far as my responsibilities pertaining to the EPRI test program, I was the GPU nuclear technical contact for the EPRI testing. Whenever EPRI needed specific technical data for the TMI plant, I was the one

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responsible to send it to EPRI. And when EPRI did disseminate various data, it came to my attention, and I would review it and then disseminate it to other GPU nuclear personnel.

Q. Thank you.

Let me return again to Mr. Lanese's tesimony of last week at approximately transcript page 145.

He reported his belief that the safety valve set pressure tolerance was plus or minus 6 percent.

What is the correct set pressure tolerance for the TMI 1 safety valves?

A. The correct set point pressure tolerance for the TMI 1 safety valves is plus or minus 1 percent. This is an ASME Code Section 3 requirement, so therefore at the TMI 1 plant, the valves are set at 2500 pounds plus or minus 25 pounds.

Q. Also, at approximately transcript pages 170 and 171, there was some confusion left on the record with respect to whether one or two safety valves were considered to be opened in calculating a plant specific back pressure for TMI 1.

Exactly what is the situation with respect to the assumptions on valve opening for that calculation?

A. The analysis performed for TMI 1 were only for one safety valve opening. There was an engineering

evaluation performed by our architect engineer, and it was decided that since the common header is 125 feet away from the valves, in other words, the valves have -- one valve has 125 feet of discharge piping before it enters the common header, and the second valve has 137 feet of discharge piping before it enters the common header, and at the common header it goes from a 6-foot pipe to a 10-inch pipe, that there would be choked flow at this expansion and therefore one valve would not see what the other valve is doing; and this was also verified by earlier EPRI calculations for TMI.

EPRI did back-pressure calculations for all the utilities and for TMI with one valve opening and then they also did the same calculations with all three valves opened. That is the two safety valves plus the PORV and the difference in back pressure was less than half of 8 percent. So, therefore, GPU feels that a single valve opening is reasonable for this back-pressure calculation.

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Q Is that your view as well?

A Yes, it is.

Q All right. I would like to turn to the question posed by Mr. Lanese by the Union for Concerned Citizens, the answer which was stricken, at approximately transcript page 147.

Mr. Lanese was asked the question, "You are saying that the 31 test, which as I understand your testimony, constituted 32 openings and closings, is in your view a satisfactory demonstration of the ability of these valves to perform as they will be required in TMI Unit 1 during feed and bleed."

Before you answer that question, are you the expert to which Mr. Lanese referred in his answer?

A Yes, I am.

Q Would you answer the question, then?

A Yes. It is my position that the 31 tests provide satisfactory demonstrations of the ability of the valves to perform their intended functions.

The valves did cycle a total of 32 times. These cycles have to be broken down into various groups, to get better understanding.

The first 25 tests included 25 cycles. Some of these tests were on short inlet piping, some were on long inlet piping. On the long inlet piping tests with both

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drained and filled loop seals, the valve experienced flutter or chatter.

There were four tests, and the fluttering lasted between .14 seconds to 1 second. In these four tests, it fluttered for approximately 1.65 seconds totally. The flutter was on the order of 100 cycles per second.

Therefore, during these four tests, the valves saw at least 165 cycles of flutter. So in the first 25 tests, which included this flutter, the valve did not experience any detrimental damage which would impair the ability of the valve to perform its intended function.

MS. WEISS: Could I ask that you slow down a little bit, Mr. Correa. We are hearing this stuff for the first time.

THE WITNESS: I'm sorry.

MS. WEISS: That's okay.

THE WITNESS: On the 26th test, this was a filled loop seal test on 400-degree subcooled water.

MS. WEISS: You are not slowing down.

THE WITNESS: I'm sorry.

On the 26th test filled loop seal, 400-degree subcooled water, the valve experienced chatter for approximately 12.5 seconds.

I should also mention that the flutter and the chatter phenomenon were caused by the inlet piping

arrangement, and not the valve itself.

So it chattered for 12.5 seconds Again, if it is approximately 100 cycles per second of chatter, this is approximately 1,250 cycles. The valve did exhibit damage to several internal parts, but the test showed, because the test had to be manually stopped -- they previously pulled a rope to lift the valve to its full open position to relieve system pressure -- the test showed that the valve was responding to the system inlet pressure the way it is supposed to through all these 1,200 cycles.

So that test, even though it was a failure from a system test standpoint, showed that the valve did perform in response to the system pressure.

The last five tests, which included 6 cycles, and these were all on the short inlet configuration -- there was one steam test, one transition test, and three water tests -- the valve performed its intended functior and sustained no damage.

So, in summary, I would have to say that except for that 26th test, the valves demonstrated that there was no wear to the internal parts, and wearing of the internal parts would indicate valve degradation, and would also affect the ability of the valve to perform its intended function.

The 26th test showed that even though the valve did sustain damage, the valve was responding to the system pressure the way it was supposed to.

BY MR. BAXTER:

Q Mr. Correa, did that answer all deal with one valve, all those tests?

A Yes. They were all one valve for all those tests.

MR. BAXTER: Thank you, Mr. Chairman. That concludes our direct.

JUDGE EDLES: Ms. Weiss, do you need a moment or two to prepare for cross-examination?

MS. WEISS: I think about five minutes would be helpful.

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

(Recess)

JUDGE EDLES: Please be seated.

Are you prepared to go forward, Mr. Pollard, or should we wait a moment or so?

MR. POLLARD: Could you just wait a moment. She will be right here.

JUDGE EDLES: Sure.

I suspect that in light of the Board's performance last week, where 20 minutes turned into an hour and a half, one might have reason to believe that when we say five minutes, it might be a moment or two more than that.

MS. WEISS: Mr. Chairman, I would like to register our continuing objection to the appearance of this witness, particularly without having prefiled written testimony. There is no reason why that couldn't have been filed in advance. This is the first time we have heard of the 1200 cycle chattering. We have not had an opportunity to check the EPRI results, and we are severely prejudiced in our ability to do this this morning.

CROSS-EXAMINATION

ON BEHALF OF INTERVENOR

BY MS. WEISS:

Q. Mr. Correa, there is no reason why you couldn't have put what you just said in writing last week, is there?

MR. BAXTER: Objection, Mr. Chairman.

JUDGE EDLES: Sustained.

BY MS. WEISS:

Q. Did you review all of Mr. Lanese's prefiled testimony before it was filed?

A. I may have given Lou some information, but I do not remember reviewing his prefiled testimony.

Q. Did you observe this 26th test where the valve chattered for approximately 1200 cycles?

A. No, I did not.

Q. Did you observe any of the EPRI tests on the TMI model safety valve?

A. No, I did not.

Q. Can you tell me what the ring settings were for this 26th test?

A. This 26th test, which was a long inlet configuration test, the ring settings were upper ring, minus 48 notches; middle ring, minus 40 notches; lower ring, plus 11 notches.

Q. Do those correspond to the current ring settings for the TMI safety valve?

A. Yes, they do.

Q. Those are exactly the same?

A. Yes.

Q. What was the inlet piping configuration for this 26th test?

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A. It was a long inlet configuration, loop seal configuration.

Q. Can you tell me, if you didn't observe the test, does your information come from a written report?

A. It comes from the EPRI report, yes.

Q. Do you have it with you?

A. Yes, I do.

Q. May I see it, please.

(Document handed to Ms. Weiss.)

Q. Can you identify for me the portion of this report where the 26th test is described.

A. Okay. This is EPRI PWR safety and relief valve test program, safety and relief valve test report, and --

MR. BAXTER: Is there a date on the document?

THE WITNESS: It is dated September 1982.

Starting at section 3.1, it describes the testing performed on the Dresser safety valve model 31739E.

BY MS. WEISS:

Q. Can you identify for me where the 26th test is described?

A. Okay. The 26th test is described on page 3-5 under Water Tests; again on table 3.1.1.B it is identified as test 1030; in table 3.1.1.C, again test 1030; table 3.1.1.D, test 1030.

Q. Thank you.

Was the valve relieving steam or water during the 26th test?

A. As I said earlier, it was a water test using 400-degree water.

I will have to correct myself on that. It was 550-degree water.

Q. I'm looking at page 3-5 of the document which you just identified, which you said was the source of your knowledge with respect to this test. Page 3-5 has a paragraph labeled "Water Test." Am I in the correct place?

A. Yes, you are.

Q. There is one sentence -- let me read the entire paragraph.

"Two high back-pressure water tests performed at nominal water temperatures of 650 and 550 degrees Fahrenheit. The first test was 650-degree water test; the valve opened, had closed, and 503 percent blowdown."

That is not the one?

A. No.

Q. "During the 550-degree water test, the valve opened and chattered; the test was terminated after the valve was manually opened to stop chattering."

That is the test we are talking about; correct?

A. Yes.

Q. And that is the entire description of that test in here?

A. No, it's not. As far as the written description, yes.

You would have to go into the tables -- okay. This report does not give the chatter time. It only summarizes the EPRI tests. There was other documentation from EPRI which did give the length of time for the chatter.

Q. Which wasn't appended to your testimony or served on the Board in any way, that you are aware of?

A. Not that I'm aware of, no.

Q. Could you describe to me the damage to the internals after the 26th test?

By the way, Mr. Correa, you don't have this further test report that you discussed with you, do you?

A. Yes, I do.

Q. May I see it?

A. Okay. This is dated that EPRI sent out in January 1982, EPRI/CE, BWR Safety and Relief Valve Test Program, Data Summary Sheets for Safety Valve, Dresser Industries, Model 31739-A, and this is test number 1030.

Under note 2 under comments and observations, this was where they discuss the 12-and-a-half-second chatter.

Q. I would like to read that note into the record, the one you just referred to.

Note 2: "The valve opened at 24008" -- scratch that -- "2408 psia. It began to flutter immediately and began to chatter approximately .08 seconds later. The chatter lasted approximately 12.5 seconds and was arrested by pulling the rope attached to the lifting lever. The rope stabilized the valve at a pressure of 2275 psia. After this the test was aborted and the system was depressurized immediately. Due to the chatter and subsequent rope pull and depressurization, the flow rate test duration and re-seat data are not available."

That is the test you are describing?

A. Yes, it is.

Q. And it doesn't say anything in there about how many times the valve opened and closed.

Could you explain to me how you know that it opened and closed 1200 times?

A. When the flutter phenomenon on the long inlet piping was first observed, EPRI set up a test force to investigate this flutter, and this test force determined from the various data plots that the flutter was on the order of 100 to 200 cycles per second.

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Q Mr. Lanese made a distinction between flutter and chatter. Would you describe the difference to us, please?

A Flutter is the valve moving between intermediate lift positions. It does not come back and hit the seat.

Chatter is the valve moving from some lift position back to the seat, and then lifting again.

MR. BAXTER: Excuse me, Ms. Weiss. There is an unanswered question.

You asked Mr. Correa about the damage to this valve, and before he answered, you asked him some more questions.

MS. WEISS: Thank you. You are right.

I'm sorry.

BY MS. WEISS:

Q Could you describe the damage to the internals?

A I would have to have the report back, please.

Q Is it true that your sole knowledge about these tests comes from the reports which EPRI sends to you?

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A Yes.

Q We are going to save that question while we have this document in front of us, so that we can go through anything else that we may have.

You reminded me. I'll ask it again.

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BY MR. POLLARD:

Q Did I understand your last answer correctly, that the information as to how many times the valve cycled per second came from a timing of the flutter and not from the timing of the chatter; is that correct?

A No. The oscillations were, I believe, measured by the pressure waves in the inlet piping, and also by trying to measure stem position, whether it be flutter or chatter.

Q From the measurements of the valve, what does the rate of -- how does the rate of flutter compare with the rate of chatter?

// A The EPRI reports, when they talked about flutter and/or chatter, made no distinction between the rate of one or the other. It was just saying that the valve was cycling at approximately 166 cycles per second, whether it be flutter or chatter.

Q Do you know whether or not they actually examined both phenomenon, in terms of how fast it is either fluttering or chattering?

A No, they did not examine each phenomenon separately, because, as I said, it was 100 cycles per second, and sometimes you really couldn't tell whether you were in a flutter cycle or a chatter cycle, because it was happening so fast.

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Q Did I understand your answer on the chattering phenomenon of the valve, that it lifts partially off the seat, does not go full open, and then reclose?

A I believe I said that chatter was opening to some position. This could be an intermediate position, or it could be a full open position. But it opens to some position, and due to system depressurization, the valve then closes, and as the system repressurizes, the valve then opens again in response to the system pressure.

Q During this 26th test, what was the blowdown set for on the valve?

MR. BAXTER: If you need the material back, feel free to ask for it, Mr. Correa.

THE WITNESS: On these safety valves, the valves are set for the steam blowdown, so therefore, the ring settings that were used were the steam ring settings to determine the water performance of the valve.

BY MR. POLLARD:

Q What was the steam blowdown setting, or what was the steam blowdown during the 26th test?

A There was no steam during the 26th test. It was 550-degree water.

Q If there had been steam, what was the valve set at in terms of blowdown?

A I believe that that ring setting would give a

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blowdown of in the rage of about 14 percent.

Q Okay. With a ring setting for a steam blowdown of 14 percent, what did the test show that the blowdown would be with water?

A On the short inlet configuration, the using these ring settings for water were in the range of 12 to 17 percent.

Q Can you tell me what the range of observed blowdown for water was with the long inlet configuration?

A There was one at 19.3 percent.

Q Now, this 26th test was the long inlet configuration with subcooled water; is that correct?

A Yes, it was.

Q All right. During the chattering of the valve, during the 26th test, what was the test pressure at the time the valve was closing?

A The data does not give the inlet piping pressure while the valve was in this chattering mode.

Q Well, is it correct, then, to say that if you don't know the pressure at which the valve was opening and closing during the chatter phenomenon, then you have no basis for relating that chatter phenomenon to what the valve would observe if it were relieving water in the feed and bleed mode at TMI 1; isn't that correct?

A I'm not really sure that I understand what the

j-6-5

question is, but this test was on a long inlet configuration, and when the same valve with the same ring settings was put on the short inlet configuration, it performed satisfactorily.

Q Perhaps I didn't phrase the question too well. Let me go through it in steps.

As I understand your oral testimony this morning, the effect of your testimony is to say that because of the chatter observed in the 26th test, which involved some 1,250 cycles of the valve, you therefore concluded that that test can be relied upon to demonstrate that this valve will perform properly on the short inlet configuration in TMI 1 during feed and bleed?

A Yes. The long inlet configuration had pressure oscillations in the pipe due to the physical arrangement of the pipe and the dynamics of the water in the pipe, and what was happening, the valve would sense system pressure in the pipe, telling it to open, and after the valve would open, a pressure wave would be set up, which would have to go all the way back to the pressurizer.

The time for this pressure wave to travel to the pressurizer and come back to the valve seat was longer than the valve opening time; therefore, the valve would open sensing system pressure, and then would sense a loss of

system pressure, and would therefore close, and then when this pressure wave came back to the valve again, it would tell the valve to open; the valve would open, and then the wave again would travel back to the pressurizer and as it was doing this, the valve would be sensing approximately 2,400 to 2,500 pounds, telling the valve to open. And then some lower value telling the valve that it would have to close, and this was causing the chattering phenomenon.

Q I understand that part of your testimony, that the valve chatters only with long inlet piping. I understand that.

That is not my question. Let me try it a different way.

How many tests were done at EPRI using the exact, or very similar configuration, and the exact ring settings that will be used at Three Mile Island Unit 1?

A There were 9 tests performed at EPRI using the short inlet configuration, and the ring settings used at TMI 1.

Q Now, of those 9 tests, how many were steam, how many were water, and how many were transition?

A There were five steam tests, one transition test, and three water tests.

Q. Of those nine tests, how many -- is it correct that tests 27 through 31 all were directly applicable to TMI 1?

A. Yes. They are the short inlet configuration with the TMI 1 ring settings.

Q. And the valve was refurbished after the 26th test; is that correct?

A. Yes, it was.

Q. Now, the question which we asked Mr. Lanese which you came back here today to answer, was: How can you take confidence from nine EPRI tests that this valve will perform reliably at TMI 1? It wasn't just nine tests. There was a total of 31 tests with the TMI 1 valve, and now you have told me nine were identical to the ones that were used at TMI 1.

If I understand your answer to that question of why should you have confidence of the EPRI test that the TMI 1 valve will work as it was predicted to open and close by the computer code analysis of feed and bleed, your response to that question was to point me to this chattering phenomenon and say there were a lot more than 32 openings and closings of this valve; there were in fact something like 1250. And that is why I came back to the original question. If you don't know at what pressure the valve was closing during this chattering phenomenon, how can you

then conclude that those 1250 openings and closings duplicate the performance that would be required of the TMI 1 valve were it being used in the feed and bleed mode?

MR. BAXTER: I just have to observe that I don't think that characterizes the direct. I don't think Mr. Correa said he was relying only on the 26th test for his degree of confidence about the capability of the valves to perform in feed and bleed. I think he relied on all 31, and he described the 26th test because it was unique.

BY MR. POLLARD:

Q. How many openings and closings are you relying upon from the EPRI test in order to gain confidence that the valve will work at TMI 1?

A. I looked at the total test program, and what I was looking at is the internals of the valve, the wear of the internals, the ability of the valve to respond to what the system requires it to respond to, and the damage that it has sustained during those operations. And also, in reviewing these EPRI tests, I also used what we testified to earlier, or what was in our direct written earlier, which was the Crystal River valve. Crystal River went through a transient, I believe, in February of 1980. The plant, I believe, was solid for two hours. The valve did actuate during that time.

After the valve had actuated, it was removed from

Crystal River and examined. There was some damage noted, and some of the damage, such as in the seat area, was similar to some of the damage noted during the EPRI test; and that valve was popped three times on steam without any refurbishment, and it popped within four pounds each time, and that tells me that since the valve has impedability, there is no friction at work in the valve which would impair its ability to perform its function.

Q. Are you relying upon that portion of the 26th test which involved chattering for 12-and-a-half seconds, and involving approximately 1250 cycles of the valve -- are you relying upon that phenomenon to gain confidence that the TMI 1 safety valve will perform properly during the feed and bleed mode of core cooling?

A. The 26th test was one of the tests that I examined, and I was using that test --

MS. WEISS: Mr. Chairman, could we get a yes or no and then an explanation?

JUDGE EDLES: Can you give a yes or no? I understand counsel's question. Maybe I'm not as sophisticated as you in these matters. I think what he's driving at is, are you relying on the 26th test, which includes the several hundred openings and closings, and I think that is a fair question.

JUDGE BUCK: I think the question was asked as

relying on test number 26. Now, you didn't say relying entirely or partially or what.

MR. POLLARD: I'm referring to the chattering of the valve. This witness explained that that amounts to about 1250 cycles of the valve during the 26th test. And my question to him is simply, are you relying upon the openings and closings of the valve during the 26th test to gain confidence that the TMI 1 safety valve will perform properly during the feed and bleed mode of core cooling.

THE WITNESS: I would have to say yes, and then qualify it by saying that the 26th test was only part of my total review.

BY MR. POLLARD:

Q. Let's assume -- because you said you don't know -- let's assume that during the 26th test, during the chattering, the valve was not fully opening and reclosing. It was only opening partially and then reclosing.

A. Yes.

Q. Would you agree that the forces on the valve components, and the damage to the valve, could have been substantially greater if the valve had fully opened and closed 1250 times in 12-and-a-half seconds?

A. Assuming that the valve didn't go to full open to damage, it could possibly have been greater, yes.

Q. On this document which I'm going to return to you,

I'm referring now to your EPRI/CE PWR Safety and Relief Valve Test Program Data Summary Sheets for the Dresser Model 31759-A and the note 2 which Ms. Weiss read into the record earlier.

The first sentence says, "The valve opened at 2408 psia.

If I understood your testimony earlier today on another point, you said the tolerance of the valve was plus or minus 1 percent, or plus or minus 25 pounds.

A. That is true, yes.

Q. Can you explain to me why this valve opened at 2408?

A. The previous tests for the valve included felled loop-seal transition and water tests, and in these tests was some flutter and/or chatter observed.

The flutter and/or chatter phenomenon does do a little bit of seat damage --

JUDGE EDLES: Excuse me. What type of damage?

THE WITNESS: Seat, seat. Causing seat leakage. This seat leakage, as the system pressure rises, the seat leakage tends to pressurize more area of the valve than just that area under the seat, and therefore would cause an earlier pop.

BY MR. POLLARD:

Q. The ring settings for this 26th test were in fact

designed to have the valve open at 2500 pounds?

A. The valve --

Q. Please. I'm sorry. Could you please, on my questions, where you can, give me a yes or no.

A. Okay. Could you repeat the question.

Q. For the 26th test were the ring settings such that the valve should have opened at 2500 pounds?

A. That really can't be given in a yes-or-no answer, because the upper ring and the middle ring do not really affect set point, and the lower ring is adjusted to give a sharper pop.

What does affect ring setting is the compression screw on the spring, and after each refurbishment at EPRI, the valve was set point tested to try to get this 2500 pounds.

MS. WEISS: Perhaps I don't understand your answer.

BY MS. WEISS:

Q. If you don't know going into the test what the set point of the valve is, how do you evaluate whether it is operating properly after the test, whether it has operated properly after the test? How do you evaluate the dating fact?

A. I don't think that I said that. The compression screw is the adjustment for the set point pressure. The

upper and middle rings do not affect set point. The lower ring affects the sharpness of the valve opening. So, therefore, you could have other middle and upper ring settings which would not affect the set point, as the compression screw.

Q. Do you know what the set point was for the 26th test?

A. It was supposed to be 2500 pounds. That's what they were setting the valve to.

Q. And it opened at 2408, which is not within 1 percent of the set point at somewhere around 4 percent, my lawyer calculations tell me.

A. Yes.

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BY MR. POLLARD:

Q. Is it correct to conclude, then, from the fact that on the 26th test the set point was 2500 pounds, and it actually opened at 2408 psia that the previous 25 opening and closings of the valve caused enough damage that you observed this almost 100-pound change in set point?

A. Yes. There was some seat damage which caused seat leakage to cause an earlier pop.

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BY MS. WEISS:

Q. I just want to know if you can tell me over what period of time the 31 tests were conducted?

A. I don't have that offhand, but I believe it

was several months.

Q. From beginning to the end of the test sequence, or series of tests?

A. Yes.

Q. I'm going to return to you the EPRI document.

A. Thank you.

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BY MR. POLLARD:

Q. Mr. Correa, do you have your original testimony in this proceeding with you on UCS contention 6?

A. The original written testimony?

Q. Yes, sir.

A. Yes, I do.

MR. CUTCHIN: Mr. Chairman, for the benefit of the rest of us, could we get a transcript citation, if Mr. Pollard has it?

MR. POLLARD: Yes. The Licensee's testimony of James H. Correa, Gary T. Urquhart and Robert C. Jones, Jr., in response to UCS contentions 5 and 6, (Valves and Valve Testing.) It is following transcript 8746.

BY MR. POLLARD:

Q. If I could direct your attention to page 12, please.

In summary you say, Contrary to the above contention -- meaning UCS contention 6 -- the TMI 1 pressure relief and safety valves have been appropriately

designed and tested. In addition, actions are being taken to provide further assurance that the valves will function properly and reliably.

Would you say that the EPRI tests contradicted your prediction, that is that the tests disclosed phenomenon that you did not anticipate?

A. Yes. The --

MR. BAXTER: I'm sorry. There were two questions in there.

Mr. Pollard, I wonder if you could separate them. One was did you see new phenomenon, and the other one was did the tests undermine your conclusion.

MR. POLLARD: Could I have the question read back, please.

JUDGE EDLES: Would the reporter please read the question back?

(Record read)

JUDGE EDLES: Mr. Baxter, if you want to repeat your comment, we can incorporate it into the record, and then let Mr. Pollard pick up.

MR. BAXTER: I should have objected to the form of the question. It seems there are two separate questions.

One, did the tests contradict your prediction, and secondly, did you see new phenomenon? And when you say, yes, then I'm not sure what the witness is answering to.

JUDGE EDLES: Mr. Pollard, why don't you try again?

MR. POLLARD: I'll rephrase the question.

BY MR. POLLARD:

Q Did the EPRI tests disclose new phenomenon?

A Yes, it did, which was the pressure oscillations in the long inlet piping.

Q By the pressure oscillations, you mean the valve flutter and chatter?

A Yes, I do.

Q Now, I recall Ms. Weiss reading a paragraph from your EPRI test document describing two water tests,

one conducted at 650 degrees, and one conducted at 550 degrees.

In the 650-degree test, is that a subcooled test?

A Yes, it was. It was a solid test.

Q And you all have already said the 550 was a subcooled test. Do you have some technical explanation for why the valve would behave properly with 650-degree water and chatter for the 550-degree water?

A As I understand it, there are two phenomenon at work here.

One is the inlet piping pressure oscillations, and the other is the flashing of the subcooled fluid.

If it flashes under the valve seat, the valve essentially thinks it is seeing steam, and therefore opens accordingly; if it flashes downstream of the valve seat, then the valve thinks that it is opening with water. And so, therefore, if the flashing is downstream of the valve seat, then you get into the inlet piping pressure oscillations.

Q Is the inlet piping pressure oscillations, is that caused solely by the long inlet piping, or is it also contributed to by the test facility itself having inadequate steam capacity? Or liquid capacity?

A It is my understanding it was the inlet piping

configuration.

Q How do you know that?

A From what EPRI has told the utilities.

BY MS. WEISS:

Q Have you done any independent evaluation on that question, Mr. Correa?

A On the inlet piping pressure oscillations, no.

Q So it is possible that since EPRI was contracted by the utilities to do these tests, that they have an interest in representing that the test facility has no defects, wouldn't you say?

MR. BAXTER: I object to that question. There is no foundation in the record for that kind of hypothetical.

JUDGE EDLES: I'm not sure that Mr. Correa is the proper person to answer that question. We could draw inferences, I assume, from the record, counsel.

Do you have any other comments?

MS. WEISS: Not on that point.

JUDGE EDLES: Then I'll sustain Mr. Baxter's objection.

BY MR. POLLARD:

Q The EPRI tests began after the close of the licensing hearing; isn't that correct?

A I'm trying to remember back.

MR. BAXTER: Excuse me, Mr. Pollard. You better give him a date, because the Licensing Board hearings went on and on.

MR. POLLARD: Right. I could change the question.

BY MR. POLLARD:

Q The EPRI tests occurred after you presented your testimony on either December 18th or December 19th of 1980?

A Yes, it was after that. I believe the first pressure valve tested was in the summer of 1981.

Q Is it correct that when you began to get data from the EPRI tests, did you or GPU or EPRI conclude that the problems observed in the EPRI tests, that is, the flutter and chatter, could be cured by changing the inlet piping configuration, and that that would be the only change necessary to eliminate the flutter and chatter?

A When the flutter and chatter was observed, I really can't say if EPRI decided, but what they did do is the test sequence happened to be such that the water test on the long inlet preceded the water test on the short inlet, and therefore, after the testing was done, EPRI made this data available to the utilities, and GPU decided that moving the valve to the short inlet would be

a prudent move to eliminate this flutter and/or chatter that was observed.

Q And then following that determination, is it not correct that further analysis of the data by EPRI disclosed that even if there were no inlet piping, that you could still have flutter and chatter for a certain combination of ring settings?

A I don't believe EPRI did any analysis along that line. EPRI did the testing and presented the test results to the utilities, and the NSSS suppliers.

Q It is correct, though, that GPU concluded at first that simply a change in the inlet piping would solve the flutter/chatter problem?

A For our valves, a change of the inlet pipe and using the EPRI ring settings that were used on the valve for the short inlet pipe would be the thing to do.

Q And that you subsequently either determined or were informed by EPRI that even with no inlet piping and the valve mounted directly on the pressurizer, there could be combinations of ring settings that would result in flutter or chatter?

A I don't believe EPRI ever informed us of that. It was not EPRI's duty to analyze data. They were just to state the facts as the test result showed.

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BY MS. WEISS:

Q Let me make it clear that -- well, let me start again.

GPU later found, isn't it true, that the valves still exhibited the fluttering or chattering phenomenon without any inlet piping mounted directly?

MR. BAXTER: I'm sorry. Later than what?

MS. WEISS: After you had determined that changing from a long inlet to a short inlet configuration would eliminate the chatter and flutter.

THE WITNESS: I would have to say that the time GPU determined to move to the short inlet, we also determined to change our plant ring settings to the EPRI ring settings that were used in the last five tests.

BY MS. WEISS:

Q You testified that it was determined simultaneously to go from long inlet to short inlet, and to change the ring settings?

A The time frame that I am talking about where GPU was involved in this task was from approximately February of 1982 through July of 1982, which involved a project to remove the loop seals and also sending two valves down to Wiley Labs to be set-point tested and have them adjusted with the final EPRI ring settings.

Q So you are saying this is a period of

six months?

A Five months, approximately.

Q I'm just trying to understand if this is the correct sequence. That the chattering and fluttering is observed during the 26th test; that it is then determined by GPU, after consultation with EPRI, that this chattering and fluttering phenomenon can be eliminated by moving from long inlet to short inlet, and it is then learned that the change in the inlet configuration is not enough; that there must be a change in the ring settings as well? Is that a correct statement of the sequence of events?

A No, it is not.

Q Did you ever write an affidavit to the Licensing Board or the Appeal Board in this case stating that changing from a long to a short inlet configuration would eliminate the chattering phenomenon observed in the EPRI tests?

A I may have. I don't remember, or I may have participated in giving data.

Q And wasn't that your opinion and GPU's opinion at one time?

A In trying to recall the events. I believe that we were also intending to use the EPRI ring settings in the final test.

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MS. WEISS: I've handed to the parties and the reporter for identification a letter to the Board signed by Mr. Baxter, counsel for GPU, dated April 22, 1982, which attaches a copy of two recent letters from GPU Nuclear to the NRC Staff, both relating to the EPRI test program, and the tests that we have been discussing here today.

I would like to have this marked for identification as UCS-49.

MR. POLLARD: 48.

MS. WEISS: 48.

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(The document referred to was marked UCS Exhibit No. 48 for identification.)

BY MS. WEISS:

Q Can you tell me if the attached letters describe the tests that we have been discussing today?

A Yes. The attached letters do describe -- at least, the second one makes reference to NUREG 0773, Item II.D.1, and the EPRI test program that was initiated in response to that item.

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Q All right.

A And the first letter also references EPRI.

MS. WEISS: I've just handed the Board and the parties to be marked for identification a letter from Mr. Baxter, counsel for GPU, to the Board, dated May 13, 1982, which encloses a letter from H. D. Hukill, Director, TMI 1, to NRC Region 1, which is a follow-up licensee event report on the tests that we have been discussing today, and the licensee event report itself.

BY MS. WEISS:

Q Would you take a look at that and tell me, Mr. Correa, if that licensee event report describes the tests we have been discussing today.

A It describes the EPRI testing, or it includes reference to the EPRI testing.

MS. WEISS: I would like to have that marked for identification as UCS 49, please.

(The document referred to was marked UCS Exhibit No. 49 for identification.)

BY MS. WEISS:

Q Did you play any role in the preparation of either of these documents?

A Yes, I did.

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BY MR. POLLARD:

Q Can you look, please, at the April 14th letter attached to Licensee counsel's letter of April 22nd, which is identified as UCS 48.

In the second paragraph, the second sentence says, "Although the EPRI tests were terminated prior to completion for long inlet piping configuration, the final EPRI results which were recently made available require evaluation to determine the ability of the TMI 1 safety valves to perform under feed and bleed cooling, if the pressurizer PORV is isolated."

Can you explain to me what it means by the EPRI tests being terminated prior to completion?

A On the long inlet configuration for the Dresser valve, there were supposed to be three water tests, 650 degrees, 550 degrees, and 400 degrees. Because the 550-degree test which we were talking about before, Test No. 26, had to be terminated due to the valve chatter, EPRI decided not to do the 400-degree water test.

Q You say EPRI decided?

A EPRI and the utilities that participated.

Q And GPU was a party to that decision?

A GPU confirmed the decision -- what I should have said, it is EPRI and the technical advisory group, which is made up of selected utilities. GPU was not a part

of that technical advisory group, but we did concur with their decision not to do the 400-degree water test.

Q Is it correct that, as you understand it, the principal reason for canceling the 450-degree water test was that there was simply observed valve chatter for that, also?

A Basically, yes.

Q Do you have any basis for knowing whether had such a test been done, with 450-degree water, the valve damage would have been greater than it was in the 550-degree test?

A I really can't say.

Q Can you explain to me, then, why you concurred in canceling the 450-degree test? Is it 400-degree or 450?

A 400 degrees.

Q I'm sorry.

A It was decided that on the long inlet configuration, the valve was -- the valve inlet pipe configuration was not performing the way it should, and the 400-degree test would confirm this.

This was noted with other valves on the long inlet where, when the degree of subcooling increased, the valve performance was -- kept on getting less than satisfactory as the degree of subcooling went down, so

we decided that the 400-degree test which showed chatter, and that chatter was not an acceptable condition for the valve.

Q Would you agree that that increasing subcooling margin is precisely what will happen if the feed and bleed cooling mode is successful?

A I do not know how the system will respond for feed and bleed.

Q Could you turn now to the document which has been marked for identification as UCS Exhibit 49.

I would like to direct your attention to the GPU letter dated May 7, 1982, and the attached licensee event report.

Did you have any role in preparing these documents or evaluating?

A Yes, I did.

Q Could you look at the unnumbered page, but about the third page is entitled at the top, "Licensee Event Report," Narrative Report, TMI-1, LER 82-004.

Towards the bottom of the page under Roman numeral III, "Description," second paragraph under the heading "Long Inlet Configuration," is that paragraph generally describing test No. 26, or EPRI Test No. 26?

A The second paragraph is describing, I believe,

four total tests.

Excuse me, five tests. Two loop seal tests with steam, one transition test, and two water tests.

Q The 550-degree water test is the EPRI Test 26?

A Yes, it is.

Q Do you notice the sentence which reads in that paragraph, "The test was terminated after the valve was manually opened to stop chatter and no data was collected"? Is that sentence correct?

A Yes, it is.

Q In other words, your determination of how many times the valve cycled during this chatter phenomenon is not based upon data from Test 26, then, is it?

A That is true. It is based upon data from earlier tests where the inlet piping calculations were shown to be in the order of 100 hertz.

Q On that earlier test from which this data is coming, what was the nature of the test? Was the valve passing water or steam?

A It was during the loop seal -- it was during passing of the loop seal, which is water, that the flutter was observed.

Q So, this was a long inlet configuration steam test with water in the seal?

A The earlier test, yes.

Q And that's where the data comes from in terms of the frequency of valve motion during chattering?

A Yes, and I also believe in the -- well, the 650-degree valve was stable, so there weren't inlet observations there. But there was an earlier test where they did observe flutter.

There were four tests where this flutter phenomenon was observed during loop seal discharge.

XX BY MS. WEISS:

Q I would like to have you look over Exhibits for identification UCS 48 and 49.

Before you do, these represent GPU's contemporaneous interpretations of the 26th test that we have been discussing today; correct?

A I believe it is all 31 tests.

Q All right.

I would like to have you -- well, let's go back.

They attempt to explain the phenomenon observed and describe GPU's intention to undertake a program to ensure that the chattering and fluttering observed during the tests would not happen at TMI; correct?

A Yes.

Q Could you look them over, please, both of them, and tell me if all the information in there is accurate, to your knowledge? If there is any corrections that you

would want to make, in other words?

A I have read the documents. I believe that they are complete and accurate.

MR. BAXTER: As of the time they were written?

THE WITNESS: As of the time they were written?

MS. WEISS: Yes. That was the question.

We will move the admission of UCS 48 and 49. We have no further questions.

JUDGE EDLES: Any objections?

MR. BAXTER: No objections.

JUDGE EDLES. So moved.

(The documents previously marked UCS Exhibits No. 48 and 49 for identification were received in evidence.)

JUDGE EDLES: Mr. Cutchin, do you have any cross-examination?

MR. CUTCHIN: Yes, I have a few questions, Mr. Chairman.

CROSS-EXAMINATION

ON BEHALF OF THE STAFF:

BY MR. CUTCHIN:

Q Mr. Correa, referring back to the April 14th letter, which is attached to UCS Exhibit 48, the sentence that was read to you by Mr. Pollard indicated that the purpose of the notification was to point out that the final EPRI results required evaluation to determine the ability of the safety valves to perform under feed and bleed cooling if the pressurizer PORV was evaluated.

Was that evaluation ever completed? Or has it

been completed as of this date?

MS. WEISS: Excuse me. You read the sentence wrong. You mean to say PORV was isolated.

MR. CUTCHIN: I'm sorry. If the PORV is isolated.

Let the document speak for itself with respect to what the sentence says.

BY MR. CUTCHIN:

Q With respect to that evaluation, has the evaluation been completed as of this date?

A Yes, it has.

Q And what did the evaluation conclude, if you know?

A The evaluation concluded that we had to go to the short inlet configuration, and use the final EPRI ring settings which we used in the last five tests.

Q And did your evaluation then believe if that were done that the valve would perform properly?

A Yes.

MR. CUTCHIN: Thank you. No further questions.

JUDGE EDLES: Mr. Adler.

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CROSS-EXAMINATION

ON BEHALF OF COMMONWEALTH OF PENNSYLANIA

BY MR. ADLER:

Q. Mr. Correa, can you tell me if a failure mode analysis has ever been performed for the TMI 1 safety valve?

A. I really don't know.

What I should say is, when we did move the valve to the short inlet configuration, the word "technical review" was performed, but whether there was a failure mode analysis, I'm really not sure.

Q. Can you tell me the event that the safety -- in the event the safety valve failed, do you have any opinion regarding whether the valve would be likely to fail open or closed?

A. It is really hard to say. If there is galling as the valve is opening, then the valve would. If there is galling on the downward movement, the valve would tend to hang up where it galls and possibly not go all the way to the seat.

Q. Can you envision any failure mode where the valve would fail entirely closed?

A. For the valve to fail entirely closed, it would have to be some damage on closing which would cause parts to gall in that position, and what we have found during the EPRI tests is that on the water discharge and on the

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flutter the valve was around, maybe 30 percent lift, and this 30 percent lift is the normal closing height as the valve closes on a steam transient. So there should be no damage occurring during a water discharge which would keep the valve closed.

MR. ADLER: Thank you. No more questions.

JUDGE EDLES: Dr. Buck, do you have any questions?

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BOARD EXAMINATION

BY JUDGE BUCK:

Q. Did you see the valve either at the EPRI test or the valve at the reactor? Did you see either of those?

A. No, I did not.

Q. Was the damage only done to the seat? There was no damage in the moving parts of the valve or anything of that nature?

A. There was other damage observed in some of the moving parts, yes.

Q. What kind; do you know?

A. Yes.

MR. BAXTER: This is on the 26th test that we are discussing? I assume you are asking about the 26th test, Dr. Buck?

JUDGE BUCK: Either that or the valve that was damaged, and I've forgotten the name of the reactor.

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THE WITNESS: Crystal River.

MR. BAXTER: Crystal River.

JUDGE BUCK: Crystal River.

THE WITNESS: Okay. At the EPRI tests, for the 26th test, after it was terminated, after the valve had chatter, the moving parts, the guide and the disk holder were galled for 360 degrees.

As I said earlier, the valve was still moving. The seat area was rolled over a little bit, and this was from the number of times that the valve had seated during this 12-and-a-half-second chatter. Some of the surfaces up in the spring area, some of the bearing surfaces, some of the wear surfaces did show galling, also.

So, due to the vast movement of the valve, there was damage noted, yes, and galling in some areas. But the valve did --

BY JUDGE BUCK:

Q. All right.

Now, how about the Crystal River valve? Did that show anything in the moving parts?

A. Okay. EPRI performed an examination of the valve for the safety and relief valve test program.

The inspection showed that the valve seat and the disk mating surfaces were extensively steam cut. This could be the reason for the lower set point due to the

leakage past the seat.

Inspection of the adjusting rings, inlet nozzle, back pressure, balancing bellows, disk guide and spindle, revealed no evidence of damage, upset metal, galling or scoring, and some of the mating surfaces showed no evidence of excessive loads, unstable operation, or banging of the internal parts.

Two abnormal conditions were found. First is an antirotation pin, which is in the top works of the valve, and the report concluded that this has no effect on the valve operation. It is basically there that when the compression screw is turned, it does not impart any torque into the spindle. That did not affect valve operation.

Q. That wasn't broken off or anything?

A. It was dislodged inside the bond, and EPRI did not conclude whether it happened during the transient at Crystal River or if it was that way from valve testing.

Q. This is primarily useful in adjusting the spring; is that correct?

A. Yes.

Q. Okay. Go ahead.

MS. WEISS: Dr. Buck, excuse me. The witness is reading from a document which we haven't seen.

JUDGE BUCK: Well, you didn't ask him questions

about it, I guess. I'll ask him to give the name of the document in a moment.

THE WITNESS: The antirotational pin serves no purpose in the valve. Its purpose is to prevent rotation of the upper spring washer during adjustment of the set pressure compression screw.

Second, the clearances between the disk holder and the disk were incorrect, and there was supposed to be a slight clearance to allow the disk to move inside the disk holder to bind itself on the seat so you get a good seating surface. In this case, there was no clearance, or the disk was held too tightly in the disk holder, and therefore that could be part of the cause of the valve leakage.

BY JUDGE BUCK:

Q. This was a faulty setting, apparently, to begin with?

A. Due to the leakage, it caused the set point to be slightly low, yes.

Q. Okay. Now, do you know how much refurbishing was necessary on these valves, either the EPRI 26th test or the Crystal River test?

A. Okay. The Crystal River valve, when it was disassembled, it was disassembled in such a way as to not to affect set point or any of the moving parts. It was then reassembled and given three steam tests, and these

three steam tests, the lift pressures were 2392 psig, 2388 psig, and 2388 psig, which showed the valve had impedability, which showed that there was probably no frictional forces in the valve causing it to malfunction.

Q. That was the Crystal River?

A. Yes.

Q. Now, on the EPRI test -- before you leave that document, Ms. Weiss would like to have the name of it. Why don't you give us all the name.

MS. WEISS: I don't care about the name. As soon as you are finished questioning, I'll take a look at it.

JUDGE BUCK: When I get through, then, you can ask it yourself, Ms. Weiss.

THE WITNESS: After the EPRI 26th test, they installed nine new parts into the valve, and they refurbished five others.

BY JUDGE BUCK:

Q. When you say "refurbish," do you know what they have to do?

A. The compression screw which showed some galling was polished and the galling was removed. The top spring washer had -- the bearing area had some galling; it was polished.

Q. You say it was removed and polished. Is this

10a7

just a hand operation, or did it have to be remachined?

A. It says polished. I assume it was a hand operation. If it said remachined, it would have been machined.

Q. Okay. That's what I want to know.

A. And the support plate assembly was straightened with a press. So there was some refurbishment to remove some galling and some of the internal parts which did show galling were replaced.

Q. You may not know the answer to that question.

chk

But what was the purpose of that loop seal to the inlet?

A. I really don't know. When I came to GPR, I already had the loop seal --

Q. I had never seen anything like that. I wondered what the purpose was, and what you lost by taking it out, other than vibration, I mean?

A. Well, as far as I know, we were the only B&W plant with this Dresser valve that had a loop seal, and now we are the same as all the other B&W plants.

Q. I wondered what the purpose was of the loop seal?

A. One of the purposes that I am aware of is, with water in the loop seal, you could get better seat tightness, seat leak tightness, with the water and with steam. So it was basically to cut down seat leakage.

Q. All right. I guess you would. It seems like

a way of asking for trouble, in having that block of water in there to get blown out first.

One last question. You talked about the header and the distance of the header -- the length of pipe to the header. How far apart in the header were the two pipes pushed?

A. Well, we had the 6-inch diameter pipe, one valve was 125 feet long, and then at the end of the 125 feet it went from a 6-inch diameter to a 10-inch diameter, and 15 inches downstream of that, the second 6-inch discharge pipe came into the header at a 45-degree angle, I believe.

Q. The first one is put in at the end of the header?

A. Yes.

Q. And the other was put in at a 45-degree angle facing away?

A. Facing downward, yes.

JUDGE BUCK: Thank you. That's all I have.

JUDGE EDLES: Dr. Gotchy.

JUDGE GOTCHY: No questions.

JUDGE EDLES: I would like to take a ten-minute recess.

Why don't you show the document to Ms. Weiss. We will take a ten-minute recess, and then reconvene.

(Recess.)

JUDGE EDLES: Please be seated. We will resume with any redirect that Mr. Baxter may have.

XX

REDIRECT EXAMINATION

BY MR. BAXTER:

Q Mr. Correa, you were explaining the lifting of the safety valve in test No. 26 at a pressure of 2408, as being caused by the effects of leakage. Would leakage affect the tolerance above the set point pressure by a similar -- to a similar extent?

A Leakage would cause the valve to pop low due to the pressurizing of a larger area. So leakage affects the valve low, and not on the high side.

Q Ms. Weiss asked you about the period of time over which the 31 tests of the TMI-1 type safety valve took place in the EPRI program. And you answered, several months.

How does that separation in time of the 31 tests influence, if it does, your confidence in the valve's ability to perform and feed and bleed?

A The 31 tests, even though they were spread out over several months, still give me good confidence in the valve.

During this time, the valve had gone through -- after each test the valve went through a cool-down cycle, and before each test it went through a heat-up cycle.

So the valve continuously had thermal movements in the valve, and if it was up on the pressurizer doing feed and bleed, it would not have such thermal transients.

Also, even though there were several inspections of the valve during this testing program, after each time the valve was reassembled, it was given a set point test, which was a minimum of three consecutive pops at the 2,500 pounds plus or minus 25 pounds. So, therefore, in actuality, the 31 tests with the 32 cycles contained more cycles than that if the set point testing is involved, also, and through all this the valve was really not showing detrimental wear.

MR. BAXTER: I have no further questions.

JUDGE EDLES: Any recross?

MS. WEISS: Yes, sir.

XX

RECROSS-EXAMINATION

BY MS. WEISS:

Q Now, you just said that you still have good confidence in the valve because it was cooled down and heated up before each test, and you said that if it was sitting on top of the pressurizer during feed and bleed, that it wouldn't observe such thermal transients.

Is that your testimony?

A What I'm talking about, as far as thermal transients go, is the valve was going during the testing

steam at 600 to 650 to seeing ambient temperature, and then back up.

During feed and bleed, I am using what was used during the EPRI test, which was 650 degrees, to maybe 400 degrees. So the EPRI testing was greater thermal cycling of the valve.

Q Over what period of time, if the valve was operating on top of the pressure during feed and bleed, would it exceed a change in temperature from 450 to 600 degrees; do you know?

A I don't remember the period of time, but in going from 650 down to ambient, there is a lot more movement in the valve in the mating parts, and this movement each time could possibly -- the next time that you completely heat up, you will not be in the same area, and if we are talking feed and bleed maybe over a two-hour period time span, the thermal movement is not that great.

Q What is the initial temperature at the safety valve when feed and bleed is started?

A I don't know.

Q Do you know what the ambient temperature in containment is when feed and bleed is started?

A No, I don't. But I believe our normal ambient is approximately 120 degrees.

Q So it would be going from about 120 degrees to

550 or 600 degrees essentially, instantaneously during feed and bleed?

A No, because the ambient is outside, and what we are talking about is what the valve sees inside, in the internals, and that is the major concern.

XX BY MR. POLLARD:

Q Let me try just to clear it up: If the plant is running along normally, the TMI-1 safety valve sitting on top of the pressurizer or near the pressurizer is at some temperature that is relatively close, I would presume, to the ambient in that part of the containment, wouldn't you agree, then, that it would go from all of the internals of the valve being at the ambient temperature -- it would essentially instantaneously rise to whatever the temperature of the primary coolant being discharged to it was?

A No. The inlet nozzle sees the pressurizer steam, so that is exposed to the primary coolant. The disk is exposed to the primary coolant. So those are all at the higher temperature.

Then after you go from that, when the valve opens, you have the valve body. So it is possible that the skin of the valve body is at ambient, but the internals are a lot closer to the reactor pressure -- to the reactor temperature.

Q In this thermal stressing that you say the valve

went through during the EPRI tests and heating up and cooling down before and after each test, over what period of time does that occur?

A What I was talking about is the general movement caused by the thermal movement, and not by thermal stresses. That if the valve --

Q My only question is, over what period of time does this thermal cycling occur?

A It occurs over the whole 31 tests, which is several months.

Q Excuse me. For one EPRI test -- we finished the other test two weeks ago. You say you are going to preheat the valve?

A Yes.

Q Over what period of time does that preheating occur?

A It could take several hours to get the valve up to the proper temperature.

XX BY MS. WEISS:

Q You were asked by Mr. Cutchin whether you had done an evaluation to determine the ability of the TMI-1 safety valves to perform under the feed and bleed cooling if the pressurizer PORV was isolated. Your answer was, yes.

I want to ask if your answer you refer to

consists of testimony that you have given here today?

A Some of the testimony that I have given here today could be part of that evaluation, yes.

Q Well, is this evaluation, then, something different, something written somewhere?

A GPU performed a safety evaluation when we moved the valve from the long inlet configuration to the short inlet configuration.

Q And is that contained in either UCS 48 and UCS 49?

A No, it is not.

Q There is some additional evaluation?

A An in-house evaluation, yes.

Q It wasn't provided to the parties or to the board in this case?

A I don't believe so.

Q Was it provided to the NRC?

A The results of the evaluation may have been. The total evaluation, I'm not sure.

Q You were reading to Dr. Buck when he was asking you about Crystal River event from a document entitled "Examination and Test of Crystal River Unit No. 3, Power Operated Relief and Safety Valves, PWR Safety and Relief Valve Test Program, EPRI," and the number is EPRI NP-80-13-LD, and there is a date on it. It says "Interim

Report," and there is a date on it of December 1980. And it says "Limited Distribution."

I suppose I'll ask you if that is in fact the document that you were reading from to Dr. Buck to describe the Crystal River event.

A Yes.

Q Did you observe the inspection of the Crystal River safety valves?

A No, I did not.

Q Was there a final report ever received? This says "Interim Report."

A No, there was not.

Q So is it true that the extent of your knowledge with respect to this evaluation comes from the EPRI document supplied to you?

A Yes, it does.

Q It is true, isn't it, that there were two safety valves at Crystal River that were removed, inspected, and then tested?

A Yes.

Q Is it accurate that you described to Dr. Buck the inspection and testing of one valve, RCV-8?

A Yes, it is.

Q And there is another one, RCV-9?

A Yes.

Q I believe that you said that the refurbishment of this valve after the inspection was done in a way so as not to affect the moving parts at all; is that correct?

A The reassembly.

Q I'm sorry.

A Reassembly. So as not to affect set point, either.

Q On page 14 of the EPRI document, it states that "Disassembly and inspection of RCV-8 as received at Wile"; is that Wiley?

A Wiley.

Q That is not a sentence. "A special disassembly procedure was specified to remove the valve bonnet assembly without removing the main spring or changing the main spring preload."

Is that an accurate description of your understanding of what was done?

A Yes.

Q That doesn't say to me that it was disassembled without affecting any of the moving parts.

A The normal disassembly is to remove the preload from the spring, which is to move the compression screw so the valve is unloaded, so the spring can be taken out, and then the rest of the valve disassembled.

When they did disassemble the valve, they

kept the compression screw down so as not to affect set point.

12a1

Q. RCV-8 is described as follows, on pages 13 to 14 of the EPRI document.

The safety valves, RCV-8 and 9, were removed for testing, disassembly and refurbishment at Wiley Laboratories, Alabama, and were not examined at CR-3. However, it is significant that Florida Power Corporation representatives indicated that safety valve RCV-8 had a history of leakage problems since its installation and had been refurbished by Florida Power Corporation maintenance personnel one or more times at CR-3 during the previous years of operation. Specifically, valve RCV-8 was reportedly leaking prior to the Crystal River 3 transient in February 1980.

Is that accurate, as far as you know?

A. Yes.

Q. I would like to read a paragraph which I suppose you summarized, which describes the results of the inspections of RCV-8. This appears on page 15 of the EPRI document.

The valve seat and disk plating surfaces were extensively steam cut. Steam cutting resulted in several hundred radial marks across the seating faces with depths of several mils. The lower surface of the disk holder (part 11) adjacent to the disk also showed erosion damage. Liquid penetrant examination of the seating surfaces of the seat and disk and the lower surface of the disk holder

showed fine radial cracks 30 to 60 mils deep scattered around the lower surfaces of the disk holder. These cracks were not visible to the unaided eye. The seat and disk were steam cut but not cracked.

Is it your understanding that that is correct?

A. Yes, it is.

Q. Now, I'm continuing on to page 16.

Two abnormal conditions were found. First, the antirotation pin was found dislodged inside the bonnet cavity. This pin was bent and had become disengaged from the upper spring washer and fallen into the valve bonnet cavity.

Is that correct, as far as you know?

A. Yes, it is.

Q. Can you say whether or not a pin knocking around inside the valve bonnet cavity might not have an effect on operation of the valve?

A. If the pin could somehow lodge itself between the spring and the bottom washer, it could. But in this case it did not --

JUDGE BUCK: Will you get closer to the microphone, please.

THE WITNESS: I'm sorry.

If the pin did lodge itself between the lower spring washer and the spring, it could affect valve operability, yes.

12a3

BY MS. WEISS:

Q. Now, I believe also in my very brief opportunity to look through this document that there is a discussion of the quality assurance problem with the test facility.

Let me see if I can find that.

Let me read it to you and see if you would agree with me that this does indicate a quality assurance problem.

Inspection of this assembly showed that insufficient clearance was available to permit any rocking or self-aligning of the disk. The inspection showed that assembly of the disk holder on the disk nut firmly retained the disk in the assembly. As a result the disk was not able to self-align readily on the seat. The differences between the specified and actual clearances could be due to initial assembly errors or deformation of the parts in service.

Do you have any -- does that indicate to you a quality assurance problem in the manufacture of the disk, or the valve? Excuse me.

A. Not necessarily, no. Because as it said, it could also happen during service.

Q. One or the other has to be the explanation, in your view?

A. But as far as quality assurance, I cannot say

12a4

that shows me a QA problem.

Q. It would have to be some problem either in the manufacture, design or operation of this valve; is that correct?

A. It could be, yes.

Q. Now, describing the retest of RCV-8, and beginning on the very bottom of page 17 of this document, opening and closing of the valve was normal during these tests with the exception that simmering of the valves occurred one to two seconds before each lift due to leakage from the valve.

Would you tell me what simmering is?

A. Simmering is right before the valve gets to the set point, the valve not really leaking -- the valve not really lifting, but there is leakage which is causing the disk to have slight movement, but the disk holder does not move, and that simmering starts to pressurize the other areas of the valve which then leads to the valve lift.

Q. RCV-9 was inspected and tested as well; correct?

A. Yes, it was.

Q. And they found at least one similarity with RCV-8. That pin was again missing from where it should have been when they inspected it; correct?

A. Yes. Which could be due to maintenance problems.

Q. Okay. And then there is a section that

summarizes the results of the inspection and tests of RCV-8 and 9.

It says, Valve RCV-8 exhibited a lift pressure approximately 100 psi, although in the same manner that it operated during the February 1980 transient at Crystal River 3.

Now, am I correct that that means that during the test it lifted 100 psi lower than the set point?

A. It lifted 100 psi below the required set point of 2500 pounds.

Q. While the reason for the low set pressure was not specifically identified, it does not appear that it was in any way related to the circumstances of the February 1980 transient. Instead, it is likely that the valve operated a low lift pressure as a result of improper adjustment of the set pressure initially effective through the valve or both.

Is that correct?

A. That is true.

Q. And then it is stated that the contamination levels of the valves after decontamination by Wiley are still such that the valves are not suitable for unrestricted shipment and that as a result it will probably not be possible to test either valve, RCV-8 and RCV-9 in the full valve safety test program.

Do you know if they were tested?

A. No, they were not tested in the EPRI test program.

MS. WEISS: I would like to confer just briefly, if I could.

BY MS. WEISS:

Q. Do you know if RCV-8 and RCV-9 are the same valves used at TMI 1?

A. They are the Dresser 31739A valve.

Q. They seem to have different sizes, and orifices.

Do you know if it is exactly the same valve?

A. Could I see what you are reading from so I can look at it.

Q. Yes. I'm reading from your document.

A. I believe it is the same valve, yes. The 3 describes the orifice size. So both Crystal River and TMI 1 have the 3 orifice.

MS. WEISS: Thank you.

Mr. Chairman, we have no further questions at this time. I would like, though, to have a copy of this document, just so that we can at some point take a look through the rest of that, and since there were extensive questions on it -- we obviously haven't had an opportunity to read the whole thing.

JUDGE EDLES: Is there any problem with that,

Mr. Baxter?

MR. BAXTER: I'm not sure, Mr. Chairman, for what purpose. I plan on letting Mr. Correa go back to work in Parsippany, New Jersey, as soon as he is excused.

JUDGE EDLES: Is the document proprietory, or is there some reason why either that document or a copy of it couldn't be supplied to Ms. Weiss?

MR. BAXTER: No. If she would like to borrow it and copy it quickly. I don't plan to keep him around the hearing for further questions.

JUDGE EDLES: I didn't understand that to be part of the request.

MR. BAXTER: We will lend it to Ms. Weiss so she can copy it.

Is there any restriction on its release?

THE WITNESS: You would be the one to interpret this.

MR. CUTCHIN: Maybe we could shorten it, Mr. Chairman. Does anyone know if that document is available in the NRC document room?

MS. WEISS: It says limited distribution. I think it is an internal document.

THE WITNESS: As far as I understand, the participating utilities did not submit this to the NRC. Possibly Crystal River did.

MR. BAXTER: We will make it available for copying.

JUDGE EDLES: Thank you.

MS. WEISS: No further questions.

JUDGE EDLES: Mr. Cutchin, any further questions?

MR. CUTCHIN: None, Mr. Chairman.

JUDGE EDLES: Mr. Adler?

MR. ADLER: No.

JUDGE EDLES: Dr. Buck?

JUDGE BUCK: No.

JUDGE EDLES: Dr. Gotchy?

JUDGE GOTCHY: No.

JUDGE EDLES: I think the witness can be excused with the thanks of the Board.

Can we go off the record for just a moment now.

(Discussion off the record.)

JUDGE EDLES: Go back on the record for the purpose of saying we will recess now until 1:15.

(Thereupon, a luncheon recess was taken at 11:45 a.m., to reconvene at 1:15 p.m., this same day.)

AFTERNOON SESSION

(1:15 p.m.)

JUDGE EDLES: Please be seated.

The Board has once again reviewed the matter of whose witness Dr. Ornstein shall be. The subpoena was requested by UCS and issued on its behalf. I indicated last week that I believed that in such circumstances the witness is ordinarily to be considered a UCS witness, but offered Staff counsel an opportunity to provide us with precedents to the contrary.

Although the Staff submitted a written response on March 11th, no precedent was cited. The Staff does make an argument, however, that calling Dr. Ornstein would constitute an indirect reimbursement of Intervenors in conflict with Congressional prohibition. Although we are extremely sensitive to that prohibition, we disagree with counsel's argument, so Dr. Ornstein shall be called as a UCS witness.

Counsel for UCS has also requested sequestration of Dr. Ornstein during cross-examination of Staff witnesses. We shall grant the request.

Ordinarily expert witnesses are allowed to be present in the hearing room in order to assist counsel. Dr. Ornstein is not assisting Staff counsel, however, and has been called as a witness only because of special circumstances discussed in ALAB 715. Counsel for the Staff

recognizes that no prejudice to the Staff's ability to present its case will result from sequestration.

The witness is being presented to determine whether there is any difference in view within the Staff regarding matters at issue before us, and in all these circumstances, we believe that sequestration is preferable. UCS's request is granted.

Dr. Ornstein is directed not to be present in the hearing room during cross-examination of Staff witnesses. Dr. Ornstein is directed not to discuss with any of the parties or their counsel matters which come up during cross-examination of Staff witnesses. I want to emphasize, however, that our ruling should in no way be construed as any lack of confidence in Dr. Ornstein's ability or willingness to tell the truth as a witness when he testifies but is intended simply to ensure a more reliable evidentiary record.

We have one remaining matter of the letter.

Have you discovered, Ms. Weiss, what the letter is?

MS. WEISS: I completely forgot to look, Mr. Chairman.

JUDGE EDLES: We will get to it at some future time.

Mr. Cutchin.

MR. CUTCHIN: Regardless of whose witness Dr. Ornstein was determined to be, I have passed out just at the break copies of his professional qualifications to the Board and all the parties.

JUDGE EDLES: I think that is extremely useful, and I appreciate that.

If that is all, I guess we move along to Mr. Jones.

MR. BAXTER: The Licensee recalls Robert Jones, Jr.

JUDGE EDLES: Mr. Jones, I remind you that you continue to be under oath.

Whereupon,

ROBERT C. JONES

was recalled as a witness by counsel for the Licensee, and, having been previously duly sworn by the Chairman, was examined and testified as follows:

DIRECT EXAMINATION

ON BEHALF OF THE LICENSEE

MR. BAXTER: Mr. Chairman, I would first like to request that the document I distributed to the Board and the parties on February 10, 1983, entitled "B&W's Small-Break LOCA," ECCS Evaluation Model, BAW-10154P, dated November 1982, be marked for identification as Licensee Exhibit No. 86.

JUDGE EDLES: Okay.

Index

BY MR. BAXTER:

Q. Mr. Jones, I call your attention to the document that bears the caption that is dated February 16, 1983, entitled Licensee's Testimony of Robert C. Jones, Jr., in response to ALAB-708, issue numbers 4 through 7, ECCS Evaluations and Boiler-Condenser Cooling.

Does this document represent testimony prepared by you or under your supervision for presentation in this hearing?

A. Yes, it does.

MR. BAXTER: Mr. Chairman, we have distributed a change page to page number 1 which simply amends again Mr. Jones' title, as was done with his previous testimony.

BY MR. BAXTER:

Q. On page 1, Mr. Jones -- I'm sorry -- page 3, line 24, should the blank there be Licensee Exhibit No. 86?

A. Yes, it should.

Q. And on page 4, line 19, should that be 86, as well?

A. Yes.

Q. On page 14, line 14?

A. That should be Exhibit 86, also.

Q. And on page 16, line 16?

A. Yes.

Q. Do you have any other changes or corrections to

make to your testimony?

A. No, I do not.

Q. Is it true and accurate, to the best of your knowledge and belief?

A. Yes, it is.

MR. BAXTER: Mr. Chairman, I would move that Mr. Jones' testimony be received into evidence and incorporated into the transcript as if read.

JUDGE EDLES: Any objection?

MS. WEISS: None.

JUDGE EDLES: So moved.

(The testimony of Mr. Jones follows.)

February 16, 1983

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING APPEAL BOARD

In the Matter of	)	
	)	
METROPOLITAN EDISON COMPANY	)	Docket No. 50-289
	)	(Restart)
(Three Mile Island Nuclear Station, Unit No. 1)	)	
	)	

LICENSEE'S TESTIMONY OF

ROBERT C. JONES, JR.

IN RESPONSE TO ALAB-708 ISSUE NOS. 4 THROUGH 7

(ECCS EVALUATIONS AND BOILER-CONDENSER COOLING)

SUMMARY

This testimony responds to the Appeal Board's stated concerns with the B&W ECCS evaluations of small-break loss-of-coolant accidents and the efficacy of boiler-condenser cooling to remove decay heat at TMI-1 for those breaks for which it is predicted to occur.

The pre-TMI-2 accident analyses to demonstrate TMI-1 compliance with 10 C.F.R. § 50.46 used the NRC approved Appendix K model and, for certain break sizes, the results of these analyses also exhibited the steam generator heat transfer characteristics associated with boiler-condenser cooling.

The post-TMI-2 accident analyses used the approved CRAFT2 computer code, but modifications were made to the model to provide a more detailed examination of plant response under boiler-condenser conditions.

A revised B&W evaluation model, submitted to the Staff for Appendix K approval, has been used to analyze a 0.01 ft^2 break, during which boiler-condenser cooling is predicted to occur, and an extrapolation of the results demonstrates that adequate core cooling is maintained. While breaks smaller than the original spectrum (i.e., 0.04 ft^2) do not need to be analyzed to demonstrate compliance with section 50.46, the response to NUREG-0737 Items II.K.3.30 and II.K.3.31 will provide further confirmation that the original spectrum analyzed was adequate (i.e., that 0.07 ft^2 is the worst case).

The foregoing analyses demonstrate the adequacy of the boiler-condenser cooling mode to remove decay heat at TMI-1. A heat transfer analysis of the steam generator provides yet a further illustration of that capability. In addition, experimental data is discussed which supports this conclusion from the analyses.

INTRODUCTION

This testimony, by Robert C. Jones, Jr., Unit Manager, Fluid and Transient Analysis Unit, Babcock & Wilcox Company, is in response to Issue Nos. 4 through 7 of the Appeal Board's Memorandum and Order of December 29, 1982 (ALAB-708). Collectively, those issues address the adequacy of the B&W Emergency Core Cooling System (ECCS) evaluations of small-break loss-of-coolant accidents (small-break LOCAs) and the efficacy of boiler-condenser cooling to remove decay heat at TMI-1 for those breaks for which it is predicted to occur.

Licensee evidence in the record which is relevant to these issues, and which may provide valuable background information, includes:

- Licensee's Testimony of Robert W. Keaten and Robert C. Jones in Response to UCS Contention Nos. 1 and 2 (Natural and Forced Circulation), ff. Tr. 4588;
- Licensee's Testimony of Robert C. Jones, Jr. and T. Gary Broughton in Response to UCS Contention No. 8 and ECNP Contention No. 1(e) (Additional LOCA Analysis), ff. Tr. 5038;
- Licensee's Testimony of Robert C. Jones, Jr. and T. Gary Broughton in Response to the Board Question on UCS Contention 8, ff. Tr. 5039;
- Licensee Exhibits 3 through 13 (small-break LOCA and other accident analyses performed before and after the TMI-2 accident; small break operator guidelines).

ISSUE NO. 4: Whether the modified B&W ECCS evaluation model for small breaks that predicts the boiler-condenser process is an NRC approved code under Appendix K to 10 CFR Part 50 (from the staff).

RESPONSE

BY WITNESS JONES:

NRC regulations provide the definition of an ECCS evaluation model.

> An evaluation model is the calculational framework for evaluating the behavior of the reactor system during a postulated loss-of-coolant accident (LOCA). It includes one or more computer programs and all other information necessary for application of the calculational framework to a specific LOCA, such as mathematical models used, assumptions included in the programs, procedure for treating the program input and output information, specification of those portions of analysis not included in computer programs, values of parameters, and all other information necessary to specify the calculational procedure.

10 C.F.R. § 50.46(c)(2).

Analyses performed prior to the TMI-2 accident to demonstrate the conformance of TMI-1 to 10 C.F.R. § 50.46 used the NRC-approved B&W ECCS evaluation model and, for certain break sizes (e.g., the 0.04 ft^2 break), the results of these analyses also exhibited the steam generator heat transfer characteristics associated with boiler-condenser cooling.

The model used for the additional small-break LOCA analyses performed after the TMI-2 accident that predict the boiler-condenser process technically was not the B&W ECCS

evaluation model approved by the NRC pursuant to Appendix K to 10 C.F.R. Part 50. The model used for those analyses was the approved B&W evaluation model modified only by the addition of two control volumes (or nodes) to provide a more detailed examination of plant response under boiler-condenser conditions. No changes were made, however, to the CRAFT2 computer code, which is the approved Appendix K code used to predict system response for these breaks.

The additional control volumes, one in each Reactor Coolant System loop, were included in order to explicitly represent the upper head, or plenum, region of each steam generator. The analytical impact of the addition of the control volumes was to allow for a more accurate representation of the formation of a steam bubble between the steam generator emergency feedwater injection point and the 180° U-bend in the top of each RCS hot leg. See Licensee Ex. 5, § 6.2.4.2.

It should also be noted, as I discuss more fully below in response to Issue No. 7, that the B&W ECCS evaluation model for small-break LOCAs has been further revised, in response to Item II.K.3.30 of NUREG-0737. The changes made to the model include the addition of a steam generator upper head region, as discussed above, and others developed in consonance with the NRC Staff. The revised model has been formally submitted to the NRC (see Licensee Ex.) for review by the Staff for compliance with Appendix K to 10 C.F.R. Part 50.

ISSUE NO. 5: Whether the staff has reviewed the B&W Appendix K model to determine the ability of the code to calculate the effects of small breaks, including reliance upon boiler-condenser circulation (from the staff).

RESPONSE

BY WITNESS JONES:

While I obviously cannot describe the scope of the Staff's review beyond what the Staff itself has reported, as I indicated above the results of the analyses performed prior to the TMI-2 accident to demonstrate the conformance of TMI-1 to 10 C.F.R. § 50.46, with the approved B&W Appendix K model, exhibited, for certain break sizes, the steam generator heat transfer characteristics associated with boiler-condenser cooling.

The documentation of a revised B&W ECCS evaluation model, submitted to the Staff in November, 1982 under NUREG-0737 Item II.K.3.30 for review against Appendix K, includes the results of an analysis of the 0.01 ft^2 break, during which boiler-condenser cooling is predicted to occur. See Licensee Ex. ____ at Appendix E.

ISSUE NO. 6: Whether only breaks slightly smaller than 0.07 ft^2 must be analyzed (from the staff).

RESPONSE

BY WITNESS JONES:

The smallest break analyzed in the demonstration. prior to the TMI-2 accident, of TMI-1 conformance to 10 C.F.R. § 50.46 was of the size 0.04 ft^2. See Jones and Broughton, ff. Tr. 5038, at 12 (Table 1); Licensee Exs. 3 and 4. Breaks smaller than 0.04 ft^2 do not need to be analyzed to demonstrate the conformance of TMI-1 to section 50.46.

Section 50.46 establishes the criteria for an acceptable emergency core cooling system. Appendix K to 10 C.F.R. Part 50 sets forth the required and acceptable features of an evaluation model used to show compliance with 10 C.F.R. § 50.46. ECCS cooling performance is to ". . .be calculated for a number of postulated loss-of-coolant accidents of different sizes, locations, and other properties sufficient to provide assurance that the entire spectrum of postulated loss-of-coolant accidents is covered." See 10 C.F.R. § 50.46(a)(1).

B&W's selection of the spectrum of small breaks to be evaluated pursuant to 10 C.F.R. § 50.46 was based on the following considerations:

1. A Core Flood Tank (CFT) line break, by its location, severely limits the Emergency Core Cooling Systems

available for accident mitigation. Considerations of break location and single active failure dictate that core cooling must be provided by one high pressure injection (HPI) train and one core flood tank, until the active low pressure injection (LPI) train can be switched from its assumed injection into the broken CFT line and balanced between the two CFT lines. This break is analyzed, then, because it would appear to represent a limiting condition.

2. A series of break sizes are evaluated wherein the consequences of the rupture are mitigated by various combinations of the three ECCS systems:

   A. A break is considered for which mitigation is provided by the LPI, CFT and HPI systems.

   B. A break is considered for which mitigation is supplied by only the CFT and the HPI systems.

   C. A break is considered for which mitigation is provided solely by the HPI system.

Breaks are uniformly located, with the exception of the Core Flood line break, between the high pressure injection point in the cold leg (reactor coolant pump discharge piping) and the inlet to the reactor vessel. This location minimizes the amount of high pressure injection available for core cooling since a significant portion of the HPI flow can be discharged directly out the break. In addition, breaks at low elevations within the Reactor

Coolant System drain the Reactor Coolant System of significantly more water than breaks at higher elevations. Thus, for accidents in which the HPI or other ECCS systems cannot instantaneously provide core cooling and cooling must be sustained for some period of time via the initial RCS inventory, that inventory is reduced in the most rapid way possible.

3. Additional breaks are considered to confirm that the above spectrum has indeed bounded the worst case. That is, as necessary, break sizes smaller and larger than the calculated worst case are considered in order to confirm that the most adverse core cooling situation has been identified.

Very small breaks, i.e., those smaller than the smallest break considered in the spectrum (0.04 ft^2), are not evaluated because they are bounded by larger breaks for the following reasons:

1. Because of the internal vent valves, condensation within the steam generator must occur prior to uncovering of the reactor core. At TMI-1, this occurs because the injection location for emergency feedwater is near the top of the steam generator. Ultimately, the steam generator is filled to 95 percent on the operating range, which assures a condensing surface above the top of the core continuously.

2. If steam condensation is occurring in the primary side of the steam generator, then the RCS pressure will be reduced to near the pressure of the secondary side of the steam generators (approximately 1000 psi) or at a higher pressure wherein the HPI flow matches the leak flow.

3. The breaks evaluated in the spectrum, those with HPI mitigation only, drain the RCS loops faster and establish steam condensation earlier than do smaller breaks. At the start of the steam condensation mode, the decay heat rate for the larger break will be higher than for the smaller break. The larger break will also be losing initial RCS inventory faster than the smaller break. Thus the potential for core uncovery is greater for the larger breaks.

4. Because it has been shown by evaluation that the HPI provides successful mitigation of a transient at a higher decay heat rate at an earlier time, the HPI will provide successful mitigation of the transient at a lower, later decay heat rate. Therefore, smaller breaks cannot have consequences in the core region more severe than the smallest break considered in the spectrum evaluation.

Therefore, while breaks smaller than the spectrum analyzed to demonstrate compliance with 10 C.F.R. § 50.46 may involve different system behavior (i.e., the repressurization cycle which is caused by the interruption of natural circulation),

core cooling is dependent upon maintaining core coolant inventory. Regardless of the specific sequence of events during a very-small-break LOCA, before core uncovery can occur, reactor coolant pressure will decrease to a point (approximately 1000 psig) where high pressure injection has been demonstrated to provide adequate core cooling for the maximum core decay heat level.

The additional small-break LOCA analyses performed after the TMI-2 accident provided further confirmation of the validity of the above described methodology. While these evaluations were for the purpose of providing an improved analytical basis for emergency operating procedures, rather than to demonstrate compliance with 10 C.F.R. § 50.46, several breaks smaller than the previously analyzed 0.04 ft^2 break were addressed. Specifically, breaks of 0.005 ft^2 and 0.01 ft^2 were evaluated. See Jones and Broughton, ff. Tr. 5038, at 6-7 and 17 (Table 6). In my opinion, the analyses for the 0.005 ft^2 and 0.01 ft^2 breaks are sufficient to demonstrate conformance to 10 C.F.R. § 50.46 pursuant to Appendix K. The results indeed showed that, compared to the larger break sizes, an increased margin relative to core uncovery existed. The effort now underway, pursuant to NUREG-0737 Items II.K.3.30 and II.K.3.31, to analyze small breaks with an improved Appendix K model, is aimed at providing yet further confirmation that the original spectrum of breaks

analyzed was adequate to demonstrate conformance to 10 C.F.R. § 50.46.

ISSUE NO. 7: Confirmation (such as by means of detailed computational analysis or experimental testing) that boiler-condenser circulation flow will transport sufficient core decay heat to the steam generators to prevent core damage (from the licensee and the staff).

RESPONSE

BY WITNESS JONES:

For certain sized small-break LOCAs, the steam generators are necessary to remove a portion of the decay heat added to the primary system.1/ The Appeal Board has questioned the adequacy of energy removal via the steam generators while operating in the boiler-condenser mode of cooling. Additional analyses are presented in this testimony to demonstrate that boiler-condenser heat removal at TMI-1 is sufficient to remove core decay heat following a LOCA. I have also provided a discussion of the experimental data which supports this conclusion from the analyses.

Before discussing the boiler-condenser mode of cooling, however, it is necessary to discuss the relationship between energy removal from the fuel rods (core cooling) and energy removal from the reactor coolant system (RCS). To ensure adequate core cooling during a small-break LOCA, it is

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1/ The discussion that follows assumes the availability of emergency feedwater and one HPI train. Steam generator heat removal is not necessary if two HPI pumps are available. See Jones and Broughton, ff. Tr. 5038.

necessary to maintain a two-phase level within the reactor vessel which is at or near the top of the core. In this manner, the core decay heat which is being generated can be removed from the fuel rods by pool boiling or, if the core is slightly uncovered, by forced convection to superheated steam. The HPI system has been designed to provide the necessary fluid makeup to the RCS to ensure adequate core heat removal.

Decay heat removal from the RCS can be accomplished in several ways, e.g., by break flow, steam generator heat removal, or combinations thereof. During a small-break LOCA, the decay heat removal is important in that it determines the system pressure and, hence, the HPI flow being provided. Therefore, to demonstrate core cooling, it is only necessary to show that sufficient decay heat removal is provided, prior to core uncovery, to allow the HPI system to replace the inventory being boiled by core decay heat removal. In this manner, level in the core can be maintained above the top of active fuel rods.

For break sizes smaller than 0.02 ft^2, decay heat removal from the RCS is accomplished by a combination of the break flow and the steam generators. See Keaten and Jones, ff. Tr. 4588, at 7. If the break sizes are smaller than 0.005 ft^2, the HPI system can compensate for the break flow and maintain the primary coolant loops essentially full of liquid such that natural circulation is not interrupted.

Assuming a break size between 0.005 and 0.02 ft^2, the HPI flow is unable to compensate for the leak flow and the RCS will saturate. Steam pockets will eventually form and grow to a volume sufficient to fill the 180° inverted U-bends at the top of both hot legs. This will result in an interruption of natural circulation. The loss of natural circulation leads to a loss of heat removal via the steam generators and the system will pressurize. See Jones and Broughton, ff. Tr. 5038, at 6-7; Keaten and Jones, ff. Tr. 4588, at 7.

As the RCS continues to lose inventory, a condensing surface will be exposed in the steam generators. This will establish the boiler-condenser mode of heat removal. This mode of heat removal will terminate the pressure increase and control RCS pressure at a value sufficient to assure adequate HPI flow for core cooling. See Jones and Broughton, ff. Tr. 5038, at 6-7.

Small-break LOCA analyses have been performed which demonstrate the adequacy of this cooling mode. These are documented in Licensee's Exhibit 5. Those analyses were performed utilizing the presently approved CRAFT2 code. Comparison of the steam generator heat removal rates calculated in those analyses to that which would be obtained by using the theoretical formulations in the new model show reasonable agreement. That is, an approximate three-foot adjustment in the condensing length would yield the same heat transfer. This

small loss of inventory, approximately ten percent of the available inventory above the top of the core, would not affect core cooling.

Since the analyses in Licensee's Exhibit 5, the B&W ECCS evaluation model and the CRAFT2 code have undergone modification in response to II.K.3.30 of NUREG-0737. The revised evaluation model and CRAFT2 code have been submitted to the NRC for review.

Within the modified CRAFT2 code, an upgraded steam generator model has been incorporated which includes heat transfer correlations specifically oriented to the boiler-condenser mode of cooling. A new 0.01 ft^2 break analysis has been performed using the revised code and is documented in BAW-10154. See Licensee Ex. ____, Appendix E. Extrapolation of the results demonstrate that adequate core cooling is maintained for breaks of the size for which boiler-condenser cooling is predicted to occur.

The capability of the steam generator to remove sufficient core decay heat to assure adequate core cooling via the HPI system during a small break LOCA is further illustrated by the analysis described below. As stated previously, adequate core cooling is assured if the core is continuously covered by a two-phase mixture. Maintenance of this condition is assured if the HPI flow provided to the system is sufficient to match or exceed the inventory boiled off from core decay heat removal.

Because the HPI flow varies with system pressure, the time at which the injected flow and core boiling match will be a function of the system pressure. The pressure/time relationship for this matchup is illustrated on Figure 1. Thus, the significant question is whether the boiler-condenser mode will assure a pressure/time relationship, before the core becomes uncovered, to yield adequate HPI to keep the core covered.

A heat transfer analysis of the steam generator, while operating in the boiler-condenser mode, was performed to develop the pressure/time relationship. Prior to any possible uncovering of the core, the full condensing surface of the steam generator will be exposed. Using this surface area, an analysis was performed to determine the RCS temperature, and hence pressure, necessary to condense all the steam being generated as a result of core decay heat removal as a function of time. It should be noted that since none of the generated steam is assumed to be removed via the break, this analysis would overpredict the RCS pressure that could exist just prior to possible core uncovery. Figures 2 and 3 show the results of the steam generator heat removal analysis for cooling on the steam generator level (at 95 percent on the operating range) and the emergency feedwater spray, respectively.

Combining the results of the HPI cooling and steam generator heat removal analyses, as illustrated in Figure 4, it is seen that boiler-condenser heat removal will provide

sufficient pressure control to result in HPI flows necessary to assure adequate core cooling after 1650 seconds. The next subject of the analysis, then, is to determine whether the core is predicted to become uncovered prior to this time.

Several small break LOCA analyses have been performed which indicate that the core could not become uncovered prior to 1650 seconds for the break sizes of interest. In Licensee's Exhibits 3 and 4, which are the section 50.46/Appendix K analyses for TMI-1, it can be seen that the 0.04 ft^2 break reaches its minimum system inventory at 3000 seconds. No uncovering of the core is calculated for this break. Since smaller breaks would lose inventory at a slower rate, the 0.04 ft^2 break would bound the results.

In addition, the analyses of the 0.01 ft^2 break (documented in Licensee's Exhibit ___ (BAW-10154), show that the boiler-condenser mode of cooling is calculated to occur at approximately 1500 seconds. At this time, there is a substantial quantity of liquid (105,600 lb or 2440 ft3) remaining above the top of the core. This inventory would have to be lost through the break prior to the core uncovering. Even if an RCS pressure of 2500 psi was assumed, which is well above the 1800 psi pressure calculated for this time, this inventory could not be lost prior to 1650 seconds.

Based on this analysis, it is clear that uncovering of the core would not occur prior to 1650 seconds for the break size

range for which boiler-condenser heat removal is necessary. Since the boiler-condenser cooling mode assures adequate pressure control after this time to enable the HPI to match or exceed the core boil-off, adequate core cooling is assured.

Turning to the Appeal Board's interest in experimental testing of the boiler-condenser mode of heat removal, it should be recognized that the actual heat transfer mechanisms are well understood. Within the primary system steam is condensed on the inside wall of the cooled steam generator. The heat then flows through the tubes, via conduction, and is transferred to the secondary side fluid. Two possible mechanisms exist for the secondary side heat transfer. These are by pool boiling on the immersed steam generator tubes and/or cooling by the emergency feedwater which is sprayed directly on the steam generator tubes.

There are several data sources available, or planned, which demonstrate the capability of the steam generator to remove heat in a boiler-condenser mode. First, there is the TMI-2 accident itself. After all of the reactor coolant pumps had been tripped at 100 minutes, filling of the steam generator by emergency feedwater commenced. During the fill period, heat removal from the RCS occurred which controlled the primary system pressure within 100 psi of the secondary side pressure. The only explanation for the pressure curves tracking together is the effect of boiler-condenser cooling in removing decay

heat. See UCS Ex. 1 (minutes 100 to 125). If the HPI system had been actuated and maintained at this time, adequate inventory would have been maintained to prevent core damage. Thus, the TMI-2 accident did not demonstrate an inadequacy of RCS heat removal (i.e., an inadequacy of boiler-condenser cooling), but rather showed the importance of maintaining adequate core inventory via the HPI.

Tests have also been run at the Alliance Research Center (ARC) which examined condensation phenomena in a high pressure facility. In these tests, a single steam generator tube was tested by exposing a condensing surface by adjusting water level on the inside surface of the tube. Then, by varying steam flow to the test section, temperature measurements were taken in order to determine the heat transfer coefficient. The calculated coefficients for these tests have confirmed the conservatism of the heat transfer model employed in the upgraded CRAFT2 code.

In the future, additional experimental data on the boiler-condenser mode of cooling and small break LOCA response will be developed at ARC. At present, an integrated systems test facility at ARC (GERDA) is being tested. It is a scaled single-loop, full height, full pressure test facility of a B&W NSS and is of similar size to Semiscale. This facility was developed for the BBR company in Germany in order to examine small break LOCA phenomena. The data from this facility is expected to be available in mid-1983.

The B&W Owner's Group, in conjunction with the NRC, is presently exploring a two-loop facility to further examine plant response to small break LOCA and other transients. This data will be used to confirm the adequacy of the computer models. Through the computer codes, this data will then enhance the understanding of plant response for improved operator training and procedures. Data from this facility is projected to be available in mid-1985.

In summary, the boiler-condenser mode of cooling is relied upon for heat removal during certain sized small break LOCAs. The basic heat removal processes are well understood and have been successfully applied in other engineering applications. The ability of the TMI-1 steam generator to remove core decay heat has been demonstrated as sufficient to provide adequate core cooling. Thus, while there are presently plans to obtain additional experimental data for the purposes of improved understanding of plant response and for code benchmarking, operation of TMI-1 prior to receipt of this data will not endanger the public health and safety.

Figure 1

HPI MATCHUP WITH CORE DECAY HEAT

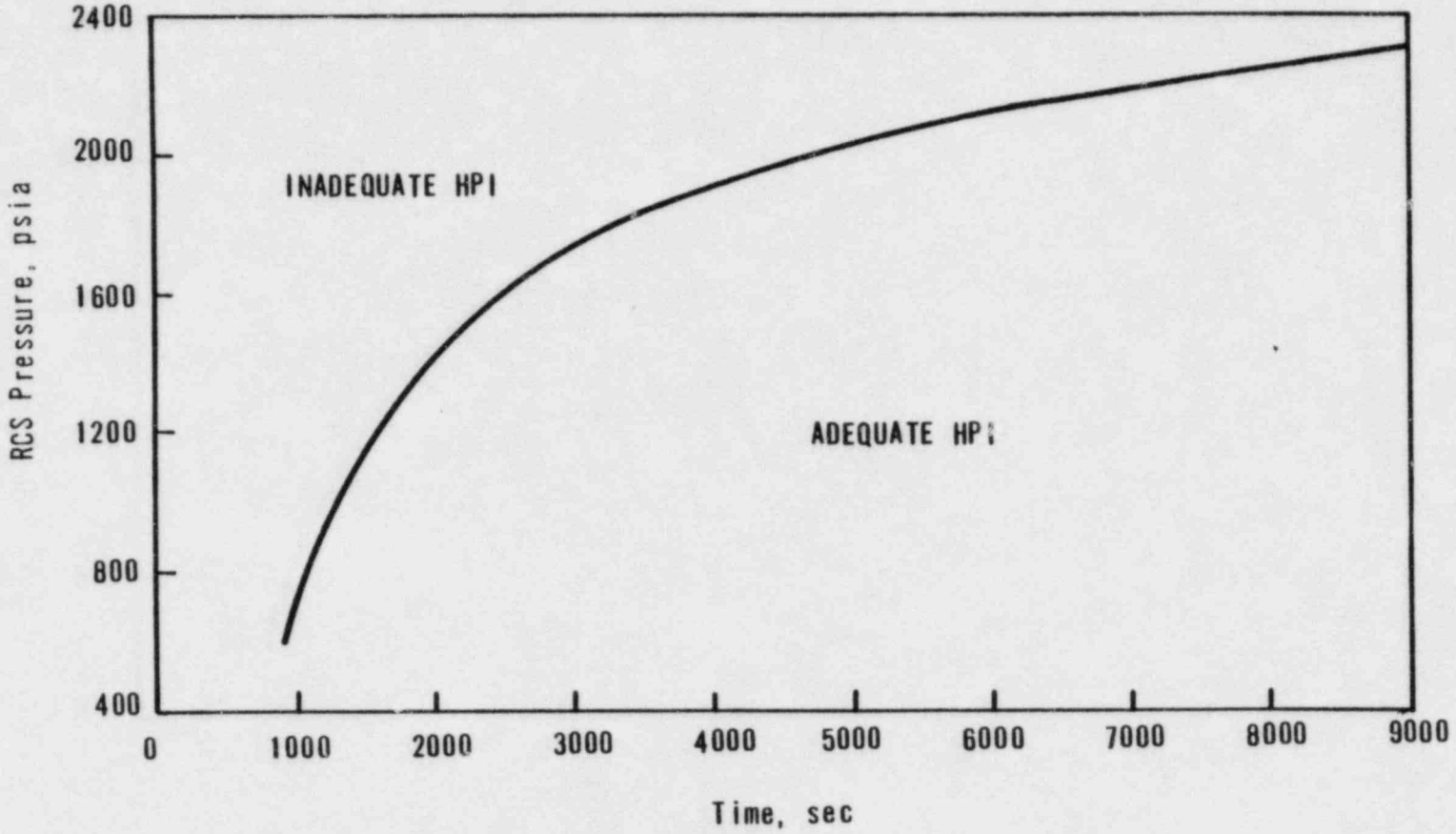


Figure 2

RC PRESSURE VS TIME FOR BOILER-CONDENSER

HEAT REMOVAL VIA SG LEVEL

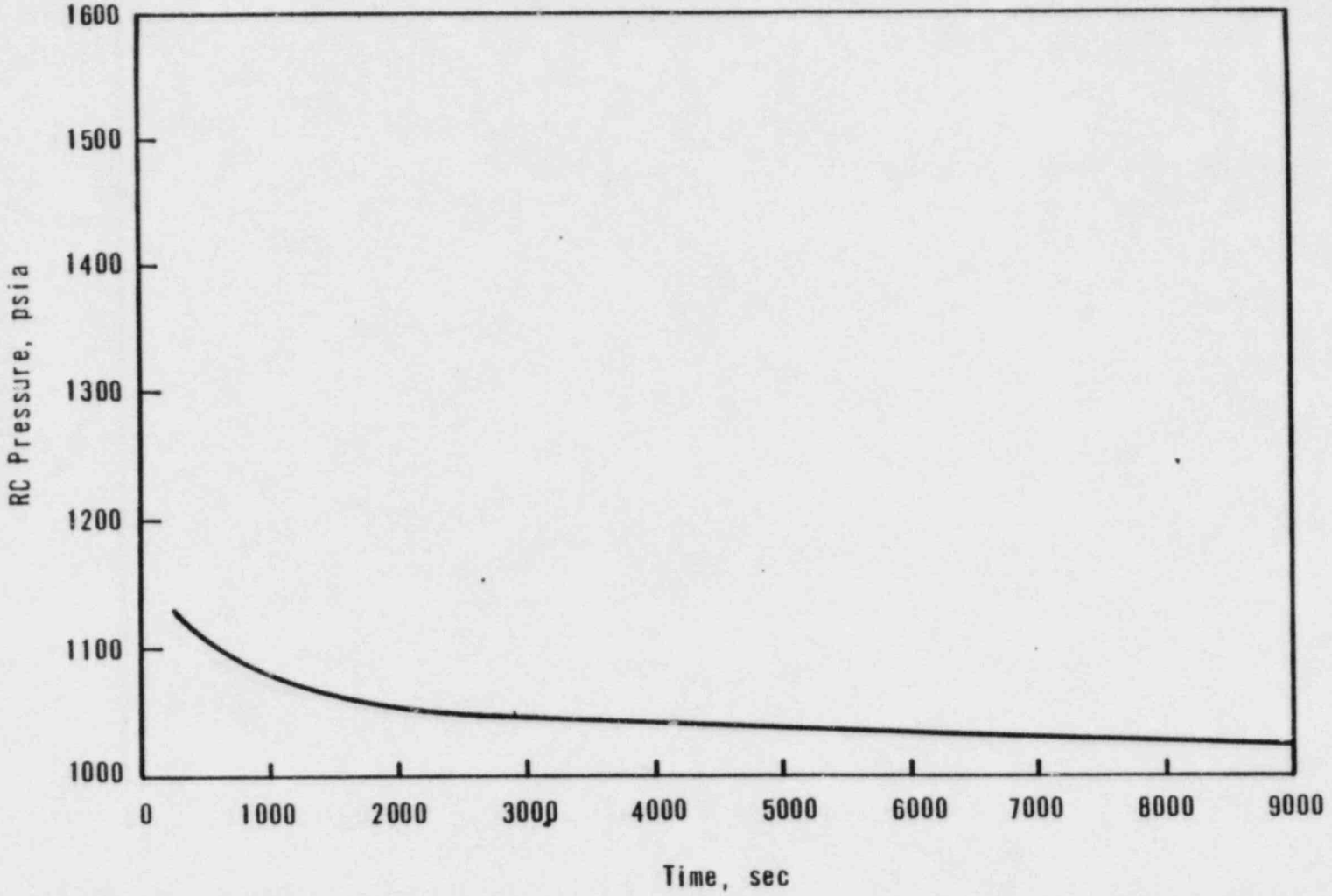


Figure 3

RC PRESSURE VS TIME FOR BOILER-CONDENSER

HEAT REMOVAL VIA EFW SPRAY

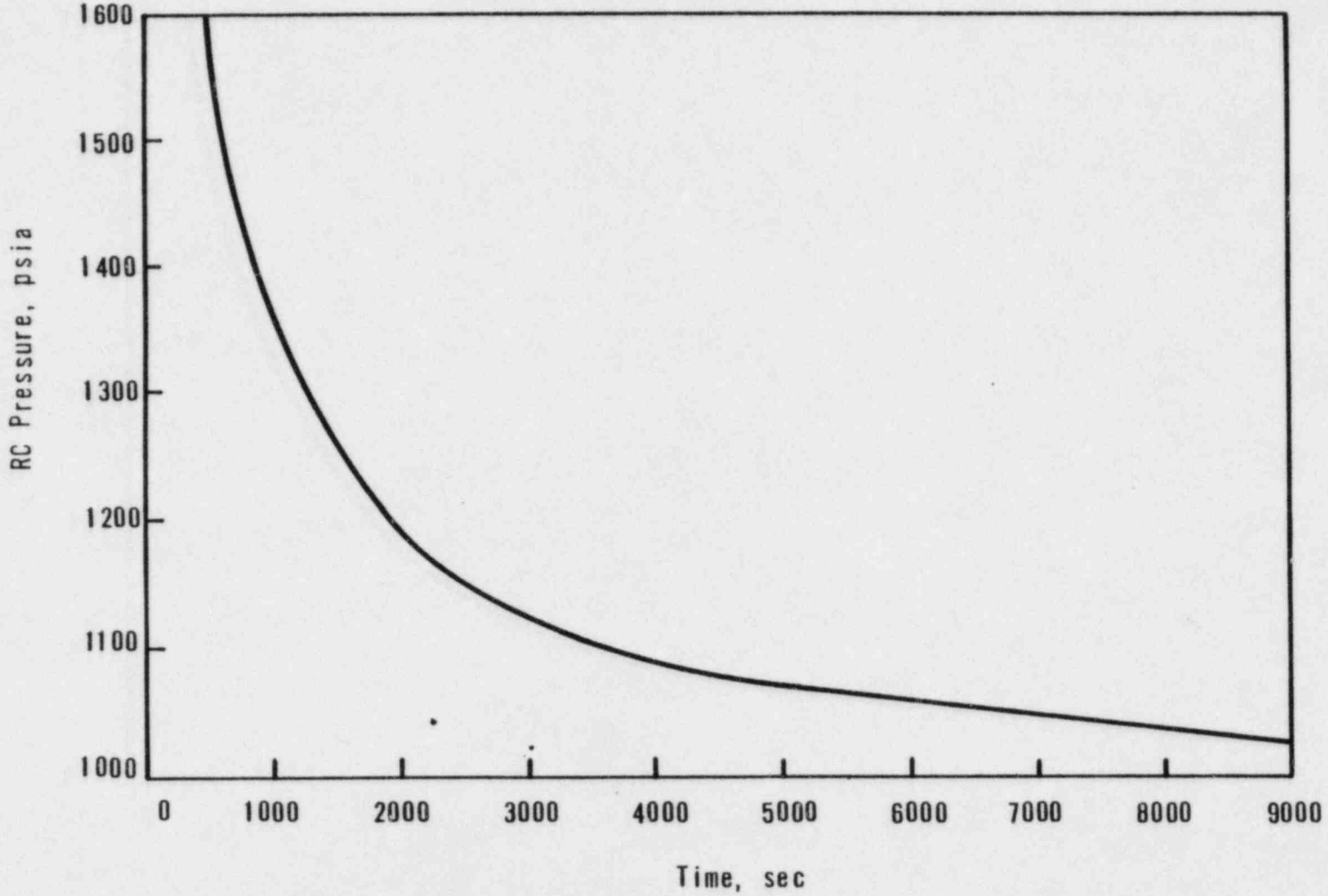
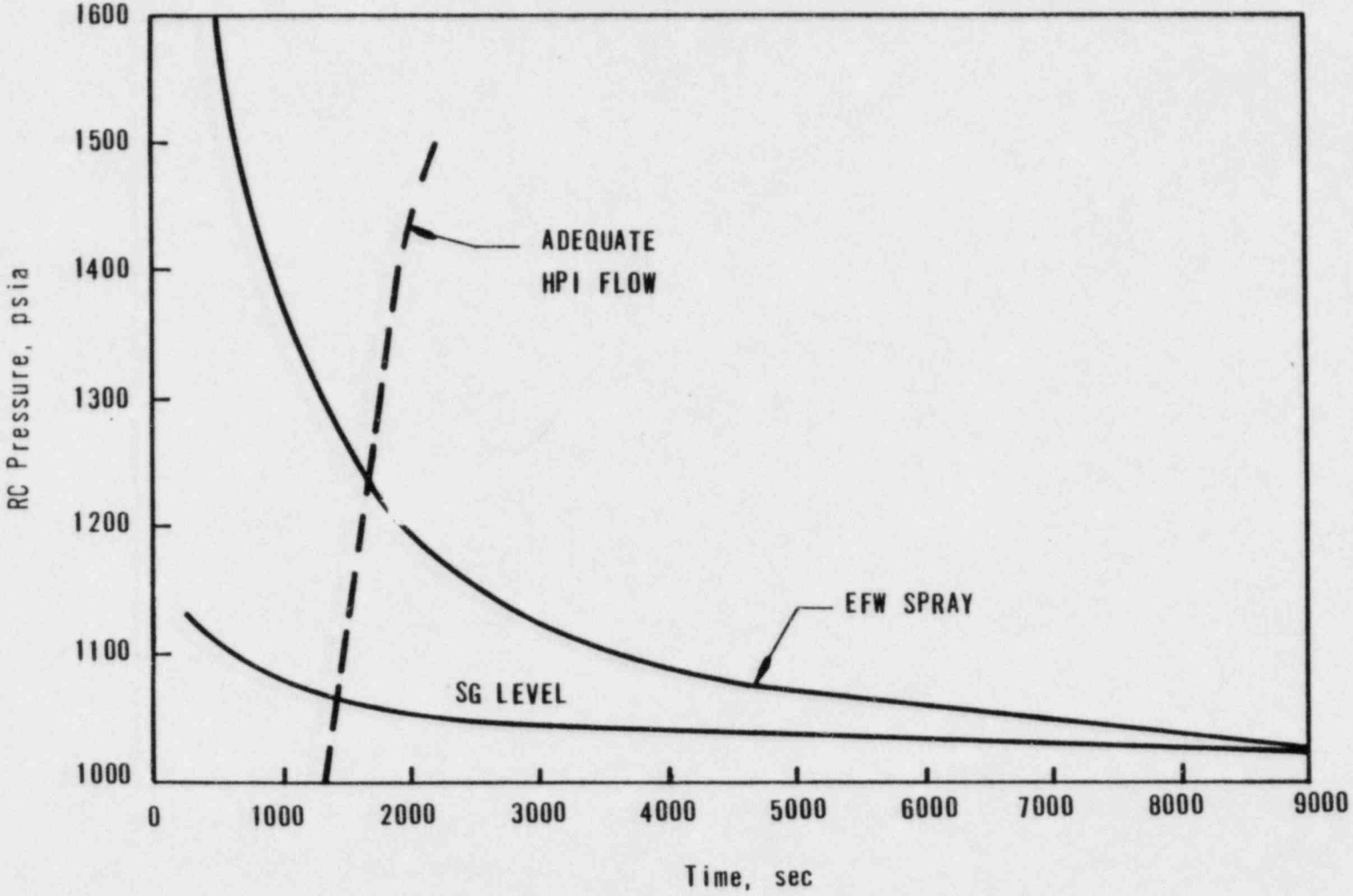


Figure 4
RELATIONSHIP OF HPI COOLING AND BOILER
CONDENSER HEAT REMOVAL



ROBERT C. JONES, JR.

Business Address: Babcock & Wilcox Company
Utility Power Generation Division
Post Office Box 1260
Lynchburg, Virginia 24505

Education: B.S., Nuclear Engineering, Pennsylvania State University, 1971. Post Graduate Courses in Physics, Lynchburg College.

Experience: February 1983 to Present: Unit Manager, Fluid and Transient Analysis Unit, B&W. Responsible for LOCA and non-LOCA safety analyses. Responsibility includes providing input to operator guidelines for responding to LOCA and non-LOCA transient scenarios.

July 1982 to February 1983: Supervisory Engineer, Operational Analysis Unit, B&W. Responsible for the performance of plant transient analyses and analyses used in the development of operator guidelines. During this period, has continued as Project Engineer for B&W analyses performed in response to NUREG-0737 Item II.K.3.30.

June 1975 to July 1982: Acting Supervisory Engineer and Supervisory Engineer, ECCS Analysis Unit, B&W. Responsible for calculation of large and small break ECCS evaluations, evaluations of mass and energy releases to the containment during a LOCA, and performance of best estimate pretest predictions of LOCA experiments as part of the NRC Standard Problem Program. Involved in the preparation of operator guidelines for small-break LOCA's and inadequate core cooling mitigation.

June 1971 to June 1975: Engineer, ECCS Analysis Unit, B&W. Performed both large and small break ECCS analyses under both the Interim Acceptance Criteria and the present Acceptance Criteria of 10 CFR 50.46 and Appendix K.

MR. BAXTER: I also move that Licensee's Exhibit No. 86 be received in evidence.

MS. WEISS: I object to that, Mr. Chairman.

JUDGE EDLES: On what basis?

MS. WEISS: I'm not sure how it is going to be used, except that the whole document, which is part of B&W's new Appendix K Evaluation -- this is one small part of it. It just seems to be referenced without differentiation, the whole thing, certain portions of the testimony. It hasn't been reviewed by the Staff, and I don't think that it has much probative value, and frankly I don't think just referencing the document as a whole is sufficient foundation for admission into evidence of the whole document.

j-i4-1

JUDGE EDLES: How does that go to admissibility as opposed to probative value, for example?

MS. WEISS: Well, that is one of the standards for admissibility in NRC proceedings, is that the document must have some probative value. I don't hink it is fair to simply -- I don't think you can bootstrap a highly technical document like this by simply referencing the whole of it in the direct testimony, and I might add that it was not indicated beforehand that this would definitely be offered.

You said that you might offer it.

MR. BAXTER: No. I don't think so.

MS. WEISS: That is my recollection.

MR. BAXTER: It was marked as an exhibit when I distributed it on February 10, and I called it a proposed exhibit, and said that Licensee plans to offer it into evidence at the upcoming hearing.

That is in my February 10th letter.

JUDGE EDLES: Just for my clarification, we are referring to the one with the blue cover, or the one with the green cover?

MR. BAXTER: No. We are referring to the one with the green cover.

MS. WEISS: I stand corrected, Mr. Baxter. You did say that you would offer it.

MR. BAXTER: If I might respond to the objection.

It is not a case of bootstrapping by simple reference. We attempted to avoid in the testimony reproducing large parts of a document that is directly relevant and supported with the conclusions that are being reached here, and I think that is a perfectly acceptable thing to do. It seems to be criticized if there is reliance on documentation not available for the Board and the parties, and now there is criticism because we do provide the document for the record.

The fact that it is lengthy is not in itself a valid objection to its admissibility, and Mr. Jones does more than reference it.

He discussed the .01 square foot break evaluations that are performed in there, and the document fully describes what that model is supposed to do.

JUDGE EDLES: Mr. Cutchin, any observations?

MR. CUTCHIN: Mr. Chairman, the Staff has no objection to the introduction of the document, and would support its introduction.

JUDGE EDLES: Mr. Adler?

MR. ADLER: We have no objection to the introduction of this document.

JUDGE EDLES: Ms. Weiss, do you have any

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further comments in light of Mr. Baxter's views?

MS. WEISS: No, sir.

JUDGE EDLES: I'll allow the introduction into evidence of the exhibit. It is moved into evidence.

(The document previously marked Licensee Exhibit No. 86 for identification was received in evidence.)

MR. BAXTER: On March 3, 1983, I distributed to the Board and the parties the B&W Regulatory Response Group's response to Board Notification 83-21, which was provided to the Board and the parties, and was the occasion for recessing the hearing last week.

As I indicated in my cover letter, Section 2 of that document is relevant, which is entitled "Emergency Feed Water EFW Spray Effectiveness," is relevant to a portion of Mr. Jones' testimony on issue No. 7, and provides some background information that is not included in the testimony on how he calculated the effectiveness of emergency feed water spray.

I have provided the entire report, of course, to all the parties. I have given the reporter a reproduction of Section 2. That is pages 201 through and including all the figures in that section, and the title page of the document and the executive summary

j-14-4

sheet, and I request that that document be marked for identification as Licensee Exhibit No. 87.

JUDGE GOTCHY: There is some information in Section 3 on the fill rate. You are not offering that in evidence?

MR. BAXTER: No.

Mr. Jones can elaborate. I don't think there was anything new in there, except for one small part, which discusses isolatable breaks.

I'm trying to limit the record to what is directly involved in the reopened proceeding, and I think the discussion there, level requirements, is essentially repetitive of what we already have somewhere in the record.

JUDGE EDLES: Any objection?

MS. WEISS: We don't have any objection to Section 2. We are a little concerned, as Dr. Gotchy, that Section 3 is being offered.

We would just like to look through there for a moment.

MR. BAXTER: The only reason for not putting in the entire report is that Section 4 deals with procedures, and it is my view that the Board has not yet reopened the proceedings with respect to procedures.

I've got copies of the entire document that we

j-14-5

can put in, with the understanding that we are not getting into Section 4.

JUDGE EDLES: Would you feel more comfortable with that, Ms. Weiss? With part 3 in, or the entire document?

MS. WEISS: I'm willing to accept Mr. Baxter's offer.

MR. BAXTER: We will ask that instead of the previous identification, that Licensee Exhibit No. 87 be identified as the entire report, entitled "Evaluation of SBLOCA Operating Procedures and Effectiveness of Emergency Feed Water Spray for B&W Designed Operating NSSS as dated February 1983," and I'll provide a copy of that to the reporter, and I would move into evidence all but Section 4.

JUDGE EDLES: Any objection?

MS. WEISS: None.

MR. CUTCHIN: None, sir.

JUDGE EDLES: So moved.

(The document previously marked Licensee Exhibit No. 87 for identification was received in evidence.)

MR. BAXTER: I have one clarifying question I would like to ask Mr. Jones before cross-examination.

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15-1

I think it will short-cut one area.

BY MR. BAXTER:

Q Mr. Jones, on page 15 of your written direct testimony, you begin discussing in the second full paragraph a heat transfer analysis of the steam generator which you performed, and on a sentence beginning on line 10, it says, "Prior to any possible uncovering of the core, the full condensing surface of the steam generator will be exposed."

What do you mean by the "full condensing surface of the steam generator"?

A Well, what I'm describing there is the condensing surface available above the overflow point of the reactor coolant pump. If you have the Board Notification 83-21, I can illustrate it for you a little better, I think.

In Attachment 2, there is a figure 4-12, which shows the relative elevations of the steam generator, the RC pumps, the reactor vessel.

The Point A, what is labeled as Point A is what I'm calling the overflow point of the pump. The condensing area that would be available above that is what I am calling in my testimony the full condensing surface area.

Now, when actually doing the calculations which are described in the testimony, there are two situations

j-15-2

examined.

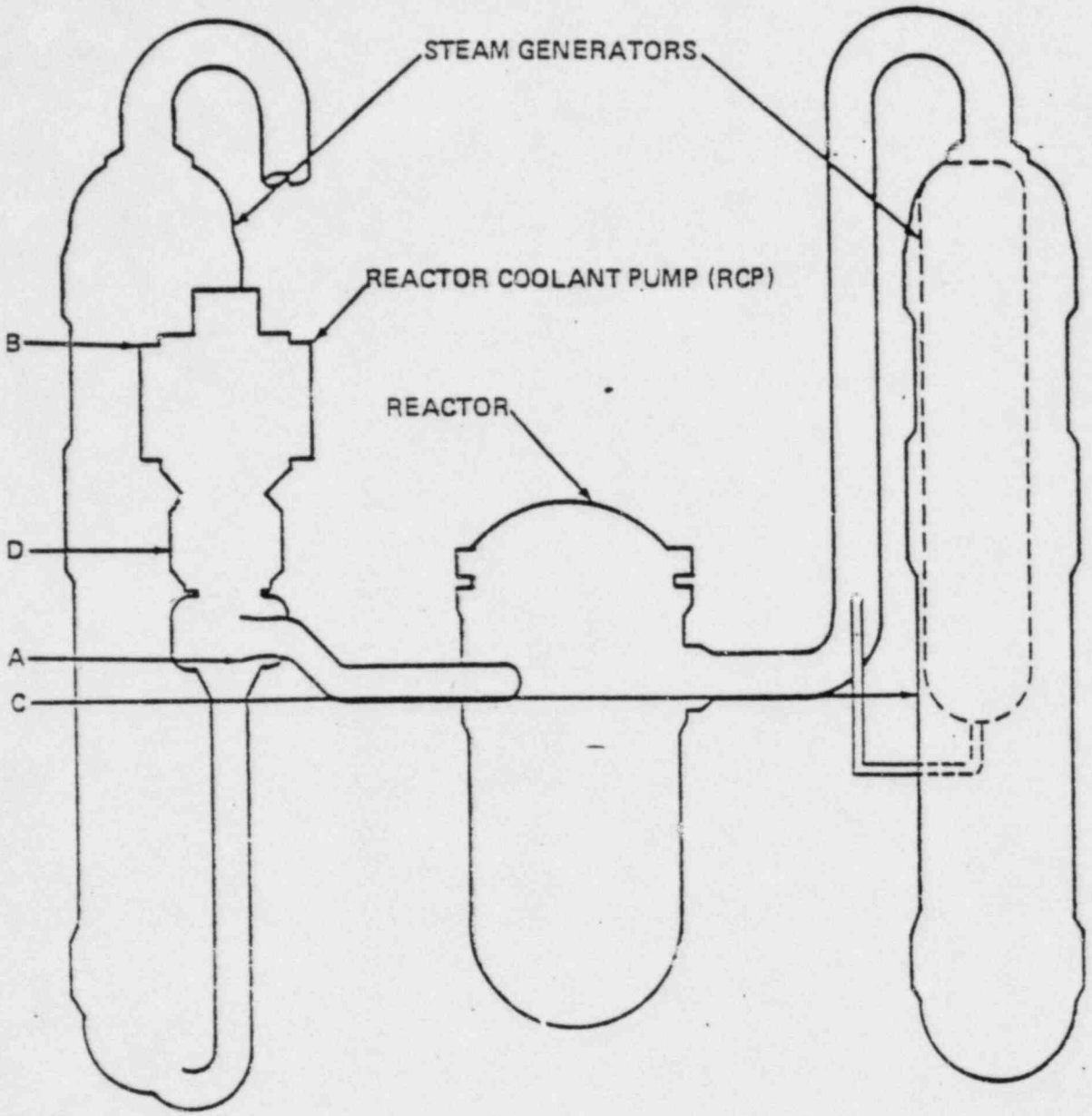
The first one deals with the surface area between the point labeled D in figure 4-12, which is the 95 percent level on the operate range, and Point A.

wetted For the aux feed water spray case, or the emergency feed water spray case, I am talking about the distance between he point labeled B and Point A, and am also accounting for the number of tubes that would be directly by the aux feed water spray.

MR. BAXTER: Mr. Chairman, can I suggest that we put a copy of this figure in the transcript at this point, and make the examination clear?

JUDGE EDLES: I think that seems sensible.

(Copy of Figure 4-12 follows)



ELEVATION A – BOTTOM OF RCP DISCHARGE NOZZLE
ELEVATION B – APPROXIMATE ELEVATION OF AFW SPARGER
ELEVATION C – 50% OF OPERATING RANGE
ELEVATION D – 95% OF OPERATING RANGE

FIGURE 4-12 REACTOR COOLANT SYSTEM ARRANGEMENT FOR THREE MILE ISLAND UNIT 2 (SELECTED ELEVATIONS)

MR. BAXTER: Mr. Jones is available for cross-examination.

JUDGE EDLES: UCS.

MS. WEISS: Thank you.

CROSS-EXAMINATION

XXX ON BEHALF OF THE INTERVENOR

BY MS. WEISS:

Q Mr. Jones, we have discussed this so many times together, sometimes I can't remember what the Board has already heard or not. So excuse me if I get repetitive.

Am I correct that there are three B&W Models referred to at various points in your testimony, and that we have referred to as the approved Appendix K Model, the revised model that is post-TMI revisions, and the new model that has recently been submitted for Appendix K review that is described in Licensee Exhibit 86; correct?

A Yes, there are three models, yes.

Q And I would like to refer to them throughout the questioning as the approved, revised, and new B&W models; okay?

MR. BAXTER: We are not stipulating that the second model is not an approved model, also, but for simplicity, we will agree to the words UCS wants to use.

BY MS. WEISS:

Q With that in mind, would you go through your

testimony and indicate to us which portions of your testimony are conclusions that are derived from the approved model, which from the revised, and which from the new?

He's smiling because we have done this before.

A Well, let's start on page 2 of the testimony, and I will try to mark out the various sections and label them accordingly.

To start off with, on page 2, between lines 18 and 23, we are talking about the approved model.

Lines 24 on page 2 carried over to line 16 on page 3, is the revised model.

Lines 17 through 25 on page 3 is the new model.

On page 4, between lines 7 and 14, it is the approved model, and between lines 15 and 20 is the new model.

On page 5, between lines 5 and 11, is the approved model.

Line 21 on page 5, continuing on to line 13 on page 7, we are talking about the approved model being used for the analyses that have been done in concert with the selection criteria described there.

On page 9, between line 8 and the end of the sentence on line 23, we are talking of the revised model.

j-15-5

And from there, from that sentence on line 23, starting "The effort," on page 9, carried over to the rest of page 10, is the new model.

On page 13, the paragraph starting on line 17, and ending on line 3, page 14, we are talking the revised model.

Between lines 4 and 17 on page 14, we are talking the new model.

Jumping over to page 16, between lines 5 and 12, we are talking the approved model.

The paragraph starting on line -- between lines 14 and 15, that whole paragraph there is with the new model, ending on line 23.

I believe that is all.

Q Then, on page 14 at line 8 and continuing on -- I'm sorry -- line 18, and continuing on to page 15, is that analysis not done with any particular code?

A The analyses starting on page 14 and carrying over through page 16, line 4, is -- it is based on a computer code, a special code that was written just simply for this testimony, just setting forth some calculations. It is not either of the three codes that you were talking about, but it does include the new features that is within the new code, or the new model.

Q Am I correct that the new model uses a different version of the Craft code that was used in the approved version?

A Yes, it does.

Q Could you describe to us what the changes are?

A There are several changes that were added, or made to the Craft2 Code. One of the changes was, we have added a nonequilibrium pressurized model.

We have also added a two-phase slip model for use in simulations of small break LOCA transients with reactor coolant pumps running.

We have also developed a new two-phase RC pump model for use in simulations, small break LOCA simulations with reactor coolant pumps running, which is based on Combustion Engineering-EPRI data.

We have also made several changes to the steam generator model. That's all.

16a1

Q. Are both the approved and the revised models thermal equilibrium models?

A. The approved and the revised model was it?

Q. Right.

A. They are both equilibrium models within any control volume. You can still have nonequilibrium behavior in the system as a whole, but within a given control volume, it will be equilibrium.

Q. And the new B&W model is also a thermal equilibrium model within any given node with the exception of the pressurizer; is that correct?

A. That's correct.

Q. On page 3 of your testimony, you discuss the additional control volumes or nodes that were added to the approved code to run the calculations after the TMI accident that we are referring to as the revised model.

Can you describe for me physically with reference to the plant system what the new node corresponds to?

A. Okay. First let me just correct a little bit of nomenclature in the question, if I could.

This analysis -- when we added the nodes, we added it to the approved model. The analyses were done with the approved CRAFT2 code.

Now, physically describing the region that was added, what it is, is, we broke out a volume between the --

16a2

between the 90-degree centerline of the 180-degree bend in the hot leg down to that region extending from there, the piping down into the upper plenum of the steam generator, and then the tube region to the elevation of the auxiliary feedwater spargers.

Q. You may have answered this, but let me make sure. For the new -- for the node representing the up side of the hot leg, that physically extends from the top of the U-bend, the midpoint of the 180-degree U-bend down to what point? Is it all the way down to the vessel outlet?

A. It extends from the 90-degree portion of the 180-degree elbow down to the inlet nozzle. I can't remember whether it includes the inlet nozzle or that it doesn't. But it is right to that basic point in the system.

Q. Would that be the inlet or the outlet nozzle?

A. I mean the outlet nozzle. Excuse me.

Q. And when you did those calculations, the revised model, but the approved CRAFT code with the new node, does that model calculate one temperature for each entire node?

A. Yes, it does.

Q. So, with that revised model is it possible for the code to predict that the node representing the up side of the hot leg is entirely filled with liquid and the new

NUCLEAR REGULATORY COMMISSION

This is to certify that the attached proceedings before the Atomic Safety and Licensing Appeal Board, in the matter of: Metropolitan Edison Company, et al., (Three Mile Island Nuclear Station, Unit 1)

Date of Proceeding: March 16, 1983

Docket Number: 50-289 (Restart)

Place of Proceeding: Bethesda, Maryland

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

Frank G. Tayloe
Official Reporter (Typed)

Official Reporter (Signature)

16a3

node is entirely filled with steam?

A. It is possible for the code to do that. I would not expect it, but it is possible.

Q. Physically that condition could never occur, could it?

A. I wouldn't say it couldn't occur. I would be surprised if it did. But generally what we see is what I will call the up side of the hot leg, the connection from the vessel to the 90 degrees on the elbow, on the 180-degree elbow. Typically what we will see in some of the calculations is a very large volume of liquid being trapped there with a small steam bubble up in the top of the volume while this extra node could indeed have a very large fraction of steam in it, and that just simply results from the differences in the densities between the steam generator, which is cold, and the hot leg, which is warmer fluid, and the bubble tends to collect on the down side of the piping.

Q. If within each node the code calculates one temperature, how is it that the code would tell you that you have steam at the top and liquid at the bottom of the same node?

A. Well, the code does a mass of energy balances and tracks inflows and outflows from the system. Obviously the node has got to be filled with something.

16a4

So if the system is saturated, it will then calculate how much steam is within any given control volume. It also calculates the separation of steam within the control volume based on the Wilson bubble rise model, and that steam can then collect in the upper regions of the model, so the output from the computer code will give you the total steam mass within the volume, and it also will tell you how much of it is in solution, if you wish, before the two-phase mixture, and where that mixture height is, so you can tell whether or not there is a steam volume trapped in the upper portion of that volume.

Q. If we could focus on the precise language of the Board question which you are asking here: It is, "Whether the modified B&W ECCS evaluation model for Small-Breaks that predicts the boiler condenser process is an NRC-approved code under Appendix K, 10 CFR Part 50."

Is the answer to that question yes or no?

A. The answer to that question is no, as I have stated in my testimony on page 2, lines 24 to 26, that sentence, where I stated that the model -- the revised model is technically not the approved ECCS evaluation model.

Q. In the middle of page 5, around line -- I guess it's 16 -- you quote a portion of 10 CFR 50.46 which reads, "It had to be calculated for a number of postulated loss-of-coolant accidents of different sizes, locations, and other properties, sufficient to provide assurance that the entire spectrum of postulated loss-of-coolant accidents is covered."

JUDGE EDLES: Ms. Weiss, do you want to speak just a little closer to the microphone, please.

BY MS. WEISS:

Q. What other properties are referred to there by the regulation?

A. Generally that has been interpreted to mean one of two items. First, the nature of the break, is it a

17a2

double-ended guillotine-type break, or is it a split or a crack in the pipe, and the other situation being the discharge coefficient.

Q. There is another portion of 50.46 dealing with long-term cooling.

It states that after any calculated successful initial operation of the ECCS, calculated core temperatures shall be maintained at an acceptably low value and the decay heat shall be removed from the extended period of time required by the long-life radioactivity remaining in the core.

For TMI might this long-term cooling mode be either high-pressure recirculation or low-pressure recirculation?

A. The long-term cooling mode at TMI can be recirculation from the reactor building sump through the LIP, or if the pressure stays elevated, through the LIP at HPI in a piggy-back fashion.

Q. So the answer is yes, it could be either high pressure or low pressue?

A. I answered it that way because I just wanted to make sure how I was interpreting your statement. That's why.

Q. I don't mean to criticize you.

What is the answer to the question? Yes?

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A. Subject to the definitions that I used, yes.

Q. What is the range of break sizes for which it is necessary to have high-pressure recirculation?

A. I'm not exactly sure, but my guess would be it would be on the order of a .02 square-foot break or less; and it would probably not be needed for those breaks in which the system would remain in the liquid natural circulation, the LO5s.

Q. For how long would it be necessary to maintain the high-pressure recirculation flow in order to satisfy the portion of 50.36 which requires keeping the temperature at acceptably low levels?

A. I don't really know the exact answer to that. With the HPI throttling criteria you would expect to be able to bring the system down in probably, say, less than a month, to pressures in which the decay heat removal system could operate. But it would obviously be break-size dependent.

MR. BAXTER: Could I make a comment off the record, Mr. Chairman, just a minute?

MS. WEISS: I would like to continue the questioning, unless there is some reason for it.

MR. BAXTER: Of course there is a reason for it.

JUDGE EDLES: Let's go off the record for just a moment.

17a4

JUDGE EDLES: Back on the record.

BY MS. WEISS:

Q. Is it correct that there have been no computer analyses with any of the models, B&W models yet, for this long-term cooling?

A. Well, there have been calculations performed to demonstrate that we have established the necessary conditions to assure that long-term cooling will be developed. Follow-on calculations from there are not necessary, and so they have not been performed directly.

Q. I have proceeded to page 7 of your testimony.

Can you give me the total tube area for the TMI-1 steam generators?

MR. BAXTER: Is that surface or cross-section?

MS. WEISS: Surface area.

THE WITNESS: Okay. The total steam generator surface area for the tubes is on the order of 115,000 square feet per generator. Now, that is for the entire length of the steam generator.

Q. With reference to the figure 4-12 that you were using earlier and that has been bound into the record, could you tell me what percentage of the tube area is above point A?

A. It is roughly 50 percent of the tube areas above that point.

Q. Can you tell me what percent is above point B, the emergency feedwater inlet?

A. It would be less than 10 percent.

Index

BY MR. POLLARD:

Q. What I would like to you took at is figure 2-3 in Lincensee Exhibit 87.

MS. WEISS: Does the Board have copies of that?

JUDGE EDLES: Yes.

BY MR. POLLARD:

Q. The dimensions shown on the left of the steam generator, am I correct that is the distance from the lower tube sheet, from the top of the lower tube sheet?

A. Yes, they are.

Q. Is this drawing sufficiently to scale that I could interpolate by measuring between the various dimensions or heights listed on that figure?

A. It appears to be.

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BY MS. WEISS:

Q. Do you know what percentage of the steam generator tubes are actually sprayed by the emergency feedwater flow?

A. Well, the actual number of tubes, or the percentage of the tubes that are sprayed by the EFW flow is a function of the initial flow rate and the distance down from the EFW sparger elevation. You have two effects:

There is basically a linear function as to the number of tubes that are initially wetted right at the EFW injection point, and that is shown on figure 2-11 of Licensee's Exhibit No. 87, and you can see it is basically a straight line.

Now, as you move down the steam generator, you have spreading of the EFW flow due to pooling on the tube support plates.

As is shown on figure 2-7, which will -- of that same exhibit -- you can see how the normalized surface, how the surface by the EFW surface changes as a result of the movement down through the various tube support plates.

BY MR. POLLARD:

Q. With the information thatwe have on the record in this proceeding, is it possible to construct either a graph or a table that would illustrate for TMI-1 the percentage of the tube area of unplugged tubes that will be wetted as a function of EFW flow.

The reason for my inquiry, the graph we have here tells me number of tubes versus height, and what I, of course, am primarily interested in is, what percent of the surface area is actually wetted of those unplugged tubes?

A. Well, I can't give you a correct number with even the information that is right here directly. However, I can kind of give you the ultimate effect after the

spreading occurs by referencing you to figures 2-17 and 2-18 of Exhibit 87.

What you see there are -- there are EFW wetted zones mapped out. Now, that is based on having penetrated to 10 percent into the steam generator, which for the flow rates at TMI-1, you would wet about 10 percent of the tubes before the flow would reach the overflow point in the pump, the EFW flow had passed that point. The model that we use only takes credit for wetting 10 percent. We don't allow it to exceed that value.

What you see here on figure 2-17 is that in that steam generator, if you run through the numbers, I think the numbers ought to be somewhere around 20 percent of the tubes are plugged in their peripheral regions by the EFW injection points, by their nozzles.

The other steam generator, the B-loop, as is readily illustrated on figure 2-18, there are very few tubes that are plugged, and that number was, I think, to be right at 8 percent.

Q. Figures 2-17 and 2-18 in Licensee's Exhibit 87, is that figure for a particular elevation, or height of the steam generator?

A. It would be right at the elevation at which the EFW had spread to wet 10 percent of the tubes, and I believe for the flow rates at TMI, that occurs within --

I think it is about 8 feet, 8 to 10 feet, moving down from the EFW sparger.

So, basically what I'm saying is, by the time the EFW has moved from the sparger elevation, 10 feet down into the steam generator, this figure -- these figures would represent the tubes that were wetted from that elevation down, basically.

Q. In other words, at an elevation above that illustrated on figures 2-17 and 2-18, there would be less tubes wet?

A. That's correct.

Q. In doing your calculations for heat transfer when you were looking at the effective heat transfer from the spray, what EFW flow rate were you using?

A. As I remember it, it was about 400 gpm per steam generator. 350 to 400 gpm, as I remember it.

Q. Am I correct that at higher elevations than illustrated in figures 2-17 and 2-18, these semicircles would be somewhat smaller in terms of the number of tubes wetted; is that correct?

A. That's correct.

Q. Now, at higher elevations than these figures, is the percentage of tubes being sprayed -- excuse me -- let me try it again.

Of the tubes being sprayed at higher elevations,

what is the percentage of plugged tubes?

A. I don't remember the exact number, but generally as you move up the steam generator from the point illustrated, those figures are illustrated, you will have a higher percentage of plugged tubes in the region.

Q. And is that because most of the tubes, or a high percentage of the tubes that are plugged are on the periphery of the bundle?

A. That's correct.

JUDGE BUCK: Mr. Jones, could I ask one question?

I couldn't quite understand your answer on figures 17 and 18. Is there no further spreading below this particular level? I believe you said this was about 10 feet down.

THE WITNESS: Yes. This is 10 percent of the steam generator tubes being wetted.

I don't really know whether or not -- we don't have any data which substantiates anything further than the 10 percent wetting. It is believed, if you were filling the steam generator up from a lower level, you would probably get additional spreading for exactly the same reasons that you got it to this point.

Within the analysis models we take a limit of 10 percent. We do not allow more than 10 percent of the tubes to ultimately be wetted.

JUDGE BUCK: I understand.

BY MR. POLLARD:

Q On Figure 207, am I correct that tube support plate 9 is what is illustrated in Figures 2-17 and 18?

A No. I don't think you are correct there. I think relative to Figures 17 and 18, you would be talking more like probably somewhere around tube sheet 11 and 12, about tube sheet 12.

Q Just for the record, Mr. Jones, when you say "tube sheet," you really mean tube support plate?

A Tube support plate. Excuse me.

Q Okay. Let's just pick one. Let's say it is 11.

j-18-2

11.

MR. POLLARD: Isn't that what he said, Mr. Baxter? I'm sorry. I hear the whisper, and I get distracted.

BY MR. POLLARD:

Q Am I correct that you said tube support plate 11 and 12 are roughly equivalent to Figures 17 and 18?

A I amended that and said it was tube support plate 12 after looking at Figure 23 for relative elevations, around 12.

Q Can I use Figure 2-7 in conjunction with my knowledge that Figure 2-17 shows that about 10 percent of the tubes will be wetted at tube support plate 12 to determine what percentage of the tubes will be wetted at any tube support plate above 12?

A You cannot use Figures 2-17 and 18 to infer how many of the unplugged tubes are wetted above tube support plate 12, no.

Q Well, I'm trying to analyze the record in this proceeding. Suppose I wanted to determine from the record, what percent of the tubes -- oh, forget whether or not they are plugged or not for the time being -- how do I determine what percent of the tubes are wetted above tube support plate 12?

A You would have to get the map of the steam

generators in order to do that, and that is not in the record. That is, that I know of.

Q You mean the map of which tubes are plugged or not plugged?

A Yes, sir.

Q Well, forget about that. Let's just talk about if all the tubes were unplugged.

A If all the tubes were unplugged?

Then what you would take -- there are a set of equations on pages 2-10 and 1-22 of Exhibit 87. Equation 1, which is the AZ over A total, knowing the EFW flow rate, you can then figure out how many tubes are wetted locally at the injection point.

Now, that is a -- that will tell you -- in a sense, the percentage of tubes wetted relative to the total tube area. And then applying equation 2, you can then obtain the number of tubes wetted relative to the initial penetration as you move down the steam generator from the EFW injection point.

BY MS. WEISS:

Q Of the three B&W models, approved, revised, the new, which of them assume that all of the emergency feed water tubes are wetted?

A The way tne approved and -- well, the approved and the revised models use the same Craft2

j-18-4

computer code, and that computer code did essentially assume that all the tubes were being wetted.

Q On Figure 4-12, which has been inserted into the transcript, could you indicate for me where main feed water enters?

A I think figure -- I would prefer not to refer to Figure 4-12. There is not a lot of detail there. I would rather refer you over to Figure 2-1 of Licensee Exhibit No. 87, and you can see from that figure the Item No. 4 is the EF -- is the main feed water injection point into the downcomer of the steam generator.

Q That appears to me to be at approximately 95 percent of the operating range. Is that about right?

A That's probably right, though it does not enter in the tube region. It enters into the downcomer part of the generator.

Q Is main feed water designed to spray directly on the tubes in the way that emergency feed water is?

A No, it is not.

Q Is it true that in calculating primary to secondary system heat transfer in the boiler condenser mode that both the new and revised models input the heat transfer coefficient and the heat transfer area? That is, they are fixed and input to the calculation, rather

j-18-5

than calculated by the model?

A No. That is not correct.

Q Explain to me why I'm wrong.

A You stated the new and revised model. The new model, you actually have the provisions for the EFW spray penetration and the movement down through the steam generator, so you in fact calculate how many tubes are wetted as a function of distance down the steam generator.

The revised and the old model, you did input directly -- well, what was in the revised model, in the revised and approved model, or the approved Craft2 code, is an overall heat transfer coefficient for the steam generator, a UA term, which is held constant throughout the transient.

The new model in fact calculates via a set of correlations what the actual heat transfer coefficients are.

Q I meant to say the revised and approved.

You listen a whole lot more carefully than I do.

Could you tell me what you mean by the UA term?

A That is kind of a standard term for heat transfer. The "U" is an overall heat transfer coefficient, which would account for the heat transfer on the inside surface of the tube through the steam generator tube, a conduction turn,

j-18-6

and then the heat removal through the steam generator.

It is a lumped heat transfer coefficient.

The "A" is the area of the generator. So the UA in a sense is a capability term, if you want, for heat transfer, so that the heat flow Q would be equal to UA Delta T, the difference in temperature between the primary and secondary side.

JUDGE EDLES: Ms. Weiss, let me ask you: I would like to take a short breat at some point. Would this be a convenient stopping point?

MS. WEISS: This is fine. Yes.

JUDGE EDLES: Okay. Why don't we take a ten-minute recess.

(Recess)

j-19-1

JUDGE EDLES: Please be seated.

Would you be kind enough to close the door in the back.

XX BY MS. WEISS:

Q Just to clarify the record, I wanted to summarize your answers to the last few questions, if I could.

Is it true that for the approved model and the revised model, both the heat transfer coefficient and the heat transfer area are inputs to the calculation?

A That's correct.

Q And they are fixed -- they remain fixed throughout the calculation?

A That's correct, also.

MR. POLLARD: Mr. Chairman, just for the clarity of the record, we had thought perhaps it might be useful to have bound into the transcript along with this other Figure 4-12, Figures 2-1 and 2-3 from Licensee Exhibit 87.

JUDGE EDLES: You mean bound in at this point?

MR. POLLARD: I thought it perhaps would be more convenient if we bound them in with the other figures, since they are both together.

JUDGE EDLES: Does that pose a problem for anyone?

Okay. Let's bind them in at this point.

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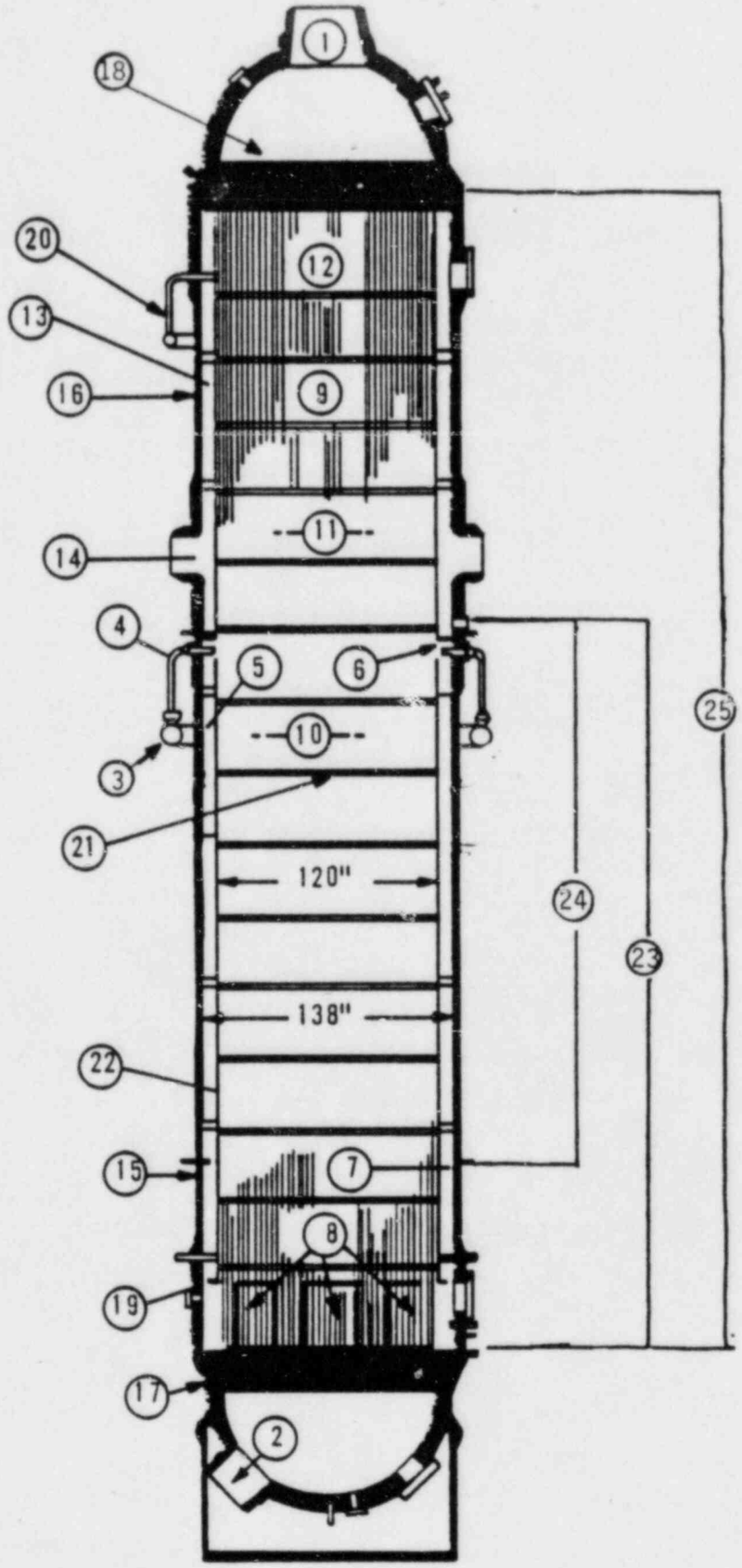
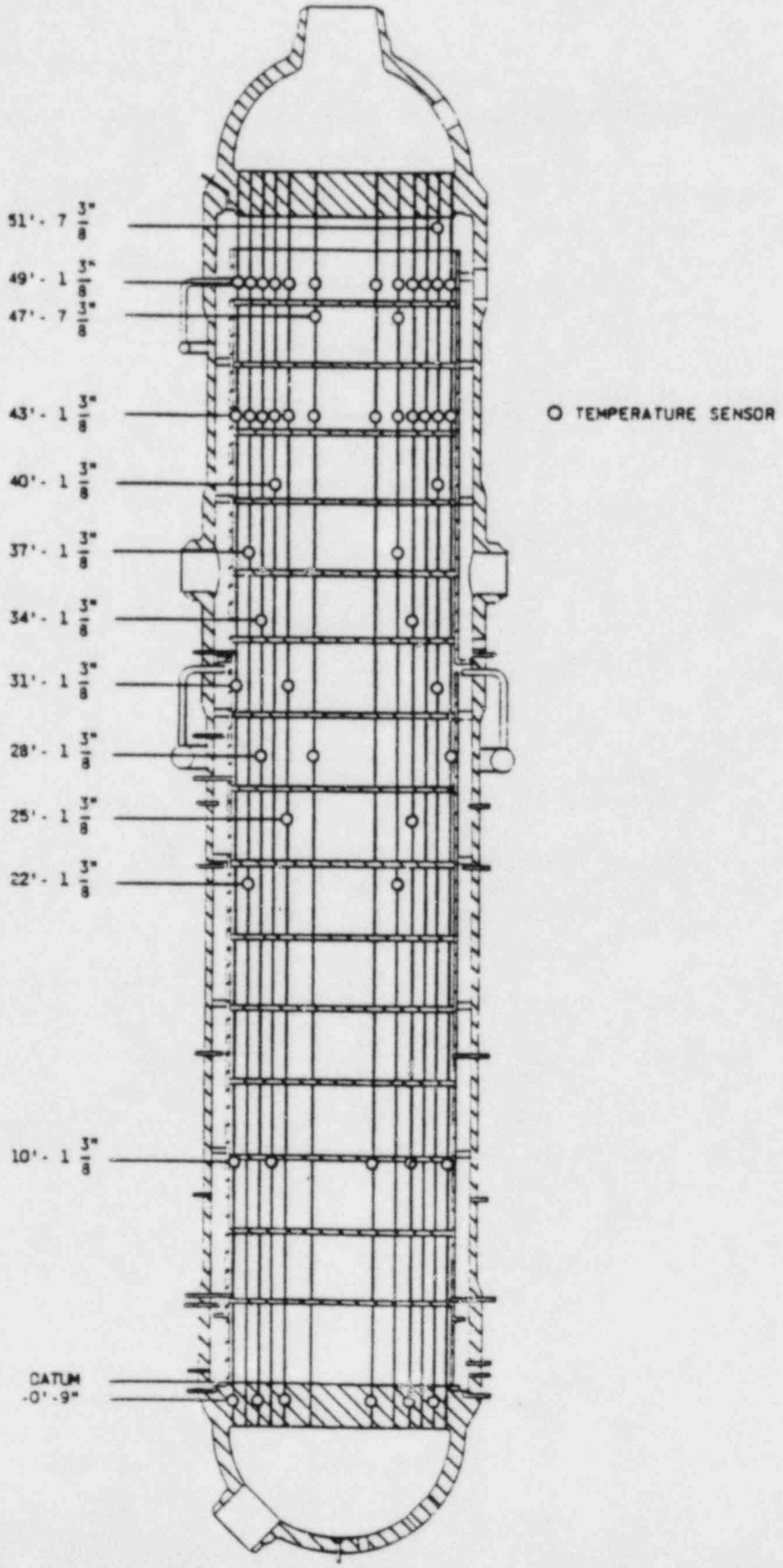
(Figure 2-1 and 2-3 follow)

Figure 2-1 NUCLEAR ONCE-THROUGH STEAM GENERATOR (OTSG)



1. PRIMARY INLET NOZZLE
2. PRIMARY OUTLET NOZZLE (2)
3. FEEDWATER HEADER
4. FEEDWATER SPRAY NOZZLES (32)
5. FEEDWATER HEATING CHAMBER
6. "BLEED" STEAM PORT
7. SATURATED FEEDWATER
8. PORTS
9. GENERATING TUBES (15,500)
10. DEPARTURE FROM NUCLEATE BOILING
11. 100% QUALITY
12. SUPERHEATED STEAM
13. STEAM ANNULUS
14. STEAM OUTLET NOZZLES (2)
15. LOWER SHELL
16. UPPER SHELL
17. LOWER TUBE SHEET
18. UPPER TUBE SHEET
19. ADJUSTABLE ORIFICE
20. EMERGENCY FEEDWATER INLET
21. TUBE SUPPORT PLATES (15)
22. CYLINDRICAL BAFFLE
23. STARTUP RANGE LEVEL
24. OPERATING RANGE LEVEL
25. WIDE RANGE LEVEL

Figure 2-3 OTSG TEMPERATURE SENSOR LOCATIONS
(OCONEE 1 - 1B OTSG)



XX-19-3

BY MR. POLLARD:

Q Mr. Jones, on Licensee Exhibit 86, Figure E-1, on page E-13, it is labeled Craft2 noding generator for small breaks used in previous SBLOCA evaluation model.

My question is, is it correct that this is the noding diagram for what we have been calling the revised model?

A Yes, it is.

Q And is it correct that, for example, node 24 is the new node that was added in previously, 23 and 24 were the same node?

A No, that is not correct.

Q Can you explain to me why not, please?

A Nodes 24 and 25 are the two new nodes that were added to the model. However, previously node 24 was combined with node 5, and node 25 was combined with node 15.

We have also separated the up and down sides of the hot leg piping within the model, the noded model.

Q Now, is it correct that in the revised model, the entire secondary side of the steam generator is represented by one node?

A For each steam generator, one node is used.

Q Focusing the next series of questions on the boiler condenser calculation, using the revised model,

j-19-4

recognizing that the heat transfer coefficients and the heat transfer areas were fixed, is it correct, then, to conclude that the heat transfer from primary to secondary depended solely upon the code's calculation in the difference in temperature between the primary and secondary sides?

A That is correct.

Q On the secondary side of the steam generator, during the boiler condenser mode, part of the tubes are submerged in liquid; part are in steam; and part are sprayed by the emergency feed water; is that correct?

A That is correct.

Q Would not the heat transfer coefficient for those three different conditions in the tubes be different?

A Yes, they would.

Q But the code uses one heat transfer coefficient for calculating the primary and the secondary side; it is not affected by whether or not the tube is submerged in liquid spray during steam?

A For the presently approved Craft2 model, the one that was used for the approved and revised studies, it will use only one coefficient for any given node used in the steam generator.

We have the steam generator broken up into two

nodes, so that we do have somewhat different UA terms for those two volumes. But it does not -- the code does not know whether it is sprayed, steam, or immersed in liquid, not the approved Craft2 code.

Q When you say you broke the steam generator up into two nodes, you are referring at that point to the primary side of the steam generator?

A That's correct. On Figure E-1, those would be nodes 5 and 6 and 15 and 16 for the two steam generators.

Q Can you tell me physically what is the dividing line, physically in terms of some physical feature of the steam generator, the dividing line between nodes 5 and 6?

A 50-50. Halfway up.

Q That is halfway between the upper and lower tube sheets?

A That is correct.

Q Now, if we look at the heat transfer coefficient and what might affect it from the primary side, on the primary side of the steam generator tubes, is it not correct that some of the tubes will contain water, some will contain steam, and some will have condensed steam running down the inside of the tube?

A Well, I'm not sure I can quite agree with the way

j-19-6

you phrased it.

Within a single tube, it could be partially liquid filled and partially steam filled. That across the tube bundle would be pretty much equal, with the exception of the tubes in which you might have boiler condenser. Indeed, it could be a condensate film which is formed in that given tube.

Q Would the heat transfer coefficient from primary to secondary side be affected by whether there was liquid steam or condensate film on the inside of the tube?

A Yes, it would.

Q Can you take the case of steam on the inside of the tube compared to a tube with a condensate film on it.

Is the heat transfer coefficient here -- let me try it a different way.

Does the presence of a condensate film increase or decrease the heat transfer coefficient? That is, from primary to secondary?

A It tends to decrease it. Now, let me -- the question in my mind --

JUDGE BUCK: Excuse me. I didn't get that answer.

THE WITNESS: It tends to decrease the heat transfer. The reason I'm saying that is that I have a bit of

j-19-7

difficulty in separating just the primary from the secondary, because they are responding to the same conditions, to some secondary side heat removal condition.

Now, the effect of forming the film in a condensate is to reduce heat transfer, because the process is basically conduction limited.

If I have steam on a cold tube with no condensate film, it's going to have a very, very high heat transfer coefficient, while condensate film tends to retard that somewhat. That is the basis for the answer.

It is difficult to answer your question in the abstract. If you are talking of the overall process, which is a steam heat transfer through the steam generator, kind of a natural convection for steam versus a condensation heat transfer mode, then the condensation heat transfer mode will be much higher than the steam mode.

20a1

Q. Is it correct, then, that on the primary side the code does not account for whether the tube contains liquid, steam, or a condensate film?

A. The presently approved CRAFT2 code will not be able to discern that difference.

Q. And that was the same CRAFT2 code used in what we are calling the revised model; is that correct?

A. That's correct.

Q. Let me turn now in the same exhibit to figure E-16 on page E-28, which is entitled "Detail Upper Plenum Model Noding Scheme (Four-Node Model)."

Am I correct that this represents the noding scheme for what we are calling the new model?

A. No, it does not.

Q. Can you direct me to a figure in this exhibit which does represent the noding scheme for the new model?

A. It is figure E-4. It is basically the same as figure E-16, with the exception of only a single node is used in the upper plenum.

Q. Let's direct our attention, then, to figure E-4.

Focusing on the noding scheme for the primary and secondary side of the steam generator, would it be a fair characterization of what has been done is that on the steam generator, we are now, instead of having divided the tubes up into two nodes, divided exactly in half on the

20a2

steam generator, we now have six nodes between the upper and lower tube sheet?

A. Well, we have six axial nodes which are used to represent both the secondary and the primary side of the steam generator within the tube region, but we do also have a radial noding scheme in the primary tubes. That is, we have a second two-tube region radially split and axially split. So we have 12 nodes for the primary side at this point between the tube region.

Q. On the six axial nodes, are those divided into precisely one-sixth of the tube length?

A. They are not one-sixth. I don't remember their exact split. But they are not equally split nodes.

Q. Does this exhibit describe for me physically what they are, how they are actually split?

A. I don't believe they do. I don't believe that is explained.

Q. Is it approximately one-sixth, or is there some important difference from that type of a division?

A. I just don't remember the actual split-up of the nodes at this time. I know they are not equal-length nodes. They were broken down based on heat transfer zones in the steam generator for the initial performance of the steam generator, but other than that, I don't remember the lengths. I just know they are all on the --

20a3

Q. Was one of the reasons for going to six axial nodes an attempt to account for the different heat transfer coefficients that actually occur from primary to secondary as a result of whether the tubes are covered with steam or liquid?

A. No, not really. One of the reasons we went to six axial nodes was just based on the way that the new steam generator model works and the secondary side performance. The new steam generator model, by its formulation, tends to underestimate the liquid mass within the secondary side of the steam generator. The more nodes you put in there, the closer to the actual volume you get, and it was a trade-off between a realistic, or reasonable liquid volume on the secondary side, run times and accuracy that was made in the overall system response.

What we found was six nodes appeared to give us that best compromise without really affecting the accuracy of the results.

Q. And on, not node, but flow path 46 and 47, which connects the downcomer to the axial node of the tubes, can you tell me, during the boiler condenser mode the direction of mass flow? That is, in those paths, 46 and 47?

A. No, I really cannot. Those are the aspirator flow paths. Their general response during the boiler condenser -- well, even during the entire transient -- is

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basically one of, if the level is dropping within the steam generator there is steam flow from the secondary side tube area into the downcomer annulus.

If, however, the generator level is filling, then you would have steam flow from the downcomer into the tube region to make space, if you wish, for the water level to rise in the downcomer to maintain hydrostatic balance. That gets further complicated when you start looking at is the system depressurizing, or where is it going. So I can't give you a general answer, but that kind of describes how the path works.

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Q. Am I correct that the purpose of that aspirator, as you call it, is during normal operations for the purpose of heating the incoming feedwater?

A. That is its purpose, yes.

Q. Then comparing this diagram that we are looking at to the physical steam generator, would it be fair to assume, then, that node 56 is at the elevation corresponding to the entrance of main feedwater; is that correct?

A. It is in that vicinity, yes.

Q. In the calculation of the boiler condenser mode for cooling water for TMI using the revised model, can you tell me, or reference me to an exhibit, the EFW flow rate versus time for the calculation?

A. I'm sorry. It's not included in the various reports I have with me.

Q. Do you know what it was?

A. No. I just don't remember. That was a long time ago.

Q. Do you know whether it was constant over time?

A. No, it was not. I do know that the FW flow was being throttled to maintain a 50-percent level in the steam generator in those calculations with the revised model. And so the EFW spray would be on intermittently as necessary to maintain that level. That is the best I can

tell you at this point.

Q. Do you recall for the revised model calculation boiler condenser the steam generator level versus time? I know you just answered that they are trying to maintain a given level. But did the calculation begin with the secondary level already there?

A. That is included in the figures I've got here.

Q. Well, I don't mean to put you to a lot of trouble. If you know the answer, that is sufficient for me.

A. I don't remember what it starts to, but the level -- at least the initial response to the transient is to decrease in level due to loss of feedwater while you are waiting for the EFW to come on. It drops below the 50-percent level and then fills back up to it, and I could check the number. My memory says about 10 or 15 minutes.

Q. I would like to recheck the number, please.

A. I thought I had that figure. I do not. I thought it was included in this package. I glanced at the wrong figure and thought that was it. I'm sorry. I don't know. It is a 10- to 15-minute time frame.

Q. Do you have some idea of the magnitude of how far below the 50-percent level it drops so I can relate that to the 10 to 15 minutes in terms of how much water was put in in that amount of time?

A. Generally, as I remember it, it drops maybe 5 feet

below the 50-percent level.

Q. Perhaps we will do better on the new model. The same question. But I would like to know for the new models calculation of boiler condenser, the EFW flow rate versus time and secondary level versus time.

A. I can't relate you to a figure in the report. However, the response of the system was roughly the same to start, which is the secondary level drop-down, a few feet: 5, maybe 10; I don't remember the exact number for this one. But it was around 5 or 10 feet, and then it was being refilled by the EFW flower, which I think was in this analysis we were using 500 gpm total flow rate.

Q. 500 gpm total --

A. EFW flow rate, total.

Q. So it was divided equally between the two steam generators?

A. Yes. And on page E-5 of the report of 87 -- 86 -- excuse me -- it is stated that the EFW -- that at 950 seconds the secondary said level set point, 50 percent of the operate range is reached, and EFW was turned off. The calculation then assumed that at 1500 seconds the EFW was turned back on in an attempt to raise it towards the 95-percent level.

Q. Am I correct, then, that after the calculation sets the steam generators at 95 percent on the operating

range, they then again in your calculations throttled emergency feedwater flow to maintain that level?

A. That is what the calculation would have done. The calculation was run only out to 1600 seconds, 1550, 1600 seconds. So that we did not achieve 95 percent level at that time. What we had done was, we had established the boiler condenser cooling mode, the system was depressurized, and we stopped the calculation.

Q. In your -- again, the new model calculation, what did you assume, or did you assume, the secondary temperature was maintained at? Was it a fixed temperature that was inputted to the code for the secondary side?

A. No, it wasn't. What we had simulated was basically a bottled-up steam generator. That is, no steam relief paths other than the atmospheric -- I'm not sure we used the dump valves. Probably just the safety valves on the secondary side. And then we would do mass and energy calculations within each of the individual generator nodes, calculate pressure, and the corresponding temperatures associated with it. So we would go through a whole thermodynamic set of calculations to determine what the temperature was as a function of time.

Q. Now, is it your understanding that if the boiler condenser mode were being used at TMI-1, the operator would be controlling the steam dump rate?

A. It is my understanding that the operator could have taken manual control of the steam generator and initiated a cooldown of the secondary side. That will in fact give him lower temperatures than what was assumed in these analyses.

Q. Is it also your understanding that the operator may be manually controlling the EFW flow?

A. I understand that he has that capability, yes, maybe.

chk

j-22-1

Q My question is, if in the course of controlling steam dumping and emergency feed water flow, the operator temporarily stops dumping steam and shuts off the EFW flow, how long will it take for the primary and secondary side to come to thermal equilibrium?

A That is really a question that is somewhat unanswerable, because it would be dependent on many parameters, such as, what is the primary side pressure to start in this condition, and what would be the secondary pressure and temperature when this situation started.

What I can say is that as far as the temperatures in the bottom of the steam generator, both primary and secondary, they will probably be fairly well coupled up. If the primary is above 1000 psi, if I have shut off EFW, shut off the steam dump valve, and depending on where my level is in the system, say, have no heat transfer, with a high primary side pressure, they may never come to equilibrium.

You wouldn't expect them to, because the generator would be limited to a temperature by the safety valves. So they could never go -- the secondary side would probably never exceed about 1050 psi. So the temperatures to the steam generator and the secondary side temperatures may not come to equilibrium.

It is a question that has too many possibilities

j-22-2

and basically is unanswerable.

Q Let me see if I can be more specific, then. Let's assume that the primary and secondary side liquid levels are at the same elevation, 95 percent on the operating range in the secondary side, and the boiling level at the primary side is at the same level, inside the tube. Is it correct that under those conditions that if there is no EFW flow, that you would essentially have little or no heat transfer from the primary and secondary side?

A If the levels in the primary and the secondary sides were indeed equal, then you would not have any heat removal -- I won't say any, there will always be some, I'm sure. But you would have very little heat removal from the primary system, via the steam generator directly.

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BY MS. WEISS:

Q The new model that has been submitted to NRC for approval under Appendix K, could you tell me when it was submitted to NRC?

A The new model was submitted to NRC on November 6, '82, with, I think, one other topical report, which is part of it, which came in, I think, in December of 1982. But it is in that time frame.

Q And how many documents in total constituted that

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submission, beyond what we have here, beyond Licensee Exhibit 86 and 87?

A There were three reports submitted. BAW 13-154, which is Exhibit 86, the C aft2 topical, which is the major, if you wish, workhorse computer code that we use, which is BAW--10092P, Rev. 3, and then there is a PHON 2 topical, which also was submitted for cleanliness.

Q Cleanliness?

A Yes, basically. We resubmitted the report from 10064, topical report 10064, it is an old code that we have used. We separated from within an old licensing submittal, and some of the benchmark cases we did. But it is basically the same code we have used back since 1974.

Q That is a gratuitous name for that code.

And Licensee Exhibit 87 wasn't submitted until March 3rd, I think, to the Staff, and March 10th to the parties?

A My understanding is Licensee Exhibit 87 was submitted to the Staff around sometime the first week of March, early March.

Q Now, the Craft2 topical, is that the document that describes the new Craft2 code and provides whatever validation and justification B&W has prepared for

that code, and that is a proprietary document; correct?

A The Craft2 code topical is proprietary, and basically, what it consists of is a whole bunch of equations, with a little bit of text explaining how the equations are used.

The justification or sensitivity studies or comparison to experimental data is not included in the Craft2 topical. A lot of that work is covered in 10154P.

Q And is it correct that there have as yet been no meetings between B&W and the Staff to discuss the questions that they may need answered on the new model?

A That's correct. We have had no meeting with the Staff since the submittal of these topicals.

Q And you haven't yet received any questions in writing, either?

A That's correct.

Q And you have run -- for the purpose of this proceeding, you have run one break size only with the new model; correct?

A That is correct.

Q That is the .01 square foot break?

A Yes. It wasn't run for this proceeding, but that is the only one that we have analyzed with the new model.

Q Could I direct you to page 13 of your testimony. The last paragraph beginning on line 17, continuing on to line 3 of the next page.

Is it correct that all of the calculations referred to in that paragraph are generic B&W calculations?

A The calculations referred to there are indeed generic for the TMI-1 class of plant, and would bound the results we would expect for TMI-1.

They are conservative with respect to what TMI-1's numbers would be.

Q. Now, for the .01 square-foot break calculation, the only one done with the new code, did that predict the occurrence of a stable boiler condenser mode?

A. The .01 analysis that was done did indeed show boiler condenser performance.

Q. Is it accurate that that calculation was carried out to 1550 seconds to the initiation of boiler condenser and then terminated?

A. I think it was carried a little further than that, but it was terminated around 16, 1700 seconds, as I remember it.

At that point in time we had a condition very similar to what we had seen using the revised model. In the old CRAFT2 codes we felt that we had enough assurance as to where the case was going to go from there.

MS. WEISS: No further questions.

JUDGE EDLES: Mr. Cutchin.

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CROSS-EXAMINATION

ON BEHALF OF THE REGULATORY STAFF

BY MR. CUTCHIN:

Q. Mr. Jones, I had one remaining question. Some have already been answered.

I believe there was a figure 3-3. It is in Licensee's Exhibit 87.

JUDGE EDLES: Mr. Cutchin, what page were you

referring to?

MR. CUTCHIN: I was referring to figure 3-3. It is in the Licensee's Exhibit 87, and I don't believe it has any page number other than figure 3-3.

JUDGE EDLES: All right.

BY MR. CUTCHIN:

Q. And the question I would pose is: How does one use that particular figure to draw conclusions regarding the ability of TMI-1 to achieve adequate energy and mass removal?

A. Well, I think to help and to discuss that curve, it's probably best to walk through the whole series of curves you use to get there, I'm afraid.

Q. Fine. You may do that.

A. And what I would like to do, then, is to refer back to my testimony itself and the figures that are attached to the testimony, figures 1 through 4.

Basically figure 3-3 is the same figure as figure 4 in my testimony, except we removed one line from one figure and added another to another figure.

But let me try to walk through it.

First off, if you go through my testimony, what we are dealing with here is an examination of the ability of the steam generator to remove energy from the primary system to ensure adequate core cooling.

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Now, the first thing that you have to recognize is that there is some interplay between heat removal from the primary system and heat removal from the core in the sense that the heat removal from the primary system basically is going to tell you what the system pressure is. That, in turn, tells you what the HPI flow is, and therefore its ability to match up with the core boil-off or the leak flow from the system.

Now, the figures in my testimony start with a hypothetical. That is, assume that I have somehow reached a condition wherein my inventory has depleted down near the top of the core, and recognizing, because of the nature of the design, that we will then expose what I have called and defined earlier today further, the full condensing surface in the steam generator. So what I have is a situation where I have the steam generator fully available to remove core decay heat, and we want to look at the capability of that generator to remove energy in a boiler condenser mode while also looking at how much HPI will be coming and whether or not it can hold the inventory in the vessel.

Now, going to the testimony in figure 1, what figure 1 simply represents is at a given pressure there is some time at which the HPI will match up with the boil-off rate in the core. So that the incoming HPI will then

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replace the inventory being boiled and thereby assure a stable inventory in the vessel.

So if my core is covered up to this point in time, I will assure adequate core cooling in the long term. So I have to the left of this line on figure 1 a situation where the HPI flow would be inadequate, and to the right where HPI flow is fully adequate.

Another way to look at that is before the core can uncover, there will also be the steam flow out the break. So it's not normally saying just boil-off matching up, but it would be matching up with leak flow in the longer term.

Now, to relate this figure simply to figure 3-3, the two dashed lines on figure 3-3 is just basically based from this curve. What is shown in my testimony is the case of 70 percent HPI. That is, a portion of the HPI being lost directly out the break. In figure 3-3 there is also a case of 100 percent HPI, in which case the break is not in the path from the HPI nozzle to the vessel, or correspondingly a break, or no break in the system, like an isolated break scenario, which was part of what we were looking at with Exhibit 87.

Now, going back to my testimony in figures 2 and 3, what we are then doing in figures 2 and 3 is saying, okay, now, at any given point in time I can calculate

how much energy, or how much boiling would be occurring in the vessel. So I know what my decay heat source is into the system.

Now, by turning around and saying, okay, let's forget about energy removal via the break and try to take all that energy out of the system in a boiler condenser heat removal mode. So that would be conservative, or overestimate the system pressure required to do this for any small-break LOCA situation. Because I'm going to have to remove all the core decay heat at this time.

What is done here is, I've looked at the two possible conditions, and there is a combination, of course, between the two, which is either spraying with the EFW, which is what figure 3 is, or the established 95-percent level on the secondary side.

Once you can calculate then is what temperature differences do you need to remove all the energy being generated in the core via the steam generator in a boiler condenser mode.

Now, these figures do account for the tube-plugging situation at TMI-1, and they were done for TMI-1 specific power levels. They did use the conservative Appendix K, decay heats. They also are based on the specific TMI-1 HPI surface.

Now, you then get these two figures, one of them

being for the level, which is figure 2, and figure 3 which is the EFW spray. Figure 3, the EFW spray, pressure versus time, is what is drawn on figure 3-3.

Now, putting this all together on the common figure, either figure 4 or figure 3-3, if you wish, what you really are finding is that the EFW spray will be fully adequate to remove all the core decay heat, assuming I've drained this primary system inventory; but prior to core uncovery, this would be the pressure trays, or something lower than that that you would have as a function of time. And the intersection of the HPI curve, with that pressure curve, essentially is defining the time at which you assure adequate HPI flow. So then the follow-on question you just have to ask yourself is, I know I have adequate energy removal after this point in time. The question is, do I have adequate inventory up to this point in time. And as the testimony shows, yes, we will have adequate inventory to prevent the core from uncovery before this time frame.

MR. CUTCHIN: Thank you.

No further questions, Mr. Chairman.

JUDGE EDLES: Mr. Adler, Mr. Dornsife?

CROSS-EXAMINATION

ON BEHALF OF COMMONWEALTH OF PENNSYLVANIA

BY MR. DORNSIFE:

Q. Mr. Jones, comparing your figures 3-2 and 3-3, and if I understand you correctly, you said that the solid curve is basically the effectiveness of the EFW spray injection, can you answer for me why -- or is it true that it appears that the EFW spray is more effective for the generic analysis than it is for TMI-1? It reduces pressure. TMI-1 appears to reduce pressure faster.

A. There are two basic differences. Number one is the power levels are different. Figure 3-2 is based on a 2772 megawatt plant, while figure 3-3 is based on 2535.

There is also a difference in the EFW flow rates that we used. Figure 3-2, as I remember it, is based on 200 gpm for generator, and the other one is about 360 or 400.

Let me just check that for one minute.

The number doesn't appear to be quoted. Those are the numbers I remember. 200 gpm in the generic, as opposed to about 360 or 400 gpm for the TMI-1 case, and then there is the tube-plugging factor, which is included only in the TMI-1 calculation. It is a combination of the three.

Q. Just based on tube-plugging alone, you would expect the TMI-1 effectiveness would be less than the other?

A. Yes, you would.

Q. You state also in that section that this EFW spray heat transfer mechanism is limiting because it is much smaller than the heat transfer that would be available if you look at the area under the steam generator level.

I'm wondering, can you give us a rough estimate of what the difference between those two heat transfer rates are?

A. Well, the actual heat flows are the same, because that is what the calculation was done for. It is just that the temperature to drive it is higher with spray as opposed to the pool, or the situation where you've got the 95-percent level.

I think the predominant reason is, to put it in probably its simplest view, the 95-percent level gives you effectively about 8 feet of condensing surface on every tube, while the spray, even if I assumed -- and this is not what is in the calculations, okay, but this is just to give you a visualization -- hits only 10 percent of the tube's maximum, and it has a distance of 26 feet to fall through. So it is effectively like 2.6 feet of condensing surface.

Now, that isn't very simplistic, maybe, because there are other dynamic responses or other heat transfer effects due to the extra length, but there is just simply a heat transfer area difference between the two.

Q On the scenario that Mr. Pollard was talking about, if EFW flow is stopped and the operator had been controlling steam flow, and he shuts that off, wouldn't eventually the secondary side pressure come up to the steam generator safety valve set point and heat transfer would again occur?

A Well, as I said, the general scenario he gave me was, there are too many possibilities to answer that question with one answer. So, I have the same problem with yours.

It is too dependent on where the levels are, and the various other things, before I could answer that one, yes, it would, or no, it wouldn't be established.

I just don't know.

Q But eventually, assuming the primary temperature was above 1150, saturation pressure, wherever the saturation point was, mode of heat transfer would occur through the safety valves, steam generator safety valves?

A Let me answer the question this way, and I hope it gets to where you are going.

If the level in the steam generator is above this spillover point in the pump -- if I can have that for a given -- then I can go somewhere with it. Then, if the primary side is indeed higher than the secondary side

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before the system could drain, ever drain and uncover the core, I would establish heat transfer to the steam generator and indeed, I would have the steam safety valves on, or, if I had EFW on as opposed to the level being above the overflow point, I have the same situation, where I could get heat transfer.

If the level is below that point, it is debatable. You would get some steam cooling, but I'm not sure how significant it would be.

Q For the range of breaks where you need boiler condenser mode of heat transfer, .005 to .02 square feet, at what point over that range would the flow out through the break match decay heat removal? At what point in time, assuming that the system were 2,500 pounds? I mean, would it be hours, an hour, two hours? I don't need an exact number.

A As I remember it, for a .01 square foot break, it is on the order of an hour and a half to two hours. That is from memory. I just don't absolutely know at this point in time, though.

Q But at that point, if the core were not uncovered, the system would depressurize by itself, if boiler condenser were not occurring?

A The system would indeed depressurize from there, yes.

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Q But I think you said earlier, in the previous round of testimony, that you have never done an analysis that assumes boiler condenser is not affected; correct? It just assumes the liquid natural circulation, and then when it depressurizes that --

A No, we have not done such an analysis. About the closest we've got to that -- I don't know if we call it the closest -- we got the two pounds. We have generator cooling to start, or we don't have generator cooling at all. Your situation that you are describing would lie between the two, but we haven't analyzed it specifically.

Q Can you offer your opinion, in saying that does happen by the time the core would uncover, that sufficient heat would be out through the break, and therefore, you wouldn't need condenser cooling?

A With one HPI, I would rather not guess; with 2 HPI's, it doesn't matter.

Q With one, there is a possibility that that could occur?

A With one HPI, there is a possibility it might make it. There is a possibility it won't. I just don't know at this point.

MR. DORNSIFE: I have no further questions. Thank you.

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BY JUDGE BUCK:

Q The worst part about being last man on the totem pole, or almost last man, most of my questions are answered.

I'll have to jump around here. I'll have to jump around and find out what has been answered and what hasn't.

One thing, I was a little surprised to hear you say that you were using the same coefficient heat transfer all through the steam generator, whether it was steam or water, and so on.

Do you have in your mind, and you can probably look this up in the tables, but maybe you have in mind, what is the total variation between heat transfer across a metal tube surface, for example, from water to water, as opposed to film steam, water steam, or steam steam?

A I would expect the difference would run factors of 100, you know, from a flowing liquid condition on the primary, and nuclear boiling on the second, you have extremely high coefficients. On the order of several thousand steam convection on the primary side, that is a fairly low coefficient.

That would be 50, 25, 4, depending on flow rate. So it could be extremely low.

Now, if it is a condensation mode, you start to

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come back and approach your normal operation. Condensation heat removal is quite efficient, and characteristic heat removals on the order of 500, 1000 btu's, per square foot, depending on the condensing length you are dealing with, you can achieve; with very short condensing lengths, your heat transfer coefficient is extremely large.

As the film thickness builds, as the condensate thickness builds, as you look down the tube, the conduction then becomes a limiting process, the conduction through the condensate film itself, and then the heat transfer coefficients could drop to overall averages of 500, 300.

It all depends on the length.

Q Well, then, in the beginning of the EFW injection, or shortly after the beginning of it, you would be getting fairly high transfer from the EFW flowing down the sides of the tubes below the level of the primary water; is that right? That would be essentially flowing water down against stagnant water in the primary side, or not?

A I would guess that hea sfer coefficient would lie -- it would be better than steam conditions, but it would be less effective than condensation. It would lie between the two. Say, on the order of 100 btu's per hour, square foot.

Q Can you give me a guess on the .01 leak, what

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the likelihood, or what likely temperature would be in the primary steam generator tubes?

A Well, you actually have a temperature distribution through the tube region. What you've got is the liquid -- well, first off, the secondary side is going to be saturated. That is just the way --

Q So, secondary will flow in and be saturated?

A Right. The primary side, the liquid that is residing in the generator, that has been there for a while in a very slow, draining mode, will probably be very close to the secondary side temperature. It is just sitting there for a long period of time.

It will cool off.

Q So it will be below saturation?

A Yes. It will probably be subcool. Well, for the .01, it would be subcool.

Q Yes.

A The steam entering the -- entering would be the saturation temperature corresponding to about 1600 psi, and then there would be kind of a gradient between there, between that and the subcooled liquid below.

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Q So you would have a fairly wide difference in temperature between the two zones?

A Yes.

Q You would still, however, get almost immediate condensation on the inside, or the primary side of the steam generator tubes high up at the time the EFW hits them?

A Oh, yes.

Q And you would start your rundown immediately?

A Yes.

If you look at Exhibit 86, Figure E-5, on page E-17, you can see there at 1500 seconds, when we turn on the EFW, in a boiler condenser -- and conditions are set up for boiler condenser, the system takes a rather rapid drop in system pressure at that point, and that is just indicative of the very good heat transfer you get via that mode.

It starts to flatten out at that point towards the end, because it has now got control, if you wish, of the system pressure. It has now achieved its more or less stable characteristics.

Q I notice in your assumptions that you -- I think it is you that puts the EFW in within a minute and a half or something like that, or is it the Staff that assumes that? One of you assumes about a minute and a half, and the other one assumes 15 minutes, or 10 minutes.

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A The EFW is automatically actuated after a loss of main feed water, and its delay time to come on is like 40 seconds. That is the design time. It starts filling from there.

Q That's what you assumed?

A That's what we assumed, yes.

Q Excuse me while I look at these for a minute.

I guess from your answer to my heat transfer problem, these are so variable you feel that taking an average is the best thing to do; is that right, or taking some sort of a fixed heat transfer, heat coefficient?

A Well, I guess the basic way to say it is the presently approved Craft model did indeed use an average. That was in examining the smaller-sized breaks. Where the heat transfer now starts to become fairly important to the evolution of the transient, then we felt that the average heat transfer coefficient no longer was ideal, and so we have changed here.

In the old calculations, the old Appendix K calculations, the fact that we used the steam generator is not an aid to the transient. It turns out to hurt us. Because those transients evolve through an initial depressurization, where the generator can remove some energy, but in the longer term, as the system continues to depressurize, the generator becomes a heat source, and

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that has a bigger feedback on the larger-sized small breaks. So the old Appendix K work, although it used this average coefficient, were conservative with respect to not using a generator at all.

Q I see. Okay.

JUDGE BUCK: I think that's all I have.

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BOARD EXAMINATION

BY JUDGE GOTCHY:

Q I just have a few questions.

Would you briefly describe what you mean on page 14, line 14, when you say "extrapolation of the results demonstrate that inadequate core cooling breaks of this size for which water condenser cooling is predicted to occur." How do you extrapolate from this point .01 square foot break analysis to .005, or that sort of thing?

A Well, in a sense, if you want to generalize the extrapolations to other break sizes, I think the figures 1 through 4 clearly illustrate and will cover all these smaller break sizes, or even the .02 and the .01.

It really covers and says, look, I really can't uncover that core for these smaller sized breaks, because the boiler condenser provides adequate heat removal.

Q I see what you mean.

A The extrapolation I was talking about there

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was a fairl, simple, just inventory-type balance at the type pressures that we are looking at there. And if you go to Figure 1, I think you can see that 1700 psi, which is the rough pressure we have for that case, 1700 or 1800 psi, you know, the time frame for which the HPI will match up for core decay heat is on the order of 3,000 seconds, and we just can't throw away the water that fast from where we were.

Q Okay. On page 15, line 11, you talk about the full condensing surface. I believe you said earlier today that was something on the order of 110,000 square feet, or something of that size.

A Well, no. What I said was, the actual tube area, exposed surface area, is on the order of 115,000 square feet in each generator.

The condensing area is going to then be some modification of that.

I would rather not guess, but it would probably be at least 20,000 square feet in each generator, at least for, like, the 95 percent level.

JUDGE BUCK: May I ask a question while you are pausing?

JUDGE GOTCHY: Yes, sir.

BY JUDGE BUCK:

Q On page 14 of your testimony, you are talking

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about the .01 square foot break analysis.

In the last sentence, middle paragraph, starting at line 14, extrapolation of results demonstrates that the adequate core cooling is maintained for breaks for the size for which boiler condenser cooling is predicted to occur.

What do you mean by "extrapolation"? What are you extrapolating here? I don't quite understand exactly what you mean.

A Well, we did not run the new model all the way out in time to demonstrate in a normal sense the Appendix K compliance.

One of the reasons for that is simply, this is the new model, these are how we are going to do, select the results of how we are going to do new analyses with the new models, and there is a follow-on effort under Item II.K.3.31 of NUREG 0737, which would be in a subsequent Appendix K analyses with this model.

So, what we did was, we tested the model and ran it for a specific case to show all the phenomena of interest, and got out to a point in time where we had demonstrated that the model was functioning properly to ourselves.

Now, what we have done here is, we have taken these analyses, and we have done two things with them. Number one is, how much different is this from what we have

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done in the past. And what we find is, yes, between 100 and 1,000 seconds, or so, there is a bit of difference between the cases, but they basically are fairly similar.

They are within 10 percent on inventory above the top of the core. So it says that really the old Appendix K work, even with this model that used an average UA, et cetera, is pretty reasonable. So that extrapolation and the work that has been done before would then be deemed to be done before.

Additionally, we took the inventory here and tried to say, could we throw it away and hurt ourselves. Forget about what we had in the past. Could we do things like throw away the mass of this pressure, wait for HPI to catch up? Do we have that kind of time? Is it necessary to run it to prove that we still have acceptable cooling, and we couldn't get rid of the water fast enough.

Q So basically, you hit, shall we say, a moderately stable situation, and from there on out, you just extrapolate pretty well, on the basis of your other codes?

A I wouldn't say the extrapolations did very well. I think it is conservative. I think we are grossly overestimating how fast we can throw the water away and still can't get in trouble.

JUDGE BUCK: Okay. Thank you.

j-25-7

XX

BY JUDGE GOTCHY:

Q Page 16, the second line, this 1,650 seconds, that assumes only cooling by the spray, no contribution of cooling from the pool water?

A That is correct. The pool water, if you look at Figure 4 -- I don't have the exact time, but in looking at it, it looks like it would say an intersection time of 1,500 seconds, 1,400 seconds.

Q I think it's about 1,350. That's what I came up with.

On page 17, where you mention -- we are talking here about the TMI-2 accident. You say that -- lines 21 to 23 -- you say during the period, heat removal from the reactor coolant system occurred which controlled the primary system pressure with 100 psi of the secondary side. You are really referring there only to the A steam generator; isn't that correct?

A Yes, that's correct.

Q Line 20, starting at line 24, there at the bottom of the page, you talk about the only explanation for this effect is boiler condenser.

Gee, I'm trying to remember. Back in the record, I think it's UCS Exhibit 1 from the other hearing, but it seemed to me that once the steam generator pressure, the A steam generator, began to drop before the water level

j-25-8

began to rise. Do you recall that?

A I'm not sure, Dr. Gotchy. I understand your question, but maybe to help me out, we have a figure in Licensee Exhibit No. 87, Figure 216, which shows the TMI-1 response in the time frame of interest here.

I'm not sure it gets to the steam generator level. But it does show some of the point, what is in the testimony.

Now, as I remember the accident, indeed, between -- if you look at the peak and the cold leg temperature, at about 94, 94 and a half seconds -- that is the solid line in the figure.

26a1

Q. Seconds or minutes?

A. I mean minutes. I'm used to looking at graphs in seconds.

You can see about that time, 93 to 94-and-a-half, you have the cold dropping, and you have the RCS pressure dropping down, and the A steam generator is kind of stable in pressure over this period of time.

What has preceded this was a dry-out of the A steam generator. And during this period of time, between roughly 93, 94 seconds -- or minutes -- and 100 minutes, or 101 minutes, thereabouts, the actual steam generator level in the A generator was zero. Well, not zero. It was really basically a steam head. And so what you had was the feedwater was being delivered and just boiled right off.

Q. Okay.

When the -- as I recall -- I think the reactor coolant pumps were tripped between about 75 minutes, and one went off about 100 minutes, and when they shut the second set of pumps off, the reactor coolant pump A, there was a lapse of the two-phase mixture cooling at that point. When that happened, could that have caused the primary system pressure to drop just coincidentally with the secondary pressure drop?

A. No. I don't believe so. And I know I have seen several reports, the NSAC report, et cetera, which have,

if you wish, blamed this on condensing steam in the primary system. This is not a unique statement. There are two reasons for it. Number one, it is awful hard to visualize why they would track so nicely. As you can see on figure 2-16, they are basically holding a constant difference between each other. The RC pressure and the steam pressure and the A-loop. They are holding basically a fairly constant difference between the two.

Secondly, if you say a possible explanation is you change the relief to steam, for example, you can do calculations and show that the steam relief capability of the PORV at this point in time is not sufficient to prevent a pressure increase, and in fact if you look later into the transient, the accident, there is a belief that the NSAC reports the system repressurization started prior to the closure of the block valve, and its reason was simply the loss of steam generator heat sink at that point in time.

Q. On your Exhibit 86, page 3, the last sentence on that page, it says natural circulation is lost at approximately 340 seconds in the intact loop and at approximately 650 seconds in the broken loop.

Is there any reason for that, or is that just coincidental?

A. I'm afraid I missed your page. Page E-3?

26a3

Q. Page E-3, the last sentence.

A. No, it is not quite coincidental. There are a couple of reasons for it. Number one is the pressurizer, by being in one loop as opposed to both loops, does indeed result in some assymetry in the system. The break itself will cause a little bit of a pressure, although small; it causes a little bit of a pressure sink, if you wish. And what we are dealing with here is fairly small differences in elevation heads as to whether you fall below a point or not fall below a point when you talk about just losing natural circulation.

So, it is not surprising that you get a little bit of timing difference between the two.

Q. I was curious.

On page E-5, in the middle of the page, I was curious why -- I guess, let me say first -- I understand the secondary level set point is 50 percent in the operating room, the EFW is turned off. That is automatic from the ICS; is that right, or is that turned off by the operator?

A. The ICS would automatically turn it off, although the operator could very well have the system in hand at this point in time.

Q. I see. Just out of curiosity, why wasn't the -- in this example, why wasn't the secondary level raised

26a4

immediately to 95 percent instead of waiting for 940 seconds to 1500 seconds before restarting the emergency feedwater flow?

A. There were a couple of reasons for it. Number one, again, as I said, the purpose of these calculations were not necessarily to be our calculations we would do for 50.46 compliance. These were done to show a new model, and typically you want to benchmark the model to your old case. The old case we ran did only assume a 50-percent level. That was one reason. So we wanted to try to be consistent there.

Secondly, by turning off the feedwater, in a sense we accelerated repressurization phenomena, and we wanted to get the model into a boiler condenser mode. The other judgment we made was, let's look at it like we would more or less normally look at an analysis where we assume operator action, which is you get there, wait a time period of 10 minutes or thereabouts, and then turn it back on.

Q. One more question. At the end of that same paragraph, you say the -- the expected result of primary side steam condensation was established which brought about an abrupt end of pressurization and enabled the system to be put into a long-term cooling mode.

In light of the fact that your analysis ends at

26a5

30 minutes, what do you mean by "long-term cooling mode" here?

A. Before I guess I was trying to answer Ms. Weiss' question on the long-term cooling, also.

Typically what is done is, the analyses are carried forward to a point in which you have, A, shown that you more or less have your primary system pressure under control. Okay. So that you know that the system is going to be moving in a depressurization manner and thereby from an HPI flow situation things get better.

Secondly, you generally run these things to a point at which the HPI flow is exceeding the inventory being lost through the boiling in the core. If that has happened, you've assured a stable vessel inventory, because you have assured the vessel pressure stays down, and the HPI -- you are sure the core cannot uncover. From there on, things get better. Decay heat comes down. The pressure comes down. So what you are now witnessing what we would term more or less a long-term cooling mode. You would no longer really have a problem with decay heat removal from the core, and that is more or less what this statement is.

Now, when I say that we put the system pressure in control, it is possible that in this longer term mode the system pressure may go up, because we refill the system

26a6
chk

above the condensing surface, and then that loses heat removal so we drop in pressure, or we drop inventory, we establish the boiler condenser surface again, and go through cycles of this.

But, again, we've already assured that at the pressure we would stablize we would indeed always have adequate HPI flow before the core is uncovered.

So, from a demonstration of meeting the core cooling requirements of 50.46, that is met, and then we deal with the rest, the operational parts more or less via the guidelines, the small reg guidelines.

Q. I had a couple of questions on the Exhibit 87.

I notice on the natural circulation test and Oconee, they apparently rely on a steam-driven turbine pump for their test instead of using, for example, a single motor-driven pump which was what was assumed in many of the cases here.

Was there a reason for that?

MS. WEISS: Could you tell us what page you are on, Dr. Gotchy?

JUDGE GOTCHY: 2-5, first full paragraph, talking here about circulation tests at Oconee.

MS. WEISS: Thank you.

27a1

BY JUDGE GOTCHY:

Q. I don't know if that is their normal procedure, but it appears they depend on a steam-driven turbine pump, because that appears about twice the flow that you would get from a turbine pump.

A. I'm just not sure at this point in time. I do not remember exactly what the Oconee secondary side feed pump situation looks like. So I don't know whether they do rely on just the steam-driven turbine pump, or what. I'm just not sure.

Q. In the first test they use a turbine pump. In the second one, they must have used a turbine plus one motor-driven, to get that flow of 600 or 700 gallons per minute of steam generator. I thought maybe you could enlighten me on that a little bit.

A. I'm afraid not.

Q. On page 2-13, the second paragraph -- this is a benchmark number 1. It says: EFW was terminated at about 12 minutes when the startup level reached 165 inches (about 40 percent on the operate range).

Was that a manual termination?

I guess it would be manual, because ICS would allow them to do it at 50, wouldn't it?

A. I'm not sure what the situation was for that test. Certainly it is a rather stable condition, as I

remember the plot.

No. I just don't know at that point. It wasn't all the loss of off-site power test. I'm not sure how it was set up exactly as to why it went only to 40 percent. You are right. Normally it should have been going to 50 percent.

Q. On page 2-18, section 2.5 -- you mentioned several times already today in your testimony that you allowed for the plugging of tubes in calculating your heat exchange for the steam generators at TMI-1. You say you subtract the surface area of the plugged tubes from apparently the total surface area.

Did you assume a random distribution of plugged tubes, or a situation more realistic to the existing TMI-1 steam generators?

A. I sat down and I counted 1500 tubes around the aux feedwater ejection nozzle. So it was the actual situation.

Q. All right. Very good.

This is just a question of curiosity, too. In figure 2-2, I tried to figure out why you didn't have eight nozzles in this sparger instead of seven.

Is there some reason there is a spray nozzle missing in one of those quadrants, a physical reason?

A. I expect if it had any physical reason it

would have been from a mechanical standpoint. But I just don't know. That is mechanical design.

Q. Let's see. Figure 3-11. That can't be right. I'm sorry. Page 3-11.

You are talking about the rate of fill for the once-through steam generator tubes. I just want to be clear. I think you said today that you assumed that the EFW comes on, I think you said 40 seconds, so that presumably at the time you would need to raise the level to 95 percent, you would be at 50 percent. I mean, there would never be a time at which the steam generators would dry out like they did during the TMI-2 accident?

A. If the system functions as designed, the generator would not dry out.

Q. And if you had a situation where it did go dry, about how long, roughly, would it take to refill it to 95 percent?

A. Well, that is going to be dependent on several things, including the transient you've got. If your primary system has heated up substantially over this time frame, a lot of the water you are just going to put in early, over a, say, 10, 15-minute time frame, is going to be boiled all off to steam. So you have some 15-minute time frame right there. And using -- I'm trying to remember the numbers now.

27a4

My guess would be it would be out in the hour time frame to get to 95 percent.

JUDGE GOTCHY: That's all I have. Thank you.

JUDGE EDLES: Mr. Baxter, do you have any questions?

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REDIRECT EXAMINATION

BY MR. BAXTER:

Q. Mr. Jones, I would like to give you a single question in an attempt to get to the bottom line on the testimony given today about the differences between the so-called approved, revised, and new models, specifically in the context of the Appeals Board's questions about the efficacy of boiler condenser cooling at TMI-1.

What has this newest modeling effort showed you about the validity of the earlier modeling in terms of overall system performance for those break sizes in which boiler condenser cooling is predicted to occur, and in your answer address specifically the fact that in the earlier modeling there was assumed -- or an input heat transfer area and heat transfer coefficients, and it was assumed that all the tubes were wetted by EFW?

A. Basically what we have seen at this point in time with the new model is that the system response early on, the transition between liquid natural circulation, two-phase circulation, the interruption, and the

establishment of boiler condenser, can be effected in time.

We are not seeing significant differences, however, in overall inventory. A little bit of pressure difference, but overall inventory, like about the top of the core, like 1500 seconds from the one case I analyzed, about a 10-percent difference at inventory.

Additionally, we have gone back and looked at the old analyses that have been done with the revised model, and compared the heat flows through the steam generator to the type of model we would now have, that we now have in the code in the new model, and what we find is that for the temperature differences that the code is predicting, the revised code at that point in time, if we just had a slightly larger condensing surface, a couple of feet, three feet -- it is in my testimony -- it is about three feet, you would get the same results, and that just happens to be the type of difference in inventory we are seeing between the two cases, about 10 percent.

In addition, the heat transfer analyses that we have done for the steam generator, the figures that are attached in my testimony are basically showing, even accounting for this information, where you do not wet all the tubes, you still have a very, very effective heat transfer mode via the steam generator.

MR. BAXTER: That's all I have.

JUDGE EDLES: Any further questions?

MS. WEISS: I think we have just a few.

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RECROSS-EXAMINATION

ON BEHALF OF THE INTERVENORS

BY MR. POLLARD:

Q. When you were discussing with Dr. Gotchy the TMI-2 accident and the indications you got from that accident that boiler condenser mode was working, I got the impression from that discussion that you thought that the initiation of emergency feedwater flow had a marked effect upon plant behavior. Was I wrong on that?

A. Well, I'm not certain the actuation of EFW during the TMI accident had marked effects on the system behavior prior to the generation of gas in that primary system.

Q. By gas, you are referring to the hydrogen?

A. Yes, sir.

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Q Now, in response to a question from Mr. Baxter, you say that there is really not much difference between a model which assumes all the tubes are wetted, and more realistic model which assumes that only 10 percent of the tubes are wetted. There seems to be somewhat of a contradiction.

Can you explain that to me?

A Actually, I really have great difficulty in trying to explain that to you. All I do know is that the results, given an offset in inventory of only about 10 percent, gives me the same heat flows, and I think part of the reason for that may just very well be that the old analyses were showing extremely small condensing surfaces. We were talking a few inches and getting all the heat flow out.

A few inches to a foot. And what we are now talking about is maybe you need three to four feet. It just doesn't take that much. It just is an extremely effective heat transfer mode, and the overall heat transfer coefficients that we had in that region of the generator apparently were fairly reasonable.

Q In your discussion with Dr. Buck of the heat transfer coefficients in the approved model, I understood you to be saying that the steam generator was actually a detriment to you in analyzing some of the larger small

j-28-2

breaks -- if I can say larger small breaks -- because you get a heat transfer from the secondary side to the primary side.

In the course of that discussion, if we made our notes correctly here, you said that that heat transfer coefficient was conservative. Now, with respect to the old approved model, which was used to demonstrate compliance with 50.46, when you say the heat transfer coefficient was conservative in the sense that it was transferring heat from secondary to primary, do you mean that the calculation was transferring more heat from secondary to primary than would in reality occur?

Is that what you mean by "conservative"?

A I think what the answer was based on was simply that if I threw the generator away for those sized breaks, the positive aspects of the generator early on, the early heat removal, were well outweighed by the reverse heat flow that occurs later in the transient.

So, what I'm saying is, based on the Appendix K work we have done, use of the steam generator is conservative, and use of full heat transfer area for a generator that is going to be basically half dry in the primary side, is probably conservative.

Q For the analysis done in support of demonstrating compliance with 50.46?

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A Yes.

The larger size small breaks, yes.

Q We should not infer, then, from your discussion with Dr. Buck that you were saying that heat transfer coefficients were conservative in terms of demonstrating compliance with Appendix K?

A For those analyses that were done, our Appendix K analyses that have been performed, it is my belief that they are conservative.

Q I understand the whole analysis. I'm trying to focus on specifically the heat transfer coefficient from secondary to primary.

A At this point in time, I would say that the heat transfer coefficients from the secondary to the primary side for the Appendix K analysis is conservative.

They will overpredict the heat flow from the secondary side to the primary side, lead to higher pressures, and thereby more discharge of the whole, and thereby the worst possible inventory consequences for the event.

MS. WEISS: I have one question that we just frankly forgot to ask.

JUDGE EDLES: Go ahead.

XX BY MS. WEISS:

Q Is the revised model capable of calculating

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a transition from the boiler condenser mode back to liquid natural circulation?

A No, it is not, although I want to add that that type of time frame is generally beyond what we would have to analyze to demonstrate any compliance with 50.46 anyway, because that is a refill of the primary system, and that means you've got plenty of inventory above the core, and therefore, you have no core cooling problems.

Q Is that answer also correct with respect to the new model?

A Yes, it is.

MS. WEISS: No further questions.

JUDGE EDLES: Mr. Cutchin?

MR. CUTCHIN: No further questions, Mr. Chairman.

JUDGE EDLES: Mr. Adler?

MR. ADLER: Nothing.

JUDGE EDLES: Mr. Baxter, anything further?

MR. BAXTER: No.

JUDGE EDLES: I think this is probably a useful time for us to quit for the day.

MR. CUTCHIN: Sir, I would like to ask if the Chairman would consider repeating for the benefit of Dr. Ornstein, who was not present before, so he won't have to have it translated to him.

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JUDGE EDLES: I'll be happy to do that.

Let me ask first, Ms. Weiss, it took us about three and a half hours to get through Mr. Jones' testimony today. Would you give me a rough estimate of what you think it is likely to take to get through the Staff tomorrow? Is that possible?

MS. WEISS: We have approximately the same number of questions. My experience is that it takes longer to get the answers from the Staff. We fully intend to finish everything tomorrow, if at all possible.

JUDGE EDLES: I think in that case, Dr. Ornstein, you probably will not be here for the morning session. My guess is, we would get to you sometime after lunch, or right after lunch.

As Mr. Cutchin suggested, let me advise you that you are directed not only not to be here during the cross-examination of the Staff, but also not to discuss with any of the parties or their counsel matters which may come up during cross-examination of the Staff witnesses.

I will ask Ms. Weiss and Mr. Cutchin to arrange between you and Dr. Ornstein, however you can manage to get hold of him, so that he is here at the right time. But at the moment, it looks like that will be right after lunch.

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Anything further?

If not, thank you, Mr. Jones, very much, for your testimony.

We will stand adjourned until tomorrow at 9:00 a.m.

(Whereupon, at 4:45 p.m., the hearing in the above-entitled matter was adjourned, to reconvene at 9:00 a.m. on Thursday, March 17, 1983.)

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