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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

In the matter of:

METROPOLITAN EDISON COMPANY, et al

(Three Mile Island Nuclear Station, Unit 1)

Docket No. 50-289 OLA

Location: Middletown, Pa.

Pages: 196 - 370

Date: Monday, July 16, 1984

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NUCLEAR REGULATORY COMMISSION

Atomic Safety and Licensing Board Panel

Metropolitan Edison Company, et al. (Three Mile Island Nuclear Station, Unit No. 1)	Docket No.
Evidentiary Hearing	50-289 OLA

Auditorium, Olmsted Building
Penn State/Capitol Campus
Middletown, Pennsylvania

Monday, July 16, 1984

The above-entitled hearing commenced at 9:00 a.m. pursuant to notice.

BEFORE:

SHELDON J. WOLFE, Administrative Judge, Chairman
DAVID L. HETRICK, Administrative Judge, Member
JAMES C. LAMB, III, Administrative Judge, Member

APPEARANCES:

BRUCE CHURCHILL, Esquire
WILBERT WASHINGTON, Esquire
DIANE BURKLEY, Esquire
(For the Licensee)

LOUISE BRADFORD
(For Three Mile Island Alert)

MARY E. WAGNER, Esquire
JOSEPH R. GRAY, Esquire
(For Nuclear Regulatory Commission Staff)

THOMAS Y. AU, Esquire
(For Commonwealth of Pennsylvania)

C O N T E N T S

WITNESSES: T. Gary Broughton; Richard F. Wilson; David G. Slear; Don K. Croneberger; F. Scott Giacobbe

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P R O C E E D I N G S

JUDGE WOLFE: All right; the hearing is in session. Pursuant to the Board's Order of June 12, 1984, the Atomic Safety and Licensing Board hearing is in session to receive evidence regarding an amendment to the operating license requested by the licensee to revise the technical specifications and approve the kinetic expansion steam generator tube repair at Three Mile Island Nuclear Station Unit No. 1. The matters to be litigated are those set forth in the Board's unpublished Memorandum and Order of June 1, 1984.

The limited appearance statements will be taken between 7:00 p.m. and 10:00 p.m. today, July 16th, and at the same time tomorrow on July 17th.

To my left is Judge David Hetrick, nuclear engineer. To my right is Judge James Lamb, an environmental engineer. I am Sheldon Wolfe, legal member and chairman of this Board.

Beginning to my left, will counsel or representatives of the parties identify yourselves for the record.

MR. CHURCHILL: Good morning, Your Honor. My name is Bruce Churchill. I am with the law firm of Shaw, Pittman, Fox and Trowbridge in Washington, D.C., representing the licensee.

On my left is Diane Burkley of the same law firm. On my right is Wilbert Washington, also of the same law firm.

MS. BRADFORD: Good morning, Judge. My name is

1 Louise Bradford, and I will represent TMIA in this proceeding.

2 JUDGE WOLFE: Ms. Doroshow will not be here any

3 time during the session; is that correct, Ms. Bradford?

4 MS. BRADFORD: That's correct.

5 JUDGE WOLFE: Fine.

6 MS. WAGNER: Good morning. My name is Mary

7 Wagner with the office of the Executive Legal Director. With

8 me today on my left, also representing the Staff, is Joseph

9 R. Gray, Assistant Chief Hearing Counsel. On my right is

10 Conrad McCracken, Section Chief of the Chemical Erosion

11 Technology Section of the NRC. Behind me is Harley Silver,

12 Project Manager for this case.

13 MR. AU: Good morning. My name is Thomas Au. I

14 am representing the Commonwealth of Pennsylvania. On my right

15 is Mr. William Dornsife from the Bureau of Radiation Protection,

16 Department of Environmental Resources.

17 JUDGE WOLFE: Could I have the gentleman's name

18 to your right, please.

19 MR. AU: William Dornsife, D-o-r-n-s-i-f-e.

20 JUDGE WOLFE: Once again, please.

21 MR. AU: D-o-r-n-s-i-f-e.

22 JUDGE WOLFE: Are there any preliminary matters

23 to be discussed? Obviously, we will have to discuss the

24 Commonwealth of Pennsylvania's motion for leave to participate

25 as an interested state pursuant to 10 CFR, Section 2.715(c).

1 Are there any other preliminary matters to be discussed
2 before we get to Pennsylvania's motion?
3 (No response.)
4 JUDGE WOLFE: Your motion was served, Mr. Au,
5 under date of July 9th; is that correct?
6 MR. AU: That's correct, sir.
7 JUDGE WOLFE: Any comments, statements or
8 objections, Mr. Churchill?
9 MR. CHURCHILL: Your Honor, on Friday, we filed
10 our Answer to the motion. We did not oppose the participation
11 in this hearing by the Commonwealth of Pennsylvania. I don't
12 know if everybody has copies of our written response. We can
13 distribute those right now to the Board and to the parties.
14 But, basically, we did not oppose it.
15 (Documents distributed to all parties by Counsel
16 Washington.)
17 JUDGE WOLFE: Anything more, Mr. Churchill?
18 MR. CHURCHILL: No, Your Honor.
19 JUDGE WOLFE: On Friday, Mr. Churchill called me
20 at the office to advise that he was filing this response, and he
21 asked what he should do with it. I told him to do exactly what
22 he is doing today; to give copies to all participating. He
23 advised at that time substantially what he has told you, namely
24 that the licensee did not object to Pennsylvania participating
25 as an interested state, but that, as indicated here today, he

1 was concerned -- can you hear me in the audience?

2 VOICE: Not very well.

3 JUDGE WOLFE: He was concerned that there might

4 be delay.

5 Anything, Ms. Bradford?

6 MS. BRADFORD: TMIA will support the motion.

7 MS. WAGNER: The NRC staff does not oppose the

8 motion of the Commonwealth for participation as an interested

9 state , but I would point out that they must take the proceeding

10 as they find it at this stage of the proceedings.

11 JUDGE WOLFE: Mr. Au, at page three of licensee's

12 Answer to your motion for leave to participate, is that an

13 accurate paraphrase, summarization, articulation of what you

14 did state to Mr. Churchill beginning with the word "moreover"

15 on page three?

16 MR. AU: Yes, sir. I have read that statement,

17 and that is an accurate statement of what I told Mr. Churchill.

18 JUDGE WOLFE: Question, Mr. Au: do you intend to

19 cross-examine yourself, or do you intend to ask one of your

20 technical experts to conduct any cross-examination?

21 MR. AU: I expect Mr. Dornsife to conduct the

22 exmaination .

23 JUDGE WOLFE: I see. And you don't plan to

24 conduct any of the cross-examination for the State?

25 MR. AU: There may be some cross-examination that

1 I may conduct to the extent that it would involve basic issues
2 and legal matters.
3 JUDGE WOLFE: You do have our rules of practice
4 with you, don't you?
5 MR. AU: Yes.
6 JUDGE WOLFE: Would you turn to Section 2.733.
7 (Counsel Au complying.)
8 JUDGE WOLFE: If the State is permitted to
9 participate, you must comply with that section. In other words,
10 such a request shall be made at the time your cross-examination
11 begins, and you must make a showing that your expert is qualified,
12 et cetera, pursuant to the requirements of that section.
13 MR. AU: The Commonwealth is prepared to abide by
14 that section.
15 JUDGE WOLFE: You, Mr. Au, and your expert have
16 read the written direct testimonies of both the Applicant and
17 the Staff submitted under date of June 29, 1984?
18 MR. AU: Yes, we both have.
19 JUDGE WOLFE: And you have read the Board's
20 Memorandum and Order of June 1, 1984?
21 MR. AU: Yes, we both have read that.
22 JUDGE WOLFE: And you are particularly aware of
23 the contents of pages 23 and 32 of that Memorandum and Order?
24 MR. AU: Yes, we are.
25 JUDGE WOLFE: And is it your intention to

1 cross-examine upon all the matters at issue as set forth at
2 pages 23 and 32 of the Memorandum and Order of June 29, 1984?
3 MR. AU: Yes, it is. It is our intention to
4 cross-examine only to clarify issues and to illuminate facts
5 as presented.
6 JUDGE WOLFE: And you will have no direct
7 testimony to present?
8 MR. AU: That's correct.
9 JUDGE WOLFE: All right. It is clear that your
10 request is quite untimely. Your motion is quite untimely. But
11 you have advised us that you do not intend to delay this
12 proceeding and that you will comply with the rules of our
13 practice. Is that correct, Mr. Au?
14 MR. AU: That is correct.
15 JUDGE WOLFE: And that you will make the necessary
16 showings under Section 2.733 of our rules in order that your
17 expert may cross-examine and, as Ms. Wagner points out -- this
18 is indicated generally in Gulf States Utilities (River Bend
19 Station Units 1 and 2), ALAB-444, 6 NRC 760, 1977--that, indeed,
20 a state must take the proceeding as it finds it and otherwise
21 comply with the Commission's rules of practice.
22 With that understanding and that stated obligation
23 on your part, we do allow your motion to participate as an
24 interested state. Certainly, the State of Pennsylvania is
25 interested in this proceeding, and there is no question as to

1 the State's standing.

2 Any other preliminary matters to be brought up by

3 the parties or by the State of Pennsylvania?

4 MS. WAGNER: Judge Wolfe, on Friday, the Staff

5 served Board Notification BN-84-131, and I don't believe every-

6 body has received a copy yet since we served it through the mail.

7 This is a Board Notification transmitting Staff review of the

8 recent TMI-1 steam generator leakage and long-term corrosion

9 test program.

10 May I distribute it to the parties?

11 JUDGE WOLFE: Yes.

12 (Documents distributed to all parties by Counsel

13 Wagner.)

14 MS. WAGNER: Judge Wolfe, on the cover memorandum

15 submitting the Board Notification, in the second paragraph, the

16 second line from the bottom, there is a date. That should be

17 July 13, 1984.

18 JUDGE WOLFE: Are you finished reading, Mr. Au?

19 MR. AU: One minute, please.

20 (Pause.)

21 MR. AU: Yes.

22 JUDGE WOLFE: Any other preliminary matters?

23 MS. BRADFORD: Your Honor?

24 JUDGE WOLFE: Yes.

25 MS. BRADFORD: The Board has ruled out some of

TMIA's contentions, including those contentions on plugging. I would request that TMIA be allowed to question both Licensee and Staff with regard to the subject of this memorandum. That is the two most recent discoveries of leakage at TMI-1. They involve plugging in some part. We would limit our questions to the tubes that are involved here.

JUDGE WOLFE: In light of this Board Notification that was handed to us today, you want to conduct some cross-examination on the issue of plugging with respect to any matters discussed in this Board Notification of July 13th; correct?

MS. BRADFORD: That is correct.

JUDGE WOLFE: Mr. Churchill?

MR. CHURCHILL: We would object to that. On the plugging contention, there has been a long history of that; first of all, getting the plugging contention around to a format in the Board's original ruling on contentions that was relevant to the proceeding and then later on summary disposition. That issue was disposed of completely on summary dispositions. There is nothing here that would indicate that there was any issue left with respect to plugging as it relates to the kinetic expansion of the tube.

Plugs ocassionally do leak. They always have and they always will. That is why we have the continuous leak test monitoring. None of this has any indication at all

whatsoever of the contention as admitted that somehow the kinetic expansion of the tube would not allow the plug to hold.

MS. BRADFORD: Judge Wolfe?

JUDGE WOLFF: Just a moment.

Ms. Wagner?

MS. WAGNER: The Staff opposes TMIA's motion insofar as it is directed to questions concerning plugging. The licensing board itself has recognized that the amendment is to revise the technical specifications to recognize steam generator tube repair techniques other than plugging as the notice of hearing stated.

In its January 9, 1984 Memorandum and Order, unpublished, the Board recognized this; that questions relating to plugging per se are not within the scope of this proceeding.

Insofar as TMIA wishes to ask other questions concerning the July 13th Board Notification, questions concerning leakage, I believe that some questions on that subject might be appropriate on cross-examination of witnesses here; insofar as the recent leakage that is the subject of the Board Notification might affect prior evaluations that you made.

JUDGE WOLFE: Any comments, Mr. Au?

MR. AU: The Commonwealth believes that this Memorandum constitutes significant new information and that some of it may relate to the contentions of TMI Alert, particularly as to the reliability of the leak rate measurements.

JUDGE WOLFE: Are you saying this Memorandum speaks to plugging?

MR. AU: No. We are not saying it speaks to the plugging issue that was raised by TMIA.

JUDGE WOLFE: What are you saying?

MR. AU: (No response.)

JUDGE WOLFE: First off, Mr. Au, do you oppose or favor support of Ms. Bradford's request, and then explain your answer.

MR. AU: We support Ms. Bradford's request to extend -- this new information relates to issues which have been admitted as contentions in this proceeding.

JUDGE WOLFE: Then you don't differ from Ms. Wagner? Ms. Wagner says "but for plugging". Am I correct, Ms. Wagner? But for plugging, the Staff has no opposition to TMIA cross-examining witnesses on the thrust of the Board Notification? Yet again, I would think, Ms. Wagner, that such cross-examination is within the scope of the remaining contentions.

Is that your contention, Mr. Au?

MR. AU: That is correct.

JUDGE WOLFE: Anything more, Mr. Churchill or Ms. Bradford?

MS. BRADFORD: Judge Wolfe, in the preliminary notification, which Staff handed me this morning, there is --

and I don't know if the Board has this preliminary notification -- the number is PNO 1-8456A.

JUDGE WOLFE: What is the date on that?

MS. BRADFORD: This is a July 9th incident. It is to this incident that I had referred earlier. This describes an event on July 9th and Licensee's discovery that several plugs were missing. In particular, it says, "The first adjacent tube, 135-74, had been plugged at the top instead of tube 135-72." Second, the plug programmed to be in tube 148-35 was missing and a loose plug was found in tube 65-3A.

TMIA's contention on plugging had gone exactly to the retention of plugs in the steam generator tubes after the kinetic expansion. There is not enough information here for me determine if these plugs were loosened as a result of kinetic expansion. However, TMIA would like to question further on this issue.

JUDGE WOLFE: Your request is denied, Ms. Bradford. The matter of plugging is not in issue. You may cross-examine to the full extent within the scope of the remaining matters that are in issue in this case. There is nothing now before us with regard to plugging.

Under those circumstances, the Boards will not extend, and this Board will not extend or expand matters that are not in contention. And under these circumstances -- and it happens in every case that I am aware of -- because of the

1 dynamic process, things always arise, circumstances always arise
2 during the construction, during the operating license or during
3 an amendment, and if there is a proceeding going on and a matter
4 is brought to the attention particularly of a Board in an
5 operating license proceeding and an amendment proceeding that
6 is outside the scope of the issues, the Board, and this Board,
7 will not hear that matter.
8 We are here to consider limited contentions --
9 not limited, but contentions that are bounded, and we will only
10 hear testimony and cross-examination on those bounded issues.
11 And necessarily under those circumstances, we must rely on the
12 NRC staff's close inspection and monitoring of what is going
13 forward in matters that are not in contention before this
14 Board.
15 Any other preliminary matters?
16 MS. BRADFORD: Judge Wolfe, one moment; one more
17 thing. May I at least inquire of the licensee the reason, if
18 they know, why these plugs were missing, et cetera?
19 JUDGE WOLFE: There is nothing to prevent you
20 during the recess from asking Mr. Churchill or discussing that
21 with Staff. It is no longer an issue before this Board. We
22 won't take up any more time with it.
23 Are there any other preliminary matters? More
24 particularly now, the Board would ask the parties: are there
25 any exhibits to be marked for identification outside of,

obviously, written direct testimony?

MS. BRADFORD: TMIA would like to enter some exhibits.

JUDGE WOLFE: Would you identify them and give them to the reporter for marking for identification, and we will consider them one after the other.

MS. BRADFORD: The first is a document which came to TMIA marked "Reference 62," which is a Battelle study. It is titled "Short Term Corrosion Evaluation of Kinetically Expanded Tubes in Mockup Tube Sheets." It is dated --

JUDGE WOLFE: Ms. Bradford, would you speak more slowly. I am trying to write.

This is Reference 62, the Battelle study, "Short Term --" and go very slowly.

MS. BRADFORD: "Short Term Corrosion Evaluation of Kinetically Expanded Tubes in Mockup Tube Sheets."

JUDGE WOLFE: Does that bear a date?

MS. BRADFORD: Yes. The date is November 21, 1983. The document is 51 pages with an appendix.

JUDGE WOLFE: All right. If you will hand that to the reporter for marking for identification.

(Whereupon, the document was marked as TIMA Exhibit No. 1 for identification.)

JUDGE WOLFE: All right. That document is marked for identification as TMIA Exhibit No. 1.

MS. BRADFORD: Judge Wolfe, I additionally have taken some excerpts from some very large documents, which I would like to enter the excerpts into the record. The reason I had to excerpt them is because the documents were so large, and it was really very burdensome for me to attempt to reproduce all of them.

JUDGE WOLFE: Do they bear face sheets from the documents from which these pages were excerpted?

MS. BRADFORD: No, they don't, but I can describe that document.

The first is a document which came to TMIA marked Reference Document 56.

JUDGE WOLFE: Fifty-six?

MS. BRADFORD: Yes. It is the Final Report-Evaluation of samples from TMI-1. It is dated July 27, 1982. The document consists of 104 pages with appendix, and there is a two-page cover letter.

JUDGE WOLFE: From whom to whom?

MS. BRADFORD: I beg your pardon?

JUDGE WOLFE: From whom to whom?

MS. BRADFORD: The cover letter is from Battelle to GPU, I believe. Let me check with Licensee.

MR. CHURCHILL: Your Honor, I have this document under a cover letter from Babcock and Wilcox to Mr. Slear at GPU-Nuclear. I don't know if that is the same cover letter you

were referring to. Could I ask: is it the entire document you want marked for identification or are there excerpts?

MS. BRADFORD: There are excerpts, parts of this document. TMIA would like to enter pages 16 and 17 of this document.

MR. CHURCHILL: I'm sorry. Could I have that again?

MS. BRADFORD: Page 16 and 17, pages 21 through 23, pages 97 through 100. Excuse me just one moment, Judge Wolfe.

(Pause.)

MS. BRADFORD: The next excerpt is page 105 and all of Appendix B of this document.

MR. CHURCHILL: I identified five excerpts from that document. Could we just mark each one of those exhibits two through six? Would that be the easiest way? Or TMIA Exhibits 2 through 6?

JUDGE WOLFE: We will mark as TMIA Exhibit 2-A pages 16 and 17; 2-B, pages 21 through 23; 2-C, 97 through 100; 2-D, page 105; and E will represent all of Appendix B.

Are there more documents?

MS. BRADFORD: I will have more documents later in this proceeding. I was not prepared to mark them now.

JUDGE WOLFE: Do you have three copies of those documents, proposed exhibits, to hand to the reporter?

MS. BRADFORD: I prepared two for the reporter, but I can supply him with the additional ones.

JUDGE WOLFE: Do all the parties and the State of Pennsylvania have copies of these proposed exhibits?

MS. BRADFORD: I will distribute them.

JUDGE WOLFE: You have copies for them?

MS. BRADFORD: Yes, I do.

JUDGE WOLFE: Do you have copies for the Board?

MS. BRADFORD: Yes, I do.

JUDGE WOLFE: Would you please distribute them.

(Documents distributed to all parties by Ms. Bradford.)

JUDGE WOLFE: We need an extra copy for the reporter.

MS. BRADFORD: I will supply it tomorrow.

JUDGE WOLFE: Do you wish to offer these into evidence now or wait for cross-examination and tender the exhibits at that time?

MS. BRADFORD: I would prefer to wait for cross-examination.

(Whereupon, the documents were marked as TMIA Exhibits Nos. 2-A, 2-B, 2-C, 2-D and 2-E for identification.)

JUDGE WOLFE: Any other exhibits?

(No response.)

JUDGE WOLFE: I am looking at what is now described as TMIA Exhibit 2-E marked for identification. That is supposed to be all of Appendix B, the last document in this batch. It doesn't look like it is an appendix at all.

MS. BRADFORD: Oh, that's a mistake.

(Pause.)

MS. BRADFORD: Judge Wolfe?

JUDGE WOLFE: Yes.

MS. BRADFORD: Just for the record, TMIA's Exhibit 2-E is the appendix to Reference 56. It is Appendix B that consists of four pages.

JUDGE WOLFE: All right.

MR. CHURCHILL: Your Honor, that looks to us to be correct. What is missing is the cover page that shows Appendix B all by itself. But for that cover page, it seems to jive with our document Reference 56.

JUDGE WOLFE: Are there any other matters now with respect to offering into evidence the exhibits?

(No response.)

JUDGE WOLFE: Do you plan during the course of the hearing -- do any other parties during the course of the hearing plan to offer into evidence any exhibits?

MR. CHURCHILL: To the best of my knowledge, Your Honor, right now we do not. We have our prepared testimony, which is all we will be putting in as far as I know at this

point.

JUDGE WOLFE: Ms. Wagner?

MS. WAGNER: The Staff is currently anticipating just introducing its prepared testimony at this point.

JUDGE WOLFE: You do not plan to offer into evidence, Ms. Wagner, the SER and Supplements 1 and 2?

MS. WAGNER: We may be offering portions of the SER.

JUDGE WOLFE: All right. We will now proceed with the hearing on the contentions remaining to be heard.

Mr. Churchill, you may call your witness or witnesses.

MR. CHURCHILL: Your Honor, I thought I would first explain just briefly how we intend to proceed.

JUDGE WOLFE: Yes.

MR. CHURCHILL: We will take them basically in order, but we might take them a little out of order with the indulgence of the Board and the parties, becuase there are one or two witnesses that have scheduling conflicts.

In general, we assume that we will put on our entire direct case. We will put it on in pieces or in groups, which will then be subject to cross-examination by the parties, by the State, and, of course, questioning by the Board.

But in general, I assumed that we would get to our entire direct case and cross-examining and questioning

before the Staff's witnesses came on. I assume this is the normal procedure.

JUDGE WOLFE: Yes.

MR. CHURCHILL: I would like to start with Issue 1.c, which is the issue on the power ascension limits. There are three witnesses sponsoring that testimony.

I would next like to do Issue 4, which was not a panel situation. There is one witness on that. It is the question on the experience with the kinetic expansion process in the industry.

These two pieces of testimony have witnesses that have scheduling difficulties. And if the Board doesn't mind, I would like to do those first.

Then what I would like to do is present a panel to do Issues 1.a, 1.b and 1.d. That is the remainder of the "1" issues. The 1.c seems to be able to be split out from that fairly readily. It doesn't seem to be related to the others.

And finally, Licensee proposes a panel for the remaining issues, which are Issues 2 and 3 and then what we have called Issue 5, which is a Contention 1.b issue on the probability or increased probability of simultaneous tube ruptures involving steam generators.

JUDGE WOLFE: I take it there are no objections to proceeding?

1 MS. BRADFORD: Judge Wolfe, I am going to have a
2 little difficulty with Licensee's ordering without any noted
3 direction. I prepared in sequence, and I am prepared today
4 with 1.a and 1.b. I do have -- I could, although I would
5 rather not, go to 1.c. I do not have cross-examination plans
6 for those issues. And that's what I meant by being prepared.
7 JUDGE WOLFE: Well, here we go again. There is
8 total lack of communication between the parties. If you
9 intended to do this, it would seem to be only fair, Mr. Churchill,
10 to have advised Ms. Bradford and Ms. Wagner that this was your
11 intention.
12 MR. CHURCHILL: Your Honor, I apologize. We
13 could have done that. We didn't really know about this,
14 because we were juggling witnesses and their schedules at the
15 last moment.
16 Generally and basically, this is a seriatim
17 presentation, but for the request to take those two out of order.
18 JUDGE WOLFE: I recognize that witnesses have to
19 be taken out of time. That is done quite frequently, and we
20 try to assist the witnesses in taking the stand and leaving
21 as promptly as possible.
22 Once again, I just don't know why you didn't
23 contact the other parties and tell them that this was what you
24 were going to do, because we are faced now with the problem
25 of Ms. Bradford not having her papers available for purposes

of cross-examination.

What do you suggest we do? Are those papers at your office, Ms. Bradford?

MS. BRADFORD: Judge Wolfe, I have generally prepared for all of the issues. However, I do not have the exhibits that I would like to enter with those issues; that is Issue 1.c and Issue 4. I do not have with me my cross-examination plan, nor have I completed the cross-examination plan. I have outlined it, but I have not completed it.

MR. CHURCHILL: Your Honor, do you think we could have about a two or three-minute recess? Perhaps we could just talk to the parties and I could talk to my witnesses, and maybe we could work something out.

JUDGE WOLFE: Or you can, at your expense, send a messenger to Ms. Bradford's office to pick up the papers that she needs.

Ms. Bradford indicates that she hasn't completed her review, so I don't think that is going to help us -- well, all right; we'll have a five-minute recess. The parties can try to figure this one out.

Let's take five minutes.

MR. CHURCHILL: Thank you, Your Honor.

(Recess.)

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JUDGE WOLFE: All right; back on the record.

Mr. Churchill?

MR. CHURCHILL: Your Honor, we have consulted with Ms. Bradford and we have gone back to a slight modification of what we would have done originally had we not had the witness scheduling problems. We are going to start by calling the panel that includes the witnesses that cover all of the contentions, 1.a through d. They will all be up there for Ms. Bradford to cross-examine on any of the Item 1 issues. Included in Item 1 is 1.c, which is sponsored by three witnesses, one of whom is the person with the schedule problems.

Ms. Bradford said that at some time during the course of the day she would try to see if she had any particular questions for him, with the idea that at the end of the day we would try to be able to excuse Mr. Broughton.

That leaves two other witnesses on issue 1.c. Ms. Bradford was kind enough to agree to that. What it amounts to is that of the five witnesses, one of them who only played a small part in these issues does have a scheduling problem; and she had said that she would try to accommodate that. The other two will still be there so long as the cross-examination goes on to deal with that issue.

JUDGE WOLFE: All right.

MR. CHURCHILL: The other conflict was Dr. Pai on issue 4, and we are going to try to put him on sometime

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1 tomorrow. That would give Ms. Bradford overnight to see what
2 questions she might have for him. Other than that, everything
3 is just going to be presented in order.
4 JUDGE WOLFE: All right; is that agreeable?
5 MS. BRADFORD: Yes, it is, Judge Wolfe.
6 JUDGE WOLFE: All right, you may call your panel,
7 Mr. Churchill.
8 MS. BURKLEY: Your Honor, I will be handling the
9 introduction of the direct examination. I would like to call
10 the first panel, which consists of Messrs. Wilson, Slear,
11 Croneberger, Giacobbe and Broughton. They will please come
12 to the witness table.
13 JUDGE WOLFE: Would you initially identify each
14 witness, beginning with my far left here?
15 MS. BURKLEY: Yes, Your Honor. On your far left
16 is Mr. Broughton, Mr. Wilson, Mr. Slear, Mr. Croneberger and
17 Mr. Giacobbe. I will be introducing each of them further to
18 assist in the identification.
19 I will start with Mr. Wilson. Would you please
20 state your full name and occupation for the record?
21 WITNESS WILSON: My name is Richard F. Wilson.
22 I am Vice-President, Technical Functions, GPU Nuclear Corpora-
23 tion.
24 JUDGE WOLFE: Why don't we swear in all of these
25 witnesses now, since they have been identified, and then you

can proceed.

MS. BURKLEY: Yes, Your Honor.

JUDGE WOLFE: Would the witnesses please stand and raise your right hands?

Whereupon,

T. GARY BROUGHTON
RICHARD F. WILSON
DAVID G. SLEAR
DON K. CRONEBERGER
F. SCOTT GIACOBBE

were called for examination and, having been first duly sworn, were examined and testified as follows:

JUDGE WOLFE: You may be seated.

DIRECT EXAMINATION

MS. BURKLEY: Mr. Wilson, would you please explain the role you played in the licensee's repairs of the steam generator at TMI-1?

WITNESS WILSON: I had overall corporate management responsibility for repairs of the steam generator. Mr. David Slear, Project Manager for the repairs, reported to me.

MS. BURKLEY: Are you familiar with the licensee's testimony entitled "Licensee's Testimony of Richard F. Wilson, David G. Slear and Don K. Croneberger on Issue 1.a, concerning Contention 1.a"?

WITNESS WILSON: I am.

MS. BURKLEY: Do you have any changes or corrections that you would like to make to that testimony at this

time?

WITNESS WILSON: No, I do not.

MS. BURKLEY: Do you adopt this testimony as your testimony in this proceeding?

WITNESS WILSON: Yes, I do.

MS. BURKLEY: Mr. Slear, would you please state your full name and occupation for the record?

WITNESS SLEAR: My name is David G. Slear; I am the Manager of Engineering Projects for Three Mile Island, Unit 1. I work for GPU Nuclear Corporation.

MS. BURKLEY: Would you please explain the role that you played in the repair of the steam generators?

WITNESS SLEAR: I was the overall task manager for the steam generator repairs, reporting directly to Mr. Wilson.

MS. BURKLEY: Are you familiar with the licensee's testimony of Richard F. Wilson, David G. Slear and Don K. Croneberger on issue 1.a, contention 1.a?

WITNESS SLEAR: Yes, I am.

MS. BURKLEY: Do you have any changes or corrections that you would like to make to that testimony at this time?

WITNESS SLEAR: I have no changes or corrections.

MS. BURKLEY: Do you adopt this testimony as your testimony in this proceeding?

WITNESS SLEAR: Yes, I do.

MS. BURKLEY: Thank you.

Mr. Croneberger, could you please state your full name and occupation for the record?

WITNESS CRONEBERGER: My name is Don K. Croneberger. I am employed by GPU Nuclear. My position is Director of Engineering Design.

MS. BURKLEY: Could you explain for the Court the role that you played in the licensee's repair of the steam generator?

WITNESS CRONEBERGER: I provided general management technical oversight of functional engineering activities in support of the repair program, including the areas of failure analysis, technical design, and chemical engineering, with special emphasis on the chemical design of the steam generators and the response of the steam generators following repair.

MS. BURKLEY: Thank you.

Are you familiar with the licensee's testimony of Richard F. Wilson, David G. Slear and Donald K. Croneberger on Issue 1.a, contention 1.a?

WITNESS CRONEBERGER: Yes, I am.

MS. BURKLEY: Do you have any modifications or changes you would like to make to that testimony?

WITNESS CRONEBERGER: No, I do not.

MS. BURKLEY: Do you adopt this testimony as your

1 testimony in this rroceeding?

2 WITNESS CRONEBERGER: Yes, I do.

3 MS. BURKLEY: Your Honor, I would ask at this

4 time that the licensee's testimony of Richard F. Wilson,

5 David G. Slear and Don K. Croneberger on issue 1.a, contention

6 1.a be incorporated into the record as if read here today.

7 JUDGE WOLFE: Is there any objection?

8 (No response.)

9 JUDGE WOLFE: Absent objection, this testimony,

10 as already described, will be incorporated into the record

11 as if read.

12 MS. BURKLEY: Thank you, Your Honor.

13 (Whereupon, the licensee's testimony of Richard

14 F. Wilson, David G. Slear and Don K. Croneberger on issue 1.a,

15 contention 1.a follows:)

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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

Before the Atomic Safety and Licensing Board

In the Matter of	)	
	)	
METROPOLITAN EDISON COMPANY, ET AL.	)	Docket No. 50-289-OLA
	)	ASLBP 83-491-04-OLA
(Three Mile Island Nuclear	)	(Steam Generator Repair)
Station, Unit No. 1)	)	

LICENSEE'S TESTIMONY OF RICHARD F. WILSON, DAVID G. SLEAR AND DON K. CRONEBERGER ON ISSUE 1.a (CONTENTION 1.a)

To Mr. Wilson:

Q1. Please state your name and address, and describe your involvement with the TMI-1 steam generator tube repair program.

A1. My name is Richard F. Wilson. I am employed by GPU Nuclear Corporation, 100 Interpace Parkway, Parsippany, New Jersey 07054. As the Vice President of Technical Functions, I was responsible for the overall project and technical management of the TMI-1 steam generator tube repair program.

A statement of my professional qualifications is attached.

To Mr. Slear:

Q2. Please state your name and address and describe your involvement with the TMI-1 steam generator tube repair program.

A2. My name is David G. Slear. I am employed by GPU Nuclear Corporation, 100 Interpace Parkway, Parsippany, New Jersey 07054. As the Manager of Engineering Projects for

TMI-1, I was the overall task manager for the TMI-1 steam generator tube repair program, reporting directly to the Vice President of Technical Functions. My responsibilities included all activities associated with the evaluation and repair of the steam generators.

A statement of my professional qualifications is attached.

To Mr. Croneberger:

Q3. Please state your name and address and describe your involvement with the TMI-1 steam generator tube repair program.

A3. My name is Don K. Croneberger. I am employed by GPU Nuclear Corporation, 100 Interpace Parkway, Parsippany, New Jersey 07054. As the Director of Engineering and Design, I provided technical management oversight of the failure analysis and repair activities with special emphasis on evaluation of the steam generator's mechanical design and the impact of the repair on the response of the components. My department also provided engineering support in the areas of Materials Engineering/Failure Analysis, Chemical Engineering and Chemistry, Mechanical Engineering and Engineering Mechanics.

A statement of my professional qualifications is attached.

To all witnesses:

Q4. What is the purpose of your testimony?

A4. The purpose of this testimony is to address Issue 1.a of Contention 1.a as enumerated at page 23 of the Board's Memorandum and Order (Rulings on Motions for Summary Disposition, dated June 1, 1984) in which the Licensing Board stated:

1. The rationale underlying certain proposed license conditions should be addressed, with attention to:

   a. Reliability of leak rate measurements.

Q5. Describe the TMI-1 license conditions for leak testing the steam generators.

A5. The existing license conditions related to primary-to-secondary (P-S) leakage through the TMI-1 once-through steam generator (OTSG) tubes are Technical Specifications (T.S.) 3.1.6.3 and 4.1.

Technical Specification 3.1.6.3 reads as follows:

> If primary-to-secondary leakage through the steam generator tubes exceeds 1 gpm total for both steam generators, the reactor shall be placed in cold shutdown within 36 hours of detection.

Technical Specification 4.1. requires that leakage be evaluated daily.

In addition, the following proposed license condition dealing with leakage will be imposed:

> <u>Repaired Steam Generators</u>
>
> In order to confirm the leak-tight integrity of the Reactor Coolant System, including the steam generators, operation of the facility shall be in accordance with the following:
>
> * * * *
>
> 2. GPU Nuclear Corporation shall confirm the baseline primary-to-secondary leakage rate established during the steam generator hot test program. If leakage exceeds the baseline leakage rate by more than 0.1 GPM [6 GPH], the facility shall be shut down and leak tested. If any increased leakage above baseline is due to defects in the tube free span, the leaking tube(s) shall be removed from service. The

baseline leakage shall be re-established, provided that the leakage limit of Tech. Spec. 3.1.6.3 is not exceeded.

The key points from this proposed condition are that: 1) Licensee was to establish its baseline leakage from the leak rate data obtained during the post repair OTSG hot test program; 2) an increase of more than 0.1 GPM (6 GPH) above this baseline at steady state operating conditions requires facility shutdown and leak testing; 3) if leakage is due to defects in the tube free span, the leaking tubes are to be removed from service; 4) leakage not identified as originating in the tube free span during this testing is deemed acceptable if it does not exceed the 1 GPM (60 GPH) limit of TMI-1 Technical Specification 3.1.6.3; 5) the baseline is re-established following shutdown and leak testing (possibly at a higher leak rate than the initial baseline); and 6) operation can then continue until the increase in leakage exceeds the new baseline by 0.1 GPM (6 GPH).

Licensee determined the baseline primary-to-secondary leakage to be 0.02 GPM (1 GPH) during the steam generator hot test program. This means that the facility is to be shut down if the leak rate reaches 7 GPH total for both steam generators, as compared to the existing limit of 60 GPH in Technical Specification 3.1.6.3.

Q6. How does this compare with the leak rate license conditions for other nuclear plants?

A6. The TMI-1 leakage limitations in Technical Specification 3.1.6.3 are comparable to those at most other pressurized water reactors (PWRs) in the United States. A recent survey by Licensee of approximately 30 PWRs showed that the vast majority of the plants have limits similar to TMI-1's current 1 GPM limit. One plant has a limit three times the current TMI-1 limit. A few of the more recently licensed plants have limits lower than T.S. 3.1.6.3. However, the proposed TMI-1 license condition of 0.1 GPM is more stringent than that for any other operating PWR in the United States.

Q7. What is the purpose of measuring primary to secondary leakage?

A7. Primary-to-secondary leak rate measurements are made periodically for all operating PWRs in the United States in order to confirm that the steam generators are performing as anticipated. TMI-1 is no different than other operating PWRs in this respect. These measurements are one aspect of an overall defense in depth approach to maintaining OTSG integrity. The program includes leak rate monitoring during operation, and periodic eddy current testing, and leak tests while shut down at cold conditions.

The leakage measurements during operation are made both to document the absolute value of leakage and to document any trends which may be cause for concern. The absolute value is

required to both assess the performance of the steam generators and to ensure that technical specification limits are not exceeded. Trends are monitored because increasing leakage may indicate ongoing chemical or mechanical degradation of the tube. Increasing leak rates are investigated further to identify leak locations and take appropriate corrective action.

The intent of the overall defense in depth program is to correct defects in tubes in order to ensure that the steam generator tubes satisfy the licensing basis specified in General Design Criterion 14, 10 C.F.R. Part 50, Appendix A, i.e., "to have an extremely low probability of abnormal leakage, or rapidly propagating failure, and of gross rupture".

Q8. How were the leakage limits in the proposed license condition for TMI-1 established?

A8. The proposed license condition is based upon stringent administrative limits imposed by Licensee as part of its own program. Licensee included a number of considerations in establishing the absolute value of the leak rate increase during steady state operating conditions which would dictate further action. These considerations are summarized as follows:

1. Establish a leak rate monitoring capability sensitive enough to detect a leak rate as low as 0.5 GPH (about 1% of the Technical Specification 3.1.6.3 limit) during power operations.

2. Establish a baseline leakage rate to take into account the anticipated, low level leakage from the mechanical plugs and the kinetically expanded joint. The current baseline

leak rate of 0.02 GPM (1 GPH) was based on monitored leakage during OTSG hot (pre-critical) testing.

3. Establish a shutdown limit sufficiently above the pre-established baseline so that we can have confidence that the change is significant as compared with the anticipated variation in the nominal monitored leak rate. The OTSG hot testing results indicate that the monitored leak rate statistical variation (twice the standard deviation from the mean value) of approximately ± 0.01 GPM (± 0.5GPH) can be expected during steady state operation.

4. Establish a shutdown limit low enough to ensure conformance with the off-site exposure limits of 10 CFR Part 50, Appendix I. These limits are based on off-site exposure to various body organs over a one year period. Licensee has evaluated off-site releases. These evaluations are based on 0.03% failed fuel. This is the failed fuel percentage prior to the last refueling, so we anticipate the actual failed fuel percentage to be less when we restart. We have determined that the gaseous release mode results in the limiting off-site exposure dose closest to an Appendix I limit. This limit is 15 mr/year exposure to the thyroid due to iodine releases. A continuous 0.1 GPM primary-to-secondary leak rate contributes about 5 mr/year to the off-site thyroid dose rate.

5. Recognize the probability of multiple leakpaths within the OTSG contributing to the aggregate leakage. The baseline leak rate value was determined at operating conditions

following an OTSG inspection and leak testing with a drip and bubble test. These cold leak tests conducted before the hot test program demonstrate that no single tube is causing all of the current 0.02 GPM (1 GPH) leakage. The results from these sensitive cold leak tests showed that the baseline leak rate value is and will be in the future the sum of multiple minor leakpaths which would not be expected to individually jeopardize the integrity of any OTSG tube.

Based on these considerations, a nominal leak rate of 0.1 GPM, above a baseline value, was established as the limit at which the plant is to initiate an orderly shutdown for OTSG inspection and identification of the leak source.

Q9. Can leakage commensurate with the license condition limit be realiably measured during plant operation?

A9. Yes. Primary-to-secondary leakage is indicated by several diverse methods at TMI-1. These methods include measuring radionoble gas concentrations on the secondary side, and measuring chemistry and radio-chemistry in secondary side OTSG water. The radionoble gas concentration measurement is the most sensitive method of quantifying the primary-to-secondary leakage rate. The leakage rate is calculated periodically by utilizing data from on-line continuous monitors and grab samples analysis. The following describes the measurement technique and our evaluation of the sensitivity of this measurement. The purpose of this description is to demonstrate that the leak rate value obtained by this measurement technique is

sufficiently sensitive relative to the proposed license condition limit.

Primary side activity is transported to the secondary system via the OTSG leakage pathway, and then carried over into the main steam system. The main steam, condensate and feedwater systems distribute the primary leakage throughout the secondary side of the plant. Non-condensable gases entrained in the steam and condensate are concentrated and removed from the system via the condenser air removal system. A measurement of radionoble gas activity in the discharge of the air removal system can be correlated with primary to secondary side OTSG leakage.

The measurement of gaseous activity is accomplished by instrumenting the vacuum pump discharge stream and providing a direct readout of condenser air removal system rate and activity concentration, and/or by taking local samples and then determining the OTSG P-S leak rate via calculation. At TMI-1 the radiation monitoring instrument provided to determine the activity measurement is a Beta scintilation detector designated RM-A5L. The instrument is located in the main condenser air removal system discharge common eight-inch diameter header. The monitor is manufactured by Victoreen, Inc., and includes a detector assembly consisting of a beta sensitive plastic crystal, optically coupled to a photomultiplier tube. The readout associated with the monitor is located in the control room. Based upon the control room readout and condenser air removal

system flow rate, leakage can be calculated as a function of RM-A5L effiency and reactor coolant system activity.

Licensee has evaluated the sensitivity of the RM-A5L monitor to determine its suitability for measuring primary to secondary leakage. For the expected ranges of condenser offgas flow, reactor power and failed fuel, we have concluded that the sensitivity is at least 0.001 GPM (0.07 GPH) during steady state operation (power operation) and 0.003 GPM (0.2 GPH) during plant cooldown (sub-critical conditions). The higher sensitivity during power operation is due to higher concentration of short half life radioisotopes in the reactor coolant system when the reactor is in operation. Thus, the measurement technique being utilized at TMI-1 is sufficiently sensitive to support the 0.1 GPM licensing condition.

Q10. What cold leak tests are utilized to determine the location of leaks and what is their sensitivity?

A10. There are two cold leak tests used to locate leaking tubes, the bubble test and the drip test. The bubble test is conducted by pressurizing the secondary side of the OTSG with nitrogen at about 135 psig. During this test the secondary side is partially drained and primary side water is maintained a few inches above the upper tubesheet. The inspector then looks for gas bubbles at the upper tubesheet bubbling through primary side water which is being maintained several inches above the upper tubesheet. Licensee has evaluated bubble test sensitivity and determined it is the most sensitive cold leak

test. Based on bubble test experience, an 80 mil diameter bubble originating once every five seconds can be located during the bubble test. This correlates to a leak rate sensitivity of 0.000005 GPM for any individual leak. The bubble test was used to test about the top 18 feet of the 56 foot long OTSG tubes. Testing this upper portion of the OTSG tubes results in testing 100% of the new kinetic expansion joints.

The entire OTSG tube length is leak tested by the drip test. The drip test is conducted by pressurizing the secondary side to approximately 150 psig. During this test, the OTSG is full of water on the secondary side and drained on the primary side. The inspector looks for drops of water coming from individual tubes on the primary side of the lower tubesheet. Based on the ability to locate one drop every three seconds, the sensitivity of the drip test is as low as 0.0002 GPM for any individual leak located at or near the lower tubesheet. For leak locations higher in the OTSG, the drop has further to travel before it can be observed at the lower tubesheet. This allows more time for evaporation of the leakage water before the water can drip down and out the bottom of the tube. This evaporation will reduce the drip test sensitivity somewhat. Even so, the drip test sensitivity for leak locations high in the OTSG remains quite good, and is estimated to be about 0.002 GPM (three drops per second).

Q11. What is the relationship or relevance of the leakrate measurements to the repairs made on the TMI-1 OTSG tubes?

A11. The leak rate measurements made at TMI-1 measure total P-S leakage from the OTSGs. This would include the contribution from leakage through the joints. As previously described, if the nominal leak rate increases by 0.1 GPM, the plant will be shut down and the individual tubes, plugs and/or joints will be identified by the nitrogen bubble test and drip tests which we discussed earlier.

Q12. Could leaks be self-sealing?

A12. Yes, in certain limited circumstances. We believe there may be a tendency for some leaks to be self-sealing, but only for leakage pathways between the expanded portion of the joint and the tubesheet. The joint is formed between the Inconel tube and the carbon steel tubesheet. Since carbon steel has a propensity for general corrosion in a normal RCS chemistry environment, corrosion products are formed in the tube-to-tubesheet joint. Industry experience indicates that these corrosion products tend to plug up leakage paths in the tight tube-to-tubesheet crevice and to stop or slow (i.e., self-seal) leakage. A trend of decreasing leakage with time for joints tested in the qualification program further confirmed this industry experience.

To be self-sealing, a leak past the joint would have to have a very small flow through a pathway sufficiently tight to

enable the build-up of corrosion products adequate to seal the leak. A leak of this size would not adversely affect the load bearing capability of the joint, or increase the probability of rupture within the joint.

Q13. Would the loss of pretension affect the usefulness of leak testing of the repaired joint?

A13. No. Leakage past a repaired joint is independent of the loss of pretension.

Pretension, or preload, was originally placed on the tubes during the manufacturing of the steam generators. The tubes were heated, which elongated them slightly by thermal expansion, and were then attached at each tubesheet. When the tubes cooled, the metal would have tried to contract back to the original length at ambient temperature, but because the ends remained fixed, contraction was prevented. This produced a tensile load on the tubes. At TMI-1, some tubes with complete circumferential cracks were freed from the original joint which fixed the tube in the upper tubesheet. These tubes contracted a small fraction of an inch, relieving all or part of the pretension. When the kinetic expansion was performed on these tubes, the tubes were again fixed at each end, but with the absence of part or all of the original pretension. This "loss of pretension" resulted in a reduction of axial tube load of only several hundred pounds.

The kinetic process relies on horizontal forces to expand the tubes, while pretension is an axial load (i.e., vertical in

direction). Since these load components are perpendicular with respect to each other, the loss of pretension does not affect the ability to expand the tube and form the new joint. Thus, kineticly expanded joints formed in tubes with loss of pretension are as tight, and therefore are no more prone to leakage, than tubes with preload.

Even if there is leakage past the repair joint, it will be through the tight crevice between the tube and tubesheet. The loss of pretension does not affect the tightness of this joint and thus can not affect the potential leakage flow path once fixed. Monitoring of leakage through such a joint is thus unaffected by a loss of pretension.

Q14. Would loss of pretension cause IGSAC cracks to be masked due to decreased leakage?

A14. In theory, a tube without pretension would exhibit a lower leak rate than a tube with pretension for a circumferential through-wall crack of a given size. In practice, however, this phenomenon is unlikely to mask the detection of a critical size crack at TMI-1.

The rigorous testing already conducted on each tube--special eddy current testing, bubble testing and leak-testing--show that such cracks do not exist in the tube pressure boundary. While the conditions which caused the circumferential intergranular stress-assisted cracking in TMI-1 have been eliminated, if such a crack were to exist, it would propagate only during conditions when the tube was placed in axial tension; this will tend to offset the effect of pretension loss.

Tubes without a pretension load are placed in axial tension under some operating conditions, just as tubes with preload are sometimes in axial compression. During the steam generator hot testing program, transients placed axial tensile loads of at least several hundred pounds on every tube in the steam generators--even those which had lost preload. Measured leak rates were assumed to come entirely from one crack, and were compared with benchmark calculations of estimated leakage through cracks of a significant size under the transient load. Tubes both with and without preload were considered. These results confirmed the conclusion reached after eddy current, drip and bubble tests--that no large cracks remain undetected in tubing in the TMI-1 steam generators.

If future cracks are hypothetically assumed to be propagating due to IGSAC at normal operating conditions, the principal direction of propagation will be axial along the tube. IGSAC propagation is principally perpendicular to the direction of highest stress. The highest tube stress is in the hoop direction at these conditions. A loss of pretension will not cause reduced leakage from axial tube cracks because there are no forces associated with loss of pretension trying to keep the crack closed.

PROFESSIONAL QUALIFICATIONS

Richard F. Wilson
Vice President, Technical Functions
GPU Nuclear Corporation

GPU Experience:

Technical responsibility for the Engineering, Design, Licensing and Technical Support of all nuclear generating stations for the GPU System. The position manages the technical resources of GPU Nuclear including day-to-day support for plant operations.

Previously was Acting Director for TMI-2 from September, 1979, to about March, 1980, and before that was Director of the Engineering and Quality Assurance Departments within the GPU Service Corporation. Between 1975 and 1977, was Manager of Quality Assurance for the GPU Service Corporation with responsibilities for design and construction Quality Assurance.

Other Experience:

Prior work experience included two years (1973-1975) as Manager of Manufacturing Engineering for Offshore Power Systems, Jacksonville, Florida. Responsibilities included activities associated with manufacturing planning, tooling, industrial engineering, manufacturing engineering, and technical support to the planned manufacturing facility. Prior to joining Offshore Power Systems, held a number of positions at the Atomic International Division of Rockwell International, 1954 to 1973. Some of these positions included Engineering Supervisor, Department Manager, Chief Project Engineer, Program Manager, and Chief Program Engineer on a wide variety of Atomic International programs. The last position was Program Manager for the Atomic International work on the fast breeder program. Performed and supervised work in almost every facet of reactor engineering, physics, facility design, safety, reactor operations, etc.

Committee affiliations have included the EEI QA Task Force, the AIF Committee on Power Plant Design, Construction and Operation, B&W Plant Owners and BWR Owners Groups, EPRI Nuclear Divisional Committee, etc. Outside the utility industry has served on a number of company and company/government advisory groups as related to specific programs.

Education and training includes a B.S. degree in Mechanical Engineering, University of California at Berkeley, 1951; an M.S. degree in Mechanical Engineering, University of Michigan, 1953; and one year attendance at the former Oak Ridge School of Reactor Technology in 1954. Has attended a large number of management and other courses, including the University of Michigan Public Utility Executive Program.

PROFESSIONAL QUALIFICATIONS

DAVID G. SLEAR

WORK EXPERIENCE

Company: GPU Nuclear Corporation

Title: TMI-1 Manager Engineering Projects

Responsibilities: Management of TMI-1 modification, which entails: Management of the $25 million annual budget allocated for plant modification; prioritization of the various phases of plant modification; oversight of the technical adequacy of plant modification and of the components involved in plant modification; consultation regarding problem resolution with respect to matters concerning plant modification; and direct supervision of 16 GPU employees. This position demands constant attention to long term and daily plant modification concerns and an extremely firm grasp of both the technical aspects of TMI-Unit 1 and of the various modes and components of modification available for implementation at TMI-Unit 1.

Dates: 1983 - Present

Company: GPU Nuclear Corporation

Title: OTSG Repair Project Manager

Responsibilities: Management (in conjunction with individual task managers) of all aspects of the OTSG Recovery program at TMI-1 including failure analysis, eddy current testing, corrosion testing, RCS examination, RCS sulfer cleanups, and plant performance analysis. This position involved direct management of the OTSG repair process and personal involvement in the decision making process with respect to the repair program. This position also entailed the definition and implementation of the overall project, and required a broad overview and analysis of the OTSG Recovery program. In his capacity as OTSG Repair Project Manager, Mr. Slear was also called

upon to deliver numerous presentations concerning project details before the NRC, ACRS, TPR, and the GPU Nuclear Corp. management.

Dates: December 1981 - November 1983

Company: GPU Service Corporation

Title: TMI-1 Manager Engineering Projects

Responsibilities: Similar to those listed for Mr. Slear's present position including management of a $20 million budget and of project engineering for modifications.

Dates: 1979 - 1981

Company: GPU Service Corporation

Title: Preliminary Engineering Manager

Responsibilities: This position entailed: the analysis and preliminary design of 400 Megawatt combustion turbines and of a 600 Megawatt coal fired power plant; extensive analysis of the reliability and availability of the components to be installed in the prospective power plant; and the establishment of a baseline criteria document for the designated plants including the technical documentation and presentation of the plant design for management review.

Dates: 1978 - 1979

Company: GPU Service Corporation

Title: Component Engineer

Responsibilities: This position entailed: the review of design specifications and technical details of products going into TMI-2, including the steam generators, pressurizer, main

condensors, cooling towers, reactor vessel, and internals; technical consultation and analysis of problems; and review of the contractor's design work on new components going into a plant.

UNITED STATES NAVY NUCLEAR SUBMARINE FORCE OFFICER

Title: Engineer Officer

Responsibilities: This position entailed: essentially primary responsibility and control of the onboard nuclear power plant; control of all engineering sections, command of 4 divisions; and supervision of approximately 55 crewmen.

Dates: 1972 - 1974

Title: Machinery Division Officer

Responsibilities: As Machinery Division Officer, Mr. Slear was responsible for: all mechanical components of the primary and secondary systems of the power plant including the steam generator, reactor, and drive controls; chemistry control of the primary and secondary systems; and the supervision of 15 crewmen. Mr. Slear also served as an Auxiliary Division Officer in charge of non-nuclear life support systems, and as a Communications Division Officer.

Dates: 1968 - 1972

Mr. Slear also attended the Nuclear Power Submarine School from 1966 - 1968, during which time he obtained one year of nuclear power plant training (6 months classroom, 6 months actual plant training) in addition to the submarine qualification program.

EDUCATION

College: University of Oklahoma

Degree: B.S. Mechanical Engineering

Dates: 1961 - 1966

College: Stevens Institute of Technology

Degree: M.S. Mechanical Engineering

Dates: 1974 - 1978

PROFESSIONAL QUALIFICATIONS

Don K. Croneberger
Director - Engineering & Design
GPU Nuclear Corporation

GPU Experience:

Technical responsibility for the Mechanical, Electrical, Civil/Structural, Chemical, Radwaste and Materials Engineering support for all nuclear generating stations for the GPU Systems.

1978 to 1980 was Manager - Design and later Manager - Engineering & Design with GPU Service Corporation. Directed design engineering activities for all nuclear and fossil power generating facilities and modifications assigned to GPUSC.

Other Experience:

Prior work experience included a number of positions at Gilbert/Commonwealth during the period 1963 to 1978. The last position was Manager Structural Engineering. It included technical responsibility for structural engineering mechanics for all nuclear and fossil generating facilities. Some of the other positions included Project Manager for balance of plant studies for a liquid metal fast breeder reactor demonstration plant. Other positions as Project Structural Engineer included responsibility for technical supervision of structural engineering and engineering mechanics for a number of domestic nuclear power plants. Earlier experience with the U.S. Navy included engineering and construction of radio telescope and ancillary experience.

Industry affiliations have included the EPRI Steam Generator Owners Group, ASME Section 3 Division 2 (former Chairman) and other industry nuclear standards activities including Nuclear Structures and Plant Design Against Missiles.

Education and training includes a B.S. degree in Civil Engineering from Pennsylvania State University, 1959. Other technical training includes courses at U.C.L.A., M.I.T. and the University of Michigan.

I have been involved in the Steam Generator tube failure issue from the beginning. I provided technical management oversight of failure analysis and repair activities. Special emphasis was placed on understanding the mechanical design of the Steam Generators and applying that understanding to the repair program and the understanding of the impact of the repair on the response of the components.

My department provided engineering support in the areas of Materials Engineering/Failure Analysis, Chemical Engineering and Chemistry, Mechanical Engineering and Engineering Mechanics.

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MS. BURKLEY: Mr. Giacobbe, would you please state your name and occupation for the record?

WITNESS GIACOBBE: I am F. Scott Giacobbe. I am Manager of Materials, Engineers Failure Analysis. My rsponsibilities were to manage and direct the failure analysis, corrosion tests, including long-term corrosion test programs associated with the steam generator repairs.

MS. BURKLEY: Thank you.

Are you familiar with the licensee's testimony captioned "Licensee's testimony of Richard F. Wilson, David G. Slear and F. Scott Giacobbe on issue i.b, contention 1.a"?

WITNESS GIACOBBE: Yes, I am.

MS. BURKLEY: Do you have any changes or corrections you would like to make to the testimony at this time?

WITNESS GIACOBBE: I do not.

MS. BURKLEY: Do you adopt this testimony as your testimony in this proceeding?

WITNESS GIACOBBE: Yes, I do.

MS. BURKLEY: Mr. Wilson, are you familiar with the licensee's testimony of Richard F. Wilson, David G. Slear and F. Scott Giacobbe on issue 1.b, contention 1.a?

WITNESS WILSON: Yes, I am.

MS. BURKLEY: Do you have any changes or corrections you would like to make to this testiomony at this time?

WITNESS WILSON: No, I do not.

MS. BURKLEY: Do you adopt this testimony as your

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1 testimony in this proceeding?

2 WITNESS WILSON: Yes, I do.

3 MS. BURKLEY: Mr. Slear, are you familiar with

4 the licensee's testimony of Richard F. Wilson, David G. Slear

5 and F. Scott Giacobbe on issue 1.b, contention 1.a?

6 WITNESS SLEAR: Yes, I am familiar with that

7 testimony.

8 MS. BURKLEY: Do you have any changes or correc-

9 tions you would like to make to that testimony at this time?

10 WITNESS SLEAR: I have no changes or corrections.

11 MS. BURKLEY: Do you adopt this testimony as your

12 testimony in this proceeding?

13 WITNESS SLEAR: Yes, I do.

14 MS. BURKLEY: Your Honor, I would ask at this

15 time that licensee's testimony of Richard F. Wilson, David G.

16 Slear and F. Scott Giacobbe on issue 1.b, contention 1.a be

17 incorporated into the record as if read here today.

18 JUDGE WOLFE: Is there any objection?

19 (No response.)

20 JUDGE WOLFE: Hearing none, the described testimony

21 is incorporated into the record as if read.

22 (Whereupon, the licensee's testimony of Richard

23 F. Wilson, David G. Slear and F. Scott Giacobbe on issue 1.b,

24 contention 1.a follows:)

25

June 29, 1984

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

Before the Atomic Safety and Licensing Board

In the Matter of	)	
	)	
METROPOLITAN EDISON COMPANY, ET AL.	)	Docket No. 50-289-OLA
	)	ASLBP 83-491-04-OLA
(Three Mile Island Nuclear	)	(Steam Generator Repair)
Station, Unit No. 1)	)	

LICENSEE'S TESTIMONY OF RICHARD F. WILSON,
DAVID G. SLEAR AND F. SCOTT GIACOBBE
ON ISSUE 1.b (CONTENTION 1.a)

To Mr. Wilson:

Q1. Please state your name and address, and describe your involvement with the TMI-1 steam generator tube repair program.

A1. My name is Richard F. Wilson. I am employed by GPU Nuclear Corporation, 100 Interpace Parkway, Parsippany, New Jersey 07054. As Vice President of Technical Functions, I was responsible for the overall project and technical management of the TMI-1 steam generator tube repair program.

A statement of my professional qualifications is attached.

To Mr. Slear:

Q2. Please state your name and address, and describe your involvement with the TMI-1 steam generator tube repair program.

A2. My name is David G. Slear. I am employed by GPU Nuclear Corporation, 100 Interpace Parkway, Parsippany, New Jersey 07054. As the Manager of Engineering Projects for TMI-1, I was the overall task manager for the TMI-1 steam generator tube repair program reporting directly to the Vice President of Technical Functions. My responsibilities included all activities associated with the evaluation and repair of the steam generators.

A statement of my professional qualifications is attached.

To Mr. Giacobbe:

Q3. Please state your name and address, and describe your involvement with the TMI-1 steam generator tube repair program.

A3. My name is F. Scott Giacobbe. I am employed by GPU Nuclear Corporation, P.O. Box 1018, Reading, Pennsylvania 19603. As Manager of Materials Engineering/Failure Analysis I have been involved in the planning and management of the failure analysis activities, corrosion testing programs, materials evaluation and tube sampling and removal programs associated with the steam generator tube repair program.

A statement of my professional qualifications is attached.

To all witnesses:

Q4. What is the purpose of your testimony?

A4. The purpose of this testimony is to address Issue 1.b of Contention 1.a as enumerated at page 23 of the Board's Memorandum and Order (Rulings on Motions for Summary Disposition, dated June 1, 1984), in which the Licensing Board stated:

> 1. The rationale underlying certain proposed license conditions should be addressed, with attention to:
>
> * * * *
>
> b. Method of determining frequency of ECT tests.

Q5. How was the frequency of eddy current testing following restart of Unit 1 determined?

A5. Industry experience has shown eddy current testing (ECT) is the preferred method for non-destructive examination of steam generator tubes to ascertain damage. The technique has the ability to detect different types of tube damage states, such as different kinds and sizes of cracks, inside and outside surface defects, and tube erosion and wear. It is used to provide knowledge of the generator state well before tubes degrade to the point of through-wall leakage or an unsafe condition develops within the generator. Characterization of the signal gives insight as to the type of damage and substantially assists the investigator in understanding the damage mechanism. As ECT is a technique for inspecting tubing remaining in service as part of the primary pressure boundary, the role of eddy current inspection for the TMI-1 steam generators is the same as for generators at any other operating plant.

The existing once-through steam generator (OTSG) Technical Specification requirements for ECT at TMI-1 implement NRC's Regulatory Guide 1.83, Rev. 1. The requirements are the same as those for other nuclear plants in that they require at least 3% of the total number of tubes in the steam generators to be examined at each inspection (certain criteria on tube selection are included). The Technical Specification testing frequency is specified to be not more than 24 months after the previous inspection with provisions that the interval could be extended to a maximum of once per 40 months, contingent on prior inspection results. Further conditions are imposed on the inspection frequency if there are primary to secondary tube leaks, degradation is in excess of Technical Specification limits, and/or a loss of coolant accident or a main steam line or feedwater line break has occurred. If, in the course of inspecting the steam generators, more than 5% of the total tubes inspected are found to be degraded (imperfections equal to or greater than 20% through-wall) or any of the tubes inspected are defective (greater than 40% through-wall), then the sample size of the inspection is increased.

Licensee has adopted supplements to the TMI eddy current test program which the NRC has incorporated into proposed license conditions. These supplements will act as a precautionary confirmation of Licensee's conclusion that crack initiation or propagation is not anticipated by chemical or mechanical means following return of the steam generators to

service. What has been proposed is that either 90 days after reaching full power or 120 calendar days after achieving 50% power (whichever occurs first), the plant would be shut down for eddy current inspection of the generators. In addition, ECT would be done at the subsequent shutdown refueling. The plant currently is loaded with fuel which would permit full power operation for a little less than one year.

In establishing the above recommended change in eddy current test frequency, we considered the conditions of the generator, the type of repairs performed within the generator, the damage mechanism leading to the repairs, and our expectation that if any new damage were to occur, it would be at a slow rate. In addition, there are considerations other than those relating to the steam generators, i.e., the overall question of plant accessibility, other operational sequences being conducted, and prudent operating practices, which dictate that the opening of steam generators, with its attendant exposure to oxygen, should be minimized.

With regard to TMI-1 specifically, there is considerable detailed information available on the state of the generator, and its recent repair. We have in place a special ECT differential probe characterization of all tubes remaining in service (approximately 29,000 tubes) and special absolute probe ECT data on over 800 tubes. We have a clear understanding of the type of damage which occurred in the generator and the reasons therefor. We have an extensive qualification program on the

repair which has tested kinetically expanded joints out to five years of load cycling and 15 years of thermal cycling. We have a general industry understanding of experience with explosively expanded tubes in tubesheets for other applications. In addition, we are performing lead corrosion tests to provide advanced confirmatory corrosion and crack behavior data.

This information has been used to draw a number of conclusions on the predicted behavior of the tubes remaining in service:

1. The initial intergranular stress-assisted cracking (IGSAC) of the steam generator tubes occurred with reduced sulfur species and with the plant cooling down or cold. Steps have since been taken to reduce levels of sulfur through chemical cleaning, stringent controls on primary system water chemistry (less than 100 ppb sulfur) and elimination of potential sulfur contamination sources. Tests have shown that the failure mechanism is inoperative in the absence of sufficiently high levels of reduced sulfur species, and that IGSAC will not reinitiate under the TMI-1 operating conditions. Thus, there is reasonable assurance that the rapid IGSAC which caused the original damage will not affect the steam generators in the future.

2. There currently exists hot operational experience on the repaired steam generator of about 40 days with no indication of leakage in excess of Licensee's new, stringent administrative limits on primary-to-secondary leak rate. This

available test data supports the conclusion that unforeseen rapid or gross changes are not taking place.

3. The long term corrosion lead tests support the conclusion that under the conditions attendant to operation, rapid chemical attack is not predicted.

4. The possibility of steam flow-induced mechanical vibration propagation of small cracks was examined analytically and found to be non-significant.

5. No mechanism has been identified relating to other mechanical crack propagation scenarios while operating at full power. Crack propagation due to thermal cycling has been shown to be small and to occur principally during the act of cooling down. Thus, mechanical crack propagation is not expected to change tube condition during operation.

Since the ECT program is designed to characterize change, there is a need to allow reasonable operating time on the generators to allow any unforeseen mechanism to cause change. It is clearly a matter of judgment as to the period of time required, but several factors considered by Licensee support the 90 days/next refueling intervals proposed:

1. Eddy current examination should take place after chemical equilibrium is obtained within the system. An extended period of time may be necessary for this to occur, given the time associated with gradual dissolution of the residual sulfur in the oxide films and its removal from the reactor coolant system (RCS). The full benefits of eddy current testing can,

again, only be obtained after operation at some period of time to allow the system to approach chemical equilibrium.

2. Mechanical propagation due to flow induced vibration at steady state operation, if any, will only occur at full or near-full steam flow conditions. To confirm these analytic conclusions the generator must be operated at full steam flow. Thus, a period of time of OTSG operation at power is required if eddy current examination is to be most meaningful.

3. The plant extended startup and power escalation program is designed to maximize operator training, plant refamiliarization, and allow non-OTSG related performance testing along the way. This same extended power escalation program allows significant time to be accumulated on the generators at reduced power. The period of time at reduced power is also a means of accumulating generator experience when the consequences of any hypothetical crack propagation are reduced.

4. Detailed technical assessments of the repair within the tubesheet do not reveal mechanisms which could lead to catastrophic failure.

The above facts and experience suggest a minimal period of several months of initial operation is necessary to ensure that sufficient data can be obtained during the inspections to trend conditions within the steam generators. Licensee's proposed augmented eddy current test program is a judgment based on the available facts regarding generator condition and potential failure mechanisms, and includes consideration of general

industry experience. Because special probes and techniques were developed for TMI-1, the condition of the TMI-1 steam generators is probably known with greater precision than for comparable steam generators at other plants. The proposed supplemental steam generator ECT program for the inspections during the operating cycle after restart will continue to utilize these special probes and techniques. It is a program which can reasonably be carried out without undue, unnecessary risk to the plant and will provide the requisite degree of insight on changes, if any, in the generator.

PROFESSIONAL QUALIFICATIONS

Richard F. Wilson
Vice President, Technical Functions
GPU Nuclear Corporation

GPU Experience:

Technical responsibility for the Engineering, Design, Licensing and Technical Support of all nuclear generating stations for the GPU System. The position manages the technical resources of GPU Nuclear including day-to-day support for plant operations.

Previously was Acting Director for TMI-2 from September, 1979, to about March, 1980, and before that was Director of the Engineering and Quality Assurance Departments within the GPU Service Corporation. Between 1975 and 1977, was Manager of Quality Assurance for the GPU Service Corporation with responsibilities for design and construction Quality Assurance.

Other Experience:

Prior work experience included two years (1973-1975) as Manager of Manufacturing Engineering for Offshore Power Systems, Jacksonville, Florida. Responsibilities included activities associated with manufacturing planning, tooling, industrial engineering, manufacturing engineering, and technical support to the planned manufacturing facility. Prior to joining Offshore Power Systems, held a number of positions at the Atomic International Division of Rockwell International, 1954 to 1973. Some of these positions included Engineering Supervisor, Department Manager, Chief Project Engineer, Program Manager, and Chief Program Engineer on a wide variety of Atomic International programs. The last position was Program Manager for the Atomic International work on the fast breeder program. Performed and supervised work in almost every facet of reactor engineering, physics, facility design, safety, reactor operations, etc.

Committee affiliations have included the EEI QA Task Force, the AIF Committee on Power Plant Design, Construction and Operation, B&W Plant Owners and BWR Owners Groups, EPRI Nuclear Divisional Committee, etc. Outside the utility industry has served on a number of company and company/government advisory groups as related to specific programs.

Education and training includes a B.S. degree in Mechanical Engineering, University of California at Berkeley, 1951; an M.S. degree in Mechanical Engineering, University of Michigan, 1953; and one year attendance at the former Oak Ridge School of Reactor Technology in 1954. Has attended a large number of management and other courses, including the University of Michigan Public Utility Executive Program.

PROFESSIONAL QUALIFICATIONS

DAVID G. SLEAR

WORK EXPERIENCE

Company: GPU Nuclear Corporation

Title: TMI-1 Manager Engineering Projects

Responsibilities: Management of TMI-1 modification, which entails: Management of the $25 million annual budget allocated for plant modification; prioritization of the various phases of plant modification; oversight of the technical adequacy of plant modification and of the components involved in plant modification; consultation regarding problem resolution with respect to matters concerning plant modification; and direct supervision of 16 GPU employees. This position demands constant attention to long term and daily plant modification concerns and an extremely firm grasp of both the technical aspects of TMI-Unit 1 and of the various modes and components of modification available for implementation at TMI-Unit 1.

Dates: 1983 - Present

Company: GPU Nuclear Corporation

Title: OTSG Repair Project Manager

Responsibilities: Management (in conjunction with individual task managers) of all aspects of the OTSG Recovery program at TMI-1 including failure analysis, eddy current testing, corrosion testing, RCS examination, RCS sulfer cleanups, and plant performance analysis. This position involved direct management of the OTSG repair process and personal involvement in the decision making process with respect to the repair program. This position also entailed the definition and implementation of the overall project, and required a broad overview and analysis of the OTSG Recovery program. In his capacity as OTSG Repair Project Manager, Mr. Slear was also called

upon to deliver numerous presentations concerning project details before the NRC, ACRS, TPR, and the GPU Nuclear Corp. management.

Dates: December 1981 - November 1983

Company: GPU Service Corporation

Title: TMI-1 Manager Engineering Projects

Responsibilities: Similar to those listed for Mr. Slear's present position including management of a $20 million budget and of project engineering for modifications.

Dates: 1979 - 1981

Company: GPU Service Corporation

Title: Preliminary Engineering Manager

Responsibilities: This position entailed: the analysis and preliminary design of 400 Megawatt combustion turbines and of a 600 Megawatt coal fired power plant; extensive analysis of the reliability and availability of the components to be installed in the prospective power plant; and the establishment of a baseline criteria document for the designated plants including the technical documentation and presentation of the plant design for management review.

Dates: 1978 - 1979

Company: GPU Service Corporation

Title: Component Engineer

Responsibilities: This position entailed: the review of design specifications and technical details of products going into TMI-2, including the steam generators, pressurizer, main

condensors, cooling towers, reactor vessel, and internals; technical consultation and analysis of problems; and review of the contractor's design work on new components going into a plant.

UNITED STATES NAVY NUCLEAR SUBMARINE FORCE OFFICER

Title: Engineer Officer

Responsibilities: This position entailed: essentially primary responsibility and control of the onboard nuclear power plant; control of all engineering sections, command of 4 divisions; and supervision of approximately 55 crewmen.

Dates: 1972 - 1974

Title: Machinery Division Officer

Responsibilities: As Machinery Division Officer, Mr. Slear was responsible for: all mechanical components of the primary and secondary systems of the power plant including the steam generator, reactor, and drive controls; chemistry control of the primary and secondary systems; and the supervision of 15 crewmen. Mr. Slear also served as an Auxiliary Division Officer in charge of non-nuclear life support systems, and as a Communications Division Officer.

Dates: 1968 - 1972

Mr. Slear also attended the Nuclear Power Submarine School from 1966 - 1968, during which time he obtained one year of nuclear power plant training (6 months classroom, 6 months actual plant training) in addition to the submarine qualification program.

EDUCATION

College: University of Oklahoma

Degree: B.S. Mechanical Engineering

Dates: 1961 - 1966

College: Stevens Institute of Technology

Degree: M.S. Mechanical Engineering

Dates: 1974 - 1978

STATEMENT OF QUALIFICATIONS AND EXPERIENCE

F. SCOTT GIACOBBE

I, F. Scott Giacobbe, am employed by General Public Utilities Nuclear Corporation as Manager, Materials Engineering/Failure Analysis. I have been in this position since July of 1982.

My education includes a Bachelor's Degree in Mechanical Engineering from Villanova University in 1970 and a Master's Degree in Materials Engineering from Drexel University in 1975.

My work experience has provided me many years of direct involvement in the materials evaluation and failure analysis of power plant components; early in my career it also provided a very intense involvement in heat exchanger tubing evaluations.

In 1970, I began my employment with Westinghouse Electric Corporation in their Heat Transfer Division as a Materials Engineer. In this position I worked on the materials selection, corrosion evaluations and failure analysis of heat exchanger components such as feedwater heaters, condensors, radioactive waste evaporators and other secondary side heat exchangers. In particular, I was responsible for assuring that tubing utilized in the Westinghouse heat exchangers was properly specified and manufactured. This function provided me with in-depth knowledge of heat exchanger tubing fabrication practices, corrosion resistant properties and failure mechanisms.

In 1977 I left Westinghouse to join General Public Utilities as a Senior Engineer in their metallurgical laboratory. This position afforded me the opportunity to expand my areas of expertise to include materials selection, corrosion evaluation and failure analysis of other components of both nuclear and fossil power plants, and to gain a broader understanding of power plant operation.

In 1978 I was promoted to supervisor of the metallurgical laboratory. This was a first line supervising position which gave me the responsibility for the daily operation of the laboratory and supervision of the technicians and engineers reporting to me. This position also carried with it a large technical responsibility which kept me heavily involved in the day-to-day materials engineering problems.

My career took on a slight change in direction in 1980 when the company reorganized and formed the Nuclear Corporation. At that time I became Materials and Welding Manager in the Nuclear Assurance Division. With this position I essentially had the same functions as before, with the added responsibility for welding at the nuclear power stations. While in this position I was responsible for the technical and metallurgical aspects of the development of the Nuclear Corporation welding program. During this time I was still supervising all failure analysis activities, including the TMI spent fuel pool pipe cracking incident.

In July 1982, another reorganization took place. At this time my section merged with the materials engineering section in the Technical Functions Division and I took over management of that newly formed section. In this position I now had functional responsibility for the materials configuration control of both GPU nuclear power plants as well as welding engineering and failure analysis. In addition, my section still provided failure analysis services to the fossil companies.

I have been involved in the steam generator tube failure issue from the beginning. I participated directly in the initial decision-making regarding the tube sampling and removal operations and was present to perform the initial visual evaluations of the removed tubing. I personally planned and oversaw the failure analysis activities performed by the outside laboratories. I also developed the corrosion testing programs which GPUN implemented to gain insight and understanding into the failure mechanism and responsible corrodants. It was also my responsibility to coordinate the input from all our technical consultants as well as plant experience and formulate the current failure scenario.

During the steam generator repair, my section also provided materials evaluation and consultation on all aspects of the repair including explosive expansion, flushing, peroxide cleaning, and so forth. My section also developed and implemented the long term corrosion testing program and is evaluating the results as the testing progresses.

Lastly, during the course of the steam generator repairs, I was responsible for making all presentations to the NRC on corrosion testing and failure analysis activities.

Over the years I have kept fully abreast with the state-of-the-art in corrosion technology through my attendance and participation in technical seminars and conferences, and through attending training sessions. I am a member of the Edison Electric Institute Materials, Piping, Welding and Corrosion Task Force, a group of industry representatives who meet to share and develop solutions to corrosion problems in the field of materials and welding in the power industry. In addition, I am a member of the American Society for Metals.

Publications

1. F. S. Giacobbe, "Examination, Evaluation and Repair of Stress Corrosion Cracking in a PWR Borated Water Piping System", NACE Corrosion 81.

2. F. S. Giacobbe, J.D. Jones, R. L. Long, D. G. Slear, "Repairs of TMI-1 OTSG Tube Failures" Plant/Operations Progress AICHE, July 1983, Vol. 2, No. 3.

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MS. BURKLEY: Mr. Broughton, would you please state your full name and occupation for the record?

WITNESS BROUGHTON: T. Gary Broughton; I'm the Director of Systems Engineering for GPU Nuclear.

MS. BURKLEY: Could you please explain what role you played in licensee's repair of the steam generator at TMI-1?

WITNESS BROUGHTON: I provided support to the steam generator project primarily in the area of plant performance.

MS. BURKLEY: Perhaps, given your scheduling problem, it might be easier if you could give us a little more detail of precisely what that involved. Then if there are specific questions, those could be directed to you today.

WITNESS BROUGHTON: With respect to the testimony that I am sponsoring, I prepared the bulk of that testimony, based on input I got from Mr. Wilson. Mr. Wilson and Mr. Slear were co-sponsors.

The issue addresses the test program for the reactor once it goes to power, and my responsibilities to GPU Nuclear involve how the plant performs as a unit in such cases as powering the operation.

MS. BURKLEY: And that responsibility is broader than the issue of the steam generator itself?

WITNESS BROUGHTON: Yes. My total responsibilities go beyond the activities of the steam generator repair process,

1 and I did provide support to the steam generator repair
2 activities in conjunction with my other responsibilities.
3 MS. BURKLEY: Are you familiar with the licensee's
4 testimony of Richard F. Wilson, David G. Slear and T. Gary
5 Broughton on issue 1.c, contention 1.a?
6 WITNESS BROUGHTON: Yes, I am.
7 MS. BURKLEY: Are there any changes or correc-
8 tions you would like to make to that testimony?
9 WITNESS BROUGHTON: No, there are not.
10 MS. BURKLEY: Do you adopt this testimony as
11 your testimony in this proceeding?
12 WITNESS BROUGHTON: Yes, I do.
13 MS. BURKLEY: Mr. Wilson, are you familiar with
14 licensee's testimony of Richard F. Wilson, David G. Slear and
15 T. Gary Broughton on issue 1.c, contention 1.a?
16 WITNESS WILSON: Yes, I am.
17 MS. BURKLEY: Are there any changes or correc-
18 tions you would like to make to that testimony at this time?
19 WITNESS WILSON: No, there are no changes.
20 MS. BURKLEY: Do you adopt this testimony as your
21 testimony in this proceeding?
22 MS. BURKLEY: Yes, I do.
23 MS. BURKLEY: Mr. Slear, are you familiar with
24 the licensee's testimony of Richard F. Wilson, David G. Slear
25 and T. Gary Broughton on issue 1.c, contention 1.a?

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WITNESS SLEAR: Yes, I am familiar with that testimony.

MS. BURKLEY: Are there any changes or corrections you would like to make to the testimony?

WITNESS SLEAR: There are no changes or corrections I would like to make.

MS. BURKLEY: Do you adopt this testimony as your testimony in this proceeding?

WITNESS SLEAR: Yes, I do.

MS. BURKLEY: Your Honor, I would request at this time that licensee's testimony of Richard F. Wilson, David G. Slear and T. Gary Broughton on issue 1.c, contention 1.a be incorporated into the record as if read here today.

JUDGE WOLFE: Is there any objection?

MS. BRADFORD: No objections.

JUDGE WOLFE: Hearing none, the described testimony is incorporated into the record as if read.

MS. BURKLEY: Thank you, Your Honor.

(Whereupon, the licensee's testimony of Richard F. Wilson, David G. Slear and T. Gary Broughton on issue 1.c, contention 1.a follows:)

June 29, 1984

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

Before the Atomic Safety and Licensing Board

In the Matter of	)	
	)	
METROPOLITAN EDISON COMPANY, ET AL.	)	Docket No. 50-289-OLA
	)	ASLBP 83-491-04-OLA
(Three Mile Island Nuclear	)	(Steam Generator Repair)
Station, Unit No. 1)	)	

LICENSEE'S TESTIMONY OF RICHARD F. WILSON,
DAVID G. SLEAR AND T. GARY BROUGHTON
ON ISSUE 1.c (CONTENTION 1.a)

To Mr. Wilson:

Q1. Please state your name and address, and describe your involvement with the TMI-1 steam generator tube repair program.

A1. My name is Richard F. Wilson. I am employed by GPU Nuclear Corporation, 100 Interpace Parkway, Parsippany, New Jersey 07054. As the Vice President of Technical Functions, I was responsible for the overall project and technical management of the TMI-1 steam generator tube repair program.

A statement of my professional qualifications is attached.

To Mr. Slear:

Q2. Please state your name and address, and describe your involvement with the TMI-1 steam generator tube repair program.

A2. My name is David G. Slear. I am employed by GPU Nuclear Corporation, 100 Interpace Parkway, Parsippany, New Jersey 07054. As the Manager of Engineering Projects for TMI-1, I was the overall task manager for the TMI-1 steam generator tube repair program reporting directly to the Vice President of Technical Functions. My responsibilities included all activities associated with the evaluation and repair of the steam generators.

A statement of my professional qualifications is attached.

To Mr. Broughton:

Q3. Please state your name and address, and describe your involvement with the TMI-1 steam generator repair program.

A3. My name is T. Gary Broughton. I am employed by GPU Nuclear Corporation, 100 Interpace Parkway, Parsippany, New Jersey 07054. As Director of Systems Engineering, I was responsible for providing support to the steam generator tube repair program primarily in the area of plant performance.

A statement of my professional qualifications is attached.

To all witnesses:

Q4. What is the purpose of your testimony?

A4. The purpose of this testimony is to address Issue 1.c of Contention 1.a as enumerated at page 23 of the Board's Memorandum and Order (Rulings on Motions for Summary Disposition, dated June 1, 1984), in which the Licensing Board stated:

1. The rationale underlying certain proposed license conditions should be addressed, with attention to:

* * * *

c. Method of determining power ascension limitations.

Q5. How were the power ascension limitations determined, and how do those limitations relate to the repair of the steam generators?

A5. In addressing the bases for determining those power ascension limitations which relate to the steam generator repair, it is useful to summarize the power ascension/post-critical test program, indicate the reason for including specific tests in the program, and describe the rationale for those limitations.

The proposed license condition concerning power ascension limitations is set forth as condition B.3. in the SER, Supplement 1, at 27:

> GPU Nuclear Corporation shall complete the post-critical test program at each power range (0-5%, 5-50%, 50-100%) in conformance with the program described in Topical Report 008, Rev. 3, and shall have available the results of that test program and a summary of its management review prior to ascension from each power range and prior to normal power operation.

As indicated in the proposed license condition, the post-critical test program (described in TR-008, Rev. 3, Appendix A, Section III) consists of three major phases: 0-5% power, 5-50% power and 50-100% power. Testing related to the steam generator repair will be performed during the three stages as follows:

Low Power Testing

During the first stage, natural circulation testing will be performed to verify the tuning of the integrated control system to maintain preset steam generator levels under loss of main feedwater and natural circulation conditions, and proper response of the emergency feedwater (EFW) system.

Escalation to 50% Power

Testing at this stage will include loss of feedwater tests and a reactor coolant system (RCS) overcooling control test.

Escalation to 100% Power

A variety of tests will be performed during this period, including the 100% turbine-generator trip.

The initial power ascension program was developed, prior to knowledge of the damage to the steam generators, by considering test requirements as a result of core reload, plant modifications made since the plant was last operated, and operator training requirements. These considerations resulted in a testing sequence, power level plateaus and development of special tests for plant modifications and operator training. Primary factors in determining the test sequence and plateaus included verification that core physics parameters are as predicted and that nuclear instruments, the integrated control system and the turbine protective system are calibrated and functioning properly.

In conjunction with the steam generator tube repair program, special pre-critical tests were developed to demonstrate steam generator operability, including drip tests, bubble

tests, normal and accelerated cooldowns (with their transient loads) and long periods of steady state leakage monitoring. These tests have now been performed and evaluated. The results confirmed the adequacy of the repair process and the operability of the steam generators.

Additionally, the power ascension/post-critical testing program described above was reviewed for its effect on the steam generators. Because the pre-critical testing verified the adequacy of the repair and the operability of the steam generators, no additional tests were needed in the post-critical test program because of the repair. It was determined, however, that two 30-day hold periods should be added to the power ascension program. This slow progression from power level to power level has several purposes:

1. To facilitate monitoring leak rate changes, especially after load-inducing transients, which will provide information on the condition of the kinetically expanded joints.

2. To detect abnormal trends as early in the program as possible.

3. To slowly increase plant power and operating history to aid in mitigation of unplanned events.

4. To gain additional experience in operating the plant with systems in normal line-ups.

The first hold period will occur at 48% power following the RCS overcooling test. This point was chosen because it immediately follows tests which load the steam generator tubes (loss of feedwater and RCS overcooling) and because it allows

operation with two main feed pumps which is the normal plant configuration. The second hold point follows testing at the 75% power plateau. Leak rate monitoring, surveillance testing and operator familiarity will occur during this hold period. Experience from the steam generator pre-critical tests corroborated that 30-day hold periods would provide adequate time for stabilizing the plant and collecting statistically valid data.

Management reviews are scheduled prior to power increases following the 48% power hold period and the 100% turbine trip test. The purpose of these reviews is to assure management that the people, plant, facilities and procedures are in a state of readiness such that the plant can be safely operated at the next power plateau. These reviews also provide management the opportunity to review all open items at that time that may have potential impact on power operations.

Q6. Are Licensee's power ascension limitations in accordance with the recommendations of the Third Party Review (TPR) Group?

A6. Yes. In its February 18, 1983 report, the TPR recommended that:

> GPU Nuclear should consider substantially extended operation at low power during a slow and deliberate power escalation the first time the plant goes critical. Although we do not have an analytical basis for a specific duration, a hold period of perhaps a month or more at 40 percent power should be considered before the Loss of Feedwater/Turbine Trip test is performed. This might be followed by another month or more at 70 percent power before final escalation to 100 percent power.

Att. 6 to the Staff's SER, TPR February 1983 Report at 11-12, Recommendation 2.

In accordance with the TPR's recommendations and its own evaluation of the power ascension program in light of the repair, Licensee determined to modify the power ascension program to add two 30-day hold periods, one at 48% power and one at 75% power. In its May 16, 1983 report, the TPR stated that "[t]he GPU Nuclear response is satisfactory." Att. 6 to the Staff's SER, TPR May 1983 Report at 7.

The TPR also recommended that Licensee "consider the possibility of deliberately running one steam generator at a higher power than the other during the first escalation hold periods." Att. 6 to the Staff's SER, TPR February 1983 Report at 12, Recommendation 3. The TPR recognized, however, that this recommendation "may involve other operating considerations which would have to be weighed before a decision could be made." Ibid.

Licensee explained to the TPR that significant operating considerations rendered this suggested approach infeasible and imprudent. In particular, the mismatch can only be implemented by operation of a single reactor coolant pump in one loop which would cause mismatched reactor coolant system flow, imbalanced feed flows and different coolant levels in each generator. This could mask changes in the plant conditions, including any abnormalities in the plant response to transients. This abnormal plant configuration would conflict with the intent of

conducting the startup in a slow, deliberate manner under normal operating conditions.

In response to Licensee's explanation, the TPR stated that "[t]he GPU Nuclear response is satisfactory." Att. 6 to the Staff's SER, TPR May 16, 1983 Report at 7.

PROFESSIONAL QUALIFICATIONS

Richard F. Wilson
Vice President, Technical Functions
GPU Nuclear Corporation

GPU Experience:

Technical responsibility for the Engineering, Design, Licensing and Technical Support of all nuclear generating stations for the GPU System. The position manages the technical resources of GPU Nuclear including day-to-day support for plant operations.

Previously was Acting Director for TMI-2 from September, 1979, to about March, 1980, and before that was Director of the Engineering and Quality Assurance Departments within the GPU Service Corporation. Between 1975 and 1977, was Manager of Quality Assurance for the GPU Service Corporation with responsibilities for design and construction Quality Assurance.

Other Experience:

Prior work experience included two years (1973-1975) as Manager of Manufacturing Engineering for Offshore Power Systems, Jacksonville, Florida. Responsibilities included activities associated with manufacturing planning, tooling, industrial engineering, manufacturing engineering, and technical support to the planned manufacturing facility. Prior to joining Offshore Power Systems, held a number of positions at the Atomic International Division of Rockwell International, 1954 to 1973. Some of these positions included Engineering Supervisor, Department Manager, Chief Project Engineer, Program Manager, and Chief Program Engineer on a wide variety of Atomic International programs. The last position was Program Manager for the Atomic International work on the fast breeder program. Performed and supervised work in almost every facet of reactor engineering, physics, facility design, safety, reactor operations, etc.

Committee affiliations have included the EEI QA Task Force, the AIF Committee on Power Plant Design, Construction and Operation, B&W Plant Owners and BWR Owners Groups, EPRI Nuclear Divisional Committee, etc. Outside the utility industry has served on a number of company and company/government advisory groups as related to specific programs.

Education and training includes a B.S. degree in Mechanical Engineering, University of California at Berkeley, 1951; an M.S. degree in Mechanical Engineering, University of Michigan, 1953; and one year attendance at the former Oak Ridge School of Reactor Technology in 1954. Has attended a large number of management and other courses, including the University of Michigan Public Utility Executive Program.

PROFESSIONAL QUALIFICATIONS

DAVID G. SLEAR

WORK EXPERIENCE

Company: GPU Nuclear Corporation

Title: TMI-1 Manager Engineering Projects

Responsibilities: Management of TMI-1 modification, which entails: Management of the $25 million annual budget allocated for plant modification; prioritization of the various phases of plant modification; oversight of the technical adequacy of plant modification and of the components involved in plant modification; consultation regarding problem resolution with respect to matters concerning plant modification; and direct supervision of 16 GPU employees. This position demands constant attention to long term and daily plant modification concerns and an extremely firm grasp of both the technical aspects of TMI-Unit 1 and of the various modes and components of modification available for implementation at TMI-Unit 1.

Dates: 1983 - Present

Company: GPU Nuclear Corporation

Title: OTSG Repair Project Manager

Responsibilities: Management (in conjunction with individual task managers) of all aspects of the OTSG Recovery program at TMI-1 including failure analysis, eddy current testing, corrosion testing, RCS examination, RCS sulfer cleanups, and plant performance analysis. This position involved direct management of the OTSG repair process and personal involvement in the decision making process with respect to the repair program. This position also entailed the definition and implementation of the overall project, and required a broad overview and analysis of the OTSG Recovery program. In his capacity as OTSG Repair Project Manager, Mr. Slear was also called

upon to deliver numerous presentations concerning project details before the NRC, ACRS, TPR, and the GPU Nuclear Corp. management.

Dates: December 1981 - November 1983

Company: GPU Service Corporation

Title: TMI-1 Manager Engineering Projects

Responsibilities: Similar to those listed for Mr. Slear's present position including management of a $20 million budget and of project engineering for modifications.

Dates: 1979 - 1981

Company: GPU Service Corporation

Title: Preliminary Engineering Manager

Responsibilities: This position entailed: the analysis and preliminary design of 400 Megawatt combustion turbines and of a 600 Megawatt coal fired power plant; extensive analysis of the reliability and availability of the components to be installed in the prospective power plant; and the establishment of a baseline criteria document for the designated plants including the technical documentation and presentation of the plant design for management review.

Dates: 1978 - 1979

Company: GPU Service Corporation

Title: Component Engineer

Responsibilities: This position entailed: the review of design specifications and technical details of products going into TMI-2, including the steam generators, pressurizer, main

condensors, cooling towers, reactor vessel, and internals; technical consultation and analysis of problems; and review of the contractor's design work on new components going into a plant.

UNITED STATES NAVY NUCLEAR SUBMARINE FORCE OFFICER

Title: Engineer Officer

Responsibilities: This position entailed: essentially primary responsibility and control of the onboard nuclear power plant; control of all engineering sections, command of 4 divisions; and supervision of approximately 55 crewmen.

Dates: 1972 - 1974

Title: Machinery Division Officer

Responsibilities: As Machinery Division Officer, Mr. Slear was responsible for: all mechanical components of the primary and secondary systems of the power plant including the steam generator, reactor, and drive controls; chemistry control of the primary and secondary systems; and the supervision of 15 crewmen. Mr. Slear also served as an Auxiliary Division Officer in charge of non-nuclear life support systems, and as a Communications Division Officer.

Dates: 1968 - 1972

Mr. Slear also attended the Nuclear Power Submarine School from 1966 - 1968, during which time he obtained one year of nuclear power plant training (6 months classroom, 6 months actual plant training) in addition to the submarine qualification program.

EDUCATION

College: University of Oklahoma

Degree: B.S. Mechanical Engineering

Dates: 1961 - 1966

College: Stevens Institute of Technology

Degree: M.S. Mechanical Engineering

Dates: 1974 - 1978

PROFESSIONAL QUALIFICATIONS

T. GARY BROUGHTON

Business Address: GPU Service Corporation
100 Interpace Parkway
Parsippany, New Jersey 07054

Education: B.A., Mathematics, Dartmouth College, 1966.

Experience: Director Systems Engineering, GPU Nuclear Corporation, November 1982 to Present. Responsible for Systems Engineering Department activities including: operating experience assessment, operating plant shift technical advisors, nuclear fuels, integrated plant analysis, risk and reliability assessment, human engineering and process computers.

Systems Analysis Director, GPU Nuclear Corporation, 1981-1982.
Responsible for human engineering, control and safety analysis, operating experience review and operating plant shift technical advisors.

Control and Safety Analysis Manager, GPU Service Corporation, 1978 to 1981.
Responsible for nuclear safety analysis and integrated thermal, hydraulic and control system analysis of nuclear and fossil plants. Supervised on-site technical support groups at Three Mile Island, Unit 2 during the post-accident period.

Safety and Licensing Engineer, Safety and Licensing Manager, GPU Service Corporation, 1976-1978. Performed and supervised nuclear licensing, environmental licensing and safety analysis for Oyster Creek, Three Mile Island and Forked River plants. Served as Technical Secretary to Oyster Creek and Three Mile Island General Office Review Boards.

Officer, U.S. Navy, 1966 to 1976.
Trained at Naval Nuclear Power School, Prototype and Submarine School. Positions held include Nuclear Propulsion Plant Watch Supervisor, Instructor at D1G prototype plant and Engineering Officer aboard a fast-attack nuclear submarine.

Publications:

EPRI CCM-5, RETRAN - A Program for One-Dimensional Transient Thermal-Hydraulic Analyses of Complex Fluid Flow Systems, Volume 4: Applications, December 1978, Section 6.1, "Analysis of Rapid Cooldown Transient - Three Mile Island Unit 2", With N.G. Trikouros and J. F. Harrison.

"The Use of RETRAN to Evaluate Alternate Accident Scenarios at TMI-2", with N. G. Trikouros. Proceeding of the ANS/ENS Topical Meeting on Thermal Reactor Safety, April 1980, CONF-800403.

"A Real-Time Method for Analyzing Nuclear Power Plant Transients", with P. S. Walsh. ANS Transactions, Volume 34 TANSAD 34 1-899 (1980).

1 MS. BURKLEY: Mr. Giacobbe, are you familiar with
2 the licensee's testimony of Don K. Croneberger and F. Scott
3 Giacobbe on issue 1.d, contention 1.a?
4 WITNESS GIACOBBE: Yes, I am.
5 MS. BURKLEY: Are there any changes or correc-
6 tion you would like to make to that testimony?
7 WITNESS GIACOBBE: No, there are not.
8 MS. BURKLEY: Do you adopt this testimony as
9 your testimony in this proceeding?
10 WITNESS GIACOBBE: Yes, I do.
11 MS. BURKLEY: Mr. Croneberger, are you familiar
12 with licensee's testimony of Don K. Croneberger and F. Scott
13 Giacobbe on issue 1.d, contention 1.a?
14 WITNESS CRONEBERGER: Yes, I am.
15 MS. BURKLEY: Are there any changes or correc-
16 tions you would like to make to that testimony?
17 WITNESS CRONEBERGER: No, there are not.
18 MS. BURKLEY: Do you adopt this testimony as your
19 testimony in this proceeding?
20 WITNESS CRONEBERGER: Yes, I do.
21 MS. BURKLEY: Your Honor, I would ask that
22 licensee's testimony of Don K. Croneberger and F. Scott Giacobbe
23 on issue 1.d, contention 1.a be incorporated into the record
24 as if read here today.
25 JUDGE WOLFE: If there are no objections.

MS. WAGNER: No objections.

JUDGE WOLFE: Hearing none, the described direct testimony will be incorporated into the record as if read.

(Whereupon, the licensee's testimony of Don K. Croneberger and F. Scott Giacobbe on issue 1.d, contention 1.a follows:)

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

Before the Atomic Safety and Licensing Board

In the Matter of	)	
	)	
METROPOLITAN EDISON COMPANY, ET AL.	)	Docket No. 50-289-OLA
	)	ASLBP 83-491-04-OLA
(Three Mile Island Nuclear	)	(Steam Generator Repair)
Station, Unit No. 1)	)	

LICENSEE'S TESTIMONY OF DON K. CRONEBERGER AND
F. SCOTT GIACOBBE ON ISSUE 1.d (CONTENTION 1.a)

To Mr. Croneberger:

Q1. Please state your name and address and describe your involvement with the TMI-1 steam generator tube repair program.

A2. My name is Don K. Croneberger. I am employed by GPU Nuclear Corporation, 100 Interpace Parkway, Parsippany, New Jersey 07054. As the director of Engineering and Design, I provided technical management oversight of the failure analysis and repair activities, with special emphasis on evaluation of the steam generator's mechanical design and the impact of the repair on the response of the components. My department also provided engineering support in the areas of Materials Engineering/Failure Analysis, Chemical Engineering and Chemistry, Mechanical Engineering and Engineering Mechanics.

A statement of my professional qualifications is attached.

To Mr. Giacobbe:

Q2. Please state your name and address, and describe your involvement with the TMI-1 steam generator tube repair program.

A2. My name is F. Scott Giacobbe. I am employed by GPU Nuclear Corporation, P.O. Box 1018, Reading, Pennsylvania 19603. As Manager of Materials Engineering/Failure Analysis, I have been involved in the planning and management of the failure analysis activities, corrosion testing programs, materials evaluation and tube sampling and removal programs associated with the steam generator tube repair program.

A statement of my professional qualifications is attached.

To all witnesses:

Q3. What is the purpose of your testimony?

A3. The purpose of this testimony is to address Issue 1.d of Contention 1.a as enumerated at page 23 of the Board's Memorandum and Order (Rulings on Motions for Summary Disposition, dated June 1, 1984), in which the Licensing Board stated:

> 1. The rationale underlying certain proposed license conditions should be addressed, with attention to:
>
> *****
>
> d. Adequacy of simulation of operating conditions by long-term corrosion tests.

Q4. What was the purpose of the long term corrosion test program?

A4. The purpose of the long term corrosion test program, the operations phase of which has now been completed, is to

verify that sulfur-induced intergranular stress-assisted cracking (IGSAC) will not reinitiate or propagate in the TMI-1 OTSGs under actual operating conditions. The tests were designed to confirm that the metallurgical, environmental, geometric and surface conditions which exist after the repair of the tubes are not detrimental to tube integrity. From the test program it will be possible to conclude whether or not the proposed chemistry limits are acceptable, whether the peroxide cleaning itself was beneficial or damaging, and, more importantly, whether the changes in electrochemical potential during operations will cause reinitiation of corrosion.

The long term corrosion tests are accordingly related to the kinetic expansion repair process, but only insofar as they verify that the repair did not render the OTSGs susceptible to reinitiation of IGSAC. (This is tested by including kinetically expanded tube samples in the test loops.) Except in this one respect, the long term corrosion tests have no relationship to the adequacy of the kinetically expanded joint. The tests were <u>not</u> designed to confirm that Licensee has provided reasonable assurance against the possibility of mechanically induced tube ruptures caused by various transients, as alleged by Contention 1.a, and, in fact, the tests provide no information one way or the other on this subject.

Q5. Did the tests adequately simulate operating conditions so as to provide reasonable assurance that corrosion will not reinitiate?

A5. Yes. The long term corrosion test program includes tests which closely simulate the typical operating environment of the steam generator tubing during steady state and transient conditions. This program will enable Licensee to predict the performance of actual TMI-1 tubes in the steam generators prior to return to operation. The program also includes comparative tests which closely simulate OTSG operation but use tubes with high residual sulfur levels (non-peroxide cleaned) and expose the tube samples to the contaminant which originally caused the IGSAC damage (thiosulfate). All tests simulated "worst case" chemistry conditions for controlled contaminants (within chemistry specification limits) in order to conservatively address the parameters known to influence stress assisted cracking.

In establishing operating parameters, to simulate both hot functional testing (HFT) and subsequent operation, time periods were chosen of approximately 40 days for the HFT cycle and 66 days for each of the six heatup/cooldown cycles expected in a year of operation. The test loops are once-through in design, with primary coolant water chemistry flowing on the inside of the tubes, just as in the OTSGs. The test cycles allowed for periodic examination of test specimens to monitor for evidence of corrosion damage.

All six heatup/cooldown cycles have been completed. Final metallographic examinations of test specimens are now in

progress. This program will enable Licensee to predict the performance of actual TMI-1 tubes in the steam generators prior to return to operation.

TEST PARAMETERS

The tests reproduced all the parameters which influence IGSAC, i.e., susceptible material, environment, and stress.

Susceptible Material

To assure that the influence of prior operation and layup on tubing was adequately represented, only tube sections removed from the TMI-1 steam generators were used as specimens. These specimens were selected from various regions of each OTSG including tube sections which had known defects. The use of actual OTSG tubes precluded any possibility that test specimens would not duplicate exactly the TMI-1 material.

The specific tube sections for the long term corrosion test were selected from tubes that had been previously removed from the steam generators for use in the failure analyses. Within the available material, the tube sections were selected to provide a maximum range of properties. These included:

1) Chemistry - test specimens were selected from representative heats of material removed from the generator. This provided a range of chemistry typical of most steam generator tubes.

2) Mechanical Properties - yield strengths of the specimens spanned the range of those tubes present in the steam generators.

3) Material susceptibility - specimens for testing were selected from tubes which displayed various levels of susceptibility to corrosion damage. Some came from tubes

with no defects and others from tubes with up to eight indications.

The test samples also contain a representative sample of tubes from various axial locations within each steam generator. The largest portion of the samples are from the upper tubesheet area, which contained the most defects. There are also samples from the lower face of the upper tubesheet, 15th tube span, and 9th tube support plate areas.

Subsequently, certain of the samples were subjected to the explosive expansion process using mockup tube sheets and then subjected to a peroxide cleaning process. This ensured that the influence of these processes on the inside surface condition was produced. Certain other samples were not peroxide cleaned, in order to test what could occur if Licensee had not undertaken the cleaning process, given the larger quantities of residual sulfur that would have remained on the tube surfaces.

C-ring samples made from actual TMI-1 tubes were also included in the test program. These samples provided a means for metallographically examining test specimens during the testing phase to look for any microstructural changes or incipient cracking.

Environment

Environmental chemistry parameters were selected to either simulate, or be more aggressive than, the water chemistry which will be maintained in the RCS. In three of the four test loops, 100 ppb of sulfate, the maximum permitted under

chemistry specifications, was used. In the fourth test loop, 100 ppb thiosulfate was put in solution. In addition, to ensure adequate conservatism, the levels of chloride and fluoride were set at the maximum amount permitted by Licensee's operating chemistry specifications (100 ppb each).

Because the testing and operation of the plant necessitates heating up and cooling down of the steam generators, the tests included typical temperature cycles. Temperatures were raised from ambient temperature to the normal operating temperature of approximately 600°F. Temperatures were held constant at operating temperature to assess any high temperature corrosion phenomenon. Periodically, the tests were cycled between 600°F and 500°F to simulate unit load changes.

The test loops were also subjected to cooldown cycles, some of which included the introduction of oxygen (as would occur when the RCS was open for inspection) and some of which did not (as would occur during normal shutdown). These cycles provided the most rigorous test sequence in view of the fact that primary-side sulfur corrosion is a low temperature phenomenon in which oxygen has a major influence.

Each HFT or operating cycle included a hold step for a minimum of one week in which the loop was aerated and maintained at a temperature between 130° and 150°F. This portion of the cycle simulated the aeration-temperature conditions which existed during the propagation of the original sulfur-induced IGSAC.

Stress

During heatup, operation, and cooldown, tubes in the actual OTSG undergo changes in stress. A net axial tensile stress could exist in the tubes during cold shutdown and steady state operation. The stress is reduced during heatup and increased during cooldown due to differential thermal expansion effects.

In order to simulate the changes in axial load, full tube specimens were loaded at a level corresponding to steady state loads during heatup, cold shutdown, and operation. During cooldown, the loads were increased to approximate the maximum allowed cooldown rate.

Residual stresses induced by the explosive expansion are also a source of loads on the tubes. Therefore, full tube specimens simulating repaired joints were kinetically expanded using the same process as in the actual steam generators to ensure representative residual stresses. These specimens were also exposed to the axial loads described above so that the worst case combination of loads was tested.

The C-ring specimens were intended to give an early indication of possible problems. Therefore, they were loaded to a level just slightly below yield, which is significantly higher than the load seen by the tubes in actual service. This would make them more susceptible to IGSAC than are the actual OTSG tubes.

SUMMARY

The long term corrosion test program includes tests which provide a valid simulation of the conditions that the OTSG tubing will experience in future TMI-1 operations. For comparison, tests have also been included which simulate what could occur if Licensee had not taken the corrective measures of peroxide cleaning and removal of possible sources of thiosulfate. Parameters known to influence corrosion and more specifically IGSAC were reproduced to the greatest extent possible. This test program provides a clear basis for empirically evaluating steam generator tube performance over approximately a one year period.

PROFESSIONAL QUALIFICATIONS

Don K. Croneberger
Director - Engineering & Design
GPU Nuclear Corporation

GPU Experience:

Technical responsibility for the Mechanical, Electrical, Civil/Structural, Chemical, Radwaste and Materials Engineering support for all nuclear generating stations for the GPU Systems.

1978 to 1980 was Manager - Design and later Manager - Engineering & Design with GPU Service Corporation. Directed design engineering activities for all nuclear and fossil power generating facilities and modifications assigned to GPUSC.

Other Experience:

Prior work experience included a number of positions at Gilbert/Commonwealth during the period 1963 to 1978. The last position was Manager Structural Engineering. It included technical responsibility for structural engineering mechanics for all nuclear and fossil generating facilities. Some of the other positions included Project Manager for balance of plant studies for a liquid metal fast breeder reactor demonstration plant. Other positions as Project Structural Engineer included responsibility for technical supervision of structural engineering and engineering mechanics for a number of domestic nuclear power plants. Earlier experience with the U.S. Navy included engineering and construction of radio telescope and ancillary experience.

Industry affiliations have included the EPRI Steam Generator Owners Group, ASME Section 3 Division 2 (former Chairman) and other industry nuclear standards activities including Nuclear Structures and Plant Design Against Missiles.

Education and training includes a B.S. degree in Civil Engineering from Pennsylvania State University, 1959. Other technical training includes courses at U.C.L.A., M.I.T. and the University of Michigan.

I have been involved in the Steam Generator tube failure issue from the beginning. I provided technical management oversight of failure analysis and repair activities. Special emphasis was placed on understanding the mechanical design of the Steam Generators and applying that understanding to the repair program and the understanding of the impact of the repair on the response of the components.

My department provided engineering support in the areas of Materials Engineering/Failure Analysis, Chemical Engineering and Chemistry, Mechanical Engineering and Engineering Mechanics.

STATEMENT OF QUALIFICATIONS AND EXPERIENCE

F. SCOTT GIACOBBE

I, F. Scott Giacobbe, am employed by General Public Utilities Nuclear Corporation as Manager, Materials Engineering/Failure Analysis. I have been in this position since July of 1982.

My education includes a Bachelor's Degree in Mechanical Engineering from Villanova University in 1970 and a Master's Degree in Materials Engineering from Drexel University in 1975.

My work experience has provided me many years of direct involvement in the materials evaluation and failure analysis of power plant components; early in my career it also provided a very intense involvement in heat exchanger tubing evaluations.

In 1970, I began my employment with Westinghouse Electric Corporation in their Heat Transfer Division as a Materials Engineer. In this position I worked on the materials selection, corrosion evaluations and failure analysis of heat exchanger components such as feedwater heaters, condensors, radioactive waste evaporators and other secondary side heat exchangers. In particular, I was responsible for assuring that tubing utilized in the Westinghouse heat exchangers was properly specified and manufactured. This function provided me with in-depth knowledge of heat exchanger tubing fabrication practices, corrosion resistant properties and failure mechanisms.

In 1977 I left Westinghouse to join General Public Utilities as a Senior Engineer in their metallurgical laboratory. This position afforded me the opportunity to expand my areas of expertise to include materials selection, corrosion evaluation and failure analysis of other components of both nuclear and fossil power plants, and to gain a broader understanding of power plant operation.

In 1978 I was promoted to supervisor of the metallurgical laboratory. This was a first line supervising position which gave me the responsibility for the daily operation of the laboratory and supervision of the technicians and engineers reporting to me. This position also carried with it a large technical responsibility which kept me heavily involved in the day-to-day materials engineering problems.

My career took on a slight change in direction in 1980 when the company reorganized and formed the Nuclear Corporation. At that time I became Materials and Welding Manager in the Nuclear Assurance Division. With this position I essentially had the same functions as before, with the added responsibility for welding at the nuclear power stations. While in this position I was responsible for the technical and metallurgical aspects of the development of the Nuclear Corporation welding program. During this time I was still supervising all failure analysis activities, including the TMI spent fuel pool pipe cracking incident.

In July 1982, another reorganization took place. At this time my section merged with the materials engineering section in the Technical Functions Division and I took over management of that newly formed section. In this position I now had functional responsibility for the materials configuration control of both GPU nuclear power plants as well as welding engineering and failure analysis. In addition, my section still provided failure analysis services to the fossil companies.

I have been involved in the steam generator tube failure issue from the beginning. I participated directly in the initial decision-making regarding the tube sampling and removal operations and was present to perform the initial visual evaluations of the removed tubing. I personally planned and oversaw the failure analysis activities performed by the outside laboratories. I also developed the corrosion testing programs which GPUN implemented to gain insight and understanding into the failure mechanism and responsible corrodants. It was also my responsibility to coordinate the input from all our technical consultants as well as plant experience and formulate the current failure scenario.

During the steam generator repair, my section also provided materials evaluation and consultation on all aspects of the repair including explosive expansion, flushing, peroxide cleaning, and so forth. My section also developed and implemented the long term corrosion testing program and is evaluating the results as the testing progresses.

Lastly, during the course of the steam generator repairs, I was responsible for making all presentations to the NRC on corrosion testing and failure analysis activities.

Over the years I have kept fully abreast with the state-of-the-art in corrosion technology through my attendance and participation in technical seminars and conferences, and through attending training sessions. I am a member of the Edison Electric Institute Materials, Piping, Welding and Corrosion Task Force, a group of industry representatives who meet to share and develop solutions to corrosion problems in the field of materials and welding in the power industry. In addition, I am a member of the American Society for Metals.

Publications

1. F. S. Giacobbe, "Examination, Evaluation and Repair of Stress Corrosion Cracking in a PWR Borated Water Piping System", NACE Corrosion 81.

2. F. S. Giacobbe, J.D. Jones, R. L. Long, D. G. Slear, "Repairs of TMI-1 OTSG Tube Failures" Plant/Operations Progress AICHE, July 1983, Vol. 2, No. 3.

MS. BURKLEY: Your Honor, this completes our direct examination with respect to issues 1.a, 1.b, 1.c and 1.d.

JUDGE WOLFE: Are the witnesses now to be turned for cross-examination?

MR. CHURCHILL: Yes, sir.

JUDGE WOLFE: Miss Bradford?

CROSS-EXAMINATION

MS. BRADFORD: Good morning, gentlemen. My name is Louise Bradford, and I represent TMIA in this proceeding.

Can you tell me on the eddy current testing method that you have used, have you had a good correlation with what you later found in your metal crack testing?

MR. CHURCHILL: Objection, Your Honor. I don't see any issue like that. Perhaps we need clarification of what issues these gentlemen testified to that she is cross-examining on.

MS. BRADFORD: This is the reliability of leak measurements.

MR. CHURCHILL: I'm not sure that I understand how a question on eddy current relates to a question on leak rate measurements.

MS. BRADFORD: I understand that you used the eddy current test to ascertain where there are cracks and other things.

JUDGE WOLFE: Is that a question?

Are you withdrawing your initial question and you are laying some foundation; is that correct, Miss Bradford?

MS. BRADFORD: That's correct, Judge Wolfe.

JUDCE WOLFE: Is there any objection to that question?

(No response.)

JUDGE WOLFE: You may answer the question.

WITNESS GIACOBBE: Could I have the question again?

WITNESS SLEAR: Could you repeat the question; I'm not sure I understand.

MS. BRADFORD: I understand that you rely on your eddy current testing methods to determine if you have cracks in the steam generator tubes, or pre-critical cracks; is that correct?

WITNESS SLEAR: Any eddy current testing --

JUDGE WOLFE: Just a moment. Isn't that the initial question you objected to, Mr. Churchill?

I thought the question that was being posed was: did you use eddy current testing for the purpose of leak rate measurements?

Now, let's get this act together. That is the question I thought you were putting to the witnesses. There was an objection to your first question.

1 Now, what is your question?

2 MS. BRADFORD: I wanted to know --

3 JUDGE WOLFE: There was an objection to your

4 first question. I understood that you withdrew it, and you

5 were going to ask a foundation question, and wasn't your

6 foundation question to the effect: did you not use eddy current

7 testing for the purposes of leak rate measurements? Wasn't

8 that your question?

9 MS. BRADFORD: No, Judge Wolfe.

10 JUDGE WOLFE: Let's have that question read

11 back as Miss Bradford posed it.

12 (Whereupon, the reporter read from the record

13 as requested.)

14 JUDGE WOLFE: If there is no objection to that

15 question, we will proceed.

16 MR. CHURCHILL: Your Honor, I confess to some

17 confusion how on the question. My first objection, I think,

18 probably goes to everything I've heard here today in that I

19 don't know what relationship Ms. Bradford's question on the

20 eddy current has to this testimony. The testimony is on the

21 reliability of leak testing. We testified as to how the leak

22 test limitations were established, how leak testing is performed

23 and how reliable it is.

24 I would object to these questions on eddy current

25 unless it can be established how that relates to the testimony

p17

1 on the reliability of leak testing.

2 MS. WAGNER: The staff as well objects to

3 Miss Bradford's question on the same grounds. I don't see

4 the relationship of this to any portion of contention 1.a.

5 JUDGE WOLFE: We are dealing, I take it, with

6 the initial testimony with regard to issue 1.a, contention 1.a,

7 and that relates to the reliability of leak rate measurements.

8 Now, where in this written direct testimony is

9 there any advertence to eddy current testing, or is there?

10 MS. BRADFORD: Judge Wolfe, perhaps I had better

11 start over and try again, if that's okay with you.

12 JUDGE WOLFE: Mr. Churchill, let's get something

13 clear here. Are we taking the sub-issues within contention

14 1.a concurrently now, or are we taking them sequentially?

15 MR. CHURCHILL: Your Honor --

16 JUDGE WOLFE: If these are being taken concurrent-

17 ly and these witnesses are here to answer questions across the

18 board on sub-issues 1.a, 1.b, 1.c and 1.d it would appear that

19 Ms. Bradford's question is proper. Which is it?

20 MR. CHURCHILL: Your Honor, I didn't think that

21 her first question was related to any of them, and I objected,

22 asking which issue and which part of the testimony was it

23 related to. I didn't think it was relative to that. Now,

24 there is something that is related to the eddy current test issue

25 in 1.d on the frequency of eddy current measurements, but Ms.

1 Bradford said she was not cross-examining on that issue, and
2 I'm not even sure that that question relates to the frequency.
3 I have presented these witnesses in this manner
4 so that Miss Bradford is free to cross-examine on issue 1 in
5 any order she wants. I only ask that if it is unclear to us
6 which issue she is talking about that we have some clarifica-
7 tion.
8 Now I have learned this morning that she basically
9 does intend to go sequentially. I presume that is still
10 correct. As far as I am concerned, she is free to go from
11 issue to issue.
12 I have done this for everybody's convenience
13 in the hope that it would take less time.
14 JUDGE WOLFE: All right.
15 But in any event, Miss Bradford, as I understand
16 it now, you have withdrawn the latest question; is that
17 correct?
18 MS. BRADFORD: Yes, I have.
19 Let's try again. On page 5 of your testimony
20 you state that the vast majority of 30 plants in the licensee
21 survey have leak rates similar to that of TMI-1. Would you
22 please be a little more specific on the term "similar"?
23 MR. CHURCHILL: Your Honor, excuse me.
24 Did you mean leak limits or leak rates?
25 MS. BRADFORD: I meant leak limits; excuse me.
MR. CHURCHILL: Thank you.

WITNESS SLEAR: The discussion concerning the 30 plants that we surveyed has to do with our existing tech spec 3.1.6.3, which has an overall leak limit on primary and secondary leakage of -- I believe it is one gallon per minute.

MS. BRADFORD: You say here that you surveyed 30 plants. I understand what your leak rate limit is. Since you are going to use the term "similar," do the 30 plants also have leak rate limits that are the same as yours, one gallon per minute?

WITNESS SLEAR: That is correct. The majority of the plants have that leak rate limit, the majority of the 30 plants that we sampled.

MS. BRADFORD: Did your survey determine how long the plants had operated?

WITNESS SLEAR: We know the list of plants that we surveyed and could determine how long they have operated. I think you can see from the testimony that some were recent plants and some, in fact, were older plants. We have identified the fact that some of the more recent plants have tech spec limits that are somewhat more restrictive than the one gallon per minute that we currently have.

MS. BRADFORD: Do any of the plants that you surveyed have a history similar to that of TMI-1; that is, five years of service and approximately five and one-half years of shut-down?

WITNESS SLEAR: I don't know the answer to that question. I am not familiar enough with the exact operating history of the other plants to relate their operating versus shut-down periods at TMI-1.

MS. BRADFORD: Is there any way -- you don't know if that was a question in your survey?

WITNESS SLEAR: As I say, we know the names of the plants that we surveyed, and, in fact, can answer that question by looking at the plants and then talking with somebody familiar with the operation of those specific plants, or calling the plants, themselves, to find out what their operating system is. There certainly are plants that have been shut down for a long period of time. I don't know which ones they were personally, and whether or not they are on that list.

MS. BRADFORD: Do you know if any of these plants have damage to the same extent that TMI-1 steam generators have?

WITNESS SLEAR: Once again I am not totally familiar with the extent of damage and the number of tubes plugged, and would have no way of assessing how much damage has occurred in a particular steam generator for those particular plants. I do not know.

MS. BRADFORD: To your knowledge, have any of these plants used the kinetic expansion method on their steam generators?

WITNESS SLEAR: To my knowledge, the kinetic

1 expansion method has not been used in any of the plants that
2 we surveyed in terms of repair. Some of the plants may have
3 been plants where the steam generators were manufactured with
4 the kinetic expansion process. There are steam generators in
5 service today that have been manufactured with the tubes
6 expanded using the kinetic expansion process, specifically
7 steam generators manufactured by combustion engineering.
8 Since I don't know exactly which list of plants
9 we surveyed, I can't be sure which ones of those may have been
10 combustion engineering plants.
11 MS. BRADFORD: When the kinetic expansion method
12 is used in the manufacturing process, are the tubes then
13 stress-relieved?
14 WITNESS SLEAR: No, they are not, to my knowledge.
15 MS. BRADFORD: Of the recently licensed plants
16 with the lower leak rate limits, how many of those have damage
17 in their steam generators?
18 WITNESS SLEAR: I can't answer that. I don't
19 know the answer to that.
20 MS. BRADFORD: What is the extent -- excuse me;
21 I withdraw the question.
22 Do you know if any of the plants that you surveyed
23 have had inner dimension initiated damages in their steam tubes?
24 WITNESS SLEAR: To my knowledge, the plants that
25 we surveyed did not have inside diameter defects on the steam

generator tubes.

MS. BRADFORD: Do you know if they have any steam generator damage?

WITNESS SLEAR: I would certainly anticipate that the majority of them have some degradation in their steam generator tubes.

MS. BRADFORD: But you are not prepared -- it was not a part of your survey?

WITNESS SLEAR: I'm not prepared to give you the specifics. The intent of our survey was to address the fact that the existing tech spec limit is, in fact, not a lot less restrictive than the majority of the plants in this country, and to point out the fact that the proposed license condition is as restrictive as any steam generator in this country.

MS. BRADFORD: What is the frequency of leak rate monitoring during operations at Three Mile Island?

WITNESS SLEAR: The leak rate monitoring done during power operations at Three Mile Island Unit 1 is used utilizing instruments which are continually reading out. There is a flow rate instrument that continuously gives a reading, and there is a radiation detector that continuously gives a reading.

It is required to take the data from these two instruments along with the current level of failed fuel in the reactor coolant system and calculate a leak rate on a periodic

1 basis. I believe that leak rate calculation is done once a
2 shift, which would be once every eight hours.
3 But I would point out that the instrument
4 associated with radiation detection is monitored in the control
5 room and is alarmed if in fact it increases to a point which
6 is predicted to be close to these proposed tech spec licensing
7 condtions; so that even though the calculation perhaps is done
8 once a shift, there are criteria -- well, there are instruments
9 that would alarm and alert the operator to the fact that he
10 was approaching or had reached the proposed license condition.
11 In addition, there are other criteria which would
12 result in calculating that leak rate more frequently. I would
13 have to look at the specific procedure to give you exactly
14 what the criteria are, but there are criteria that would have
15 the operator calculating the leak rate on a more frequent
16 basis.
17 MS. BRADFORD: Is this leak rate calculation
18 part of the overall reactor coolant leak rate calculation, or
19 is it a different calculation than the steam generator?
20 WITNESS SLEAR: It is a different calculation
21 than the overall reactor coolant calculation. However, I
22 believe its result is factored into the overall reactor coolant
23 leak rate calculation. Is that correct? The primary /secondary
24 leak rate number is part of the overall stress leak rate?
25 WITNESS CRONEBERGER: The RCS unidentified leak

1 rate is calculated with a method independent of that used
2 for calculating the primary/secondary leakage. The RCS-
3 identified leak rate does not use the number which is calculated
4 for the primary /secondary leak rate. They are two independent
5 methods, and the RCS-identified leak rate does not rely upon
6 the primary/secondary leak rate measurement at all.
7 MS. BRADFORD: Before I go any further with this
8 questioning, I just wanted to ask -- I neglected to ask the
9 rest of the panel. Mr. Wilson was answering solely on the
10 questions about the review of the plant.
11 You indicated that there were things you didn't
12 know, how much damage and so forth. I wonder if any of the
13 other panel members had that information.
14 WITNESS WILSON: I do not. I have not surveyed
15 individually each operating plant and ascertained the exact
16 damage or status of their generators.
17 MS. BRADFORD: Did anyone on the panel -- were
18 any of you involved in conducting the survey?
19 WITNESS SLEAR: I don't believe anyone on the
20 panel was involved in conducting the survey.
21 MS. BRADFORD: Thank you.
22 Now I am going back to your leak rate. What is
23 the margin of error for your leak rate calculation?
24 WITNESS SLEAR: I think you'll notice in the
25 testimony that we have provided that we saw a deviation as

we went through the hot test program of approximately plus or minus .5 gallons per hour.

It is a statistical deviation as opposed to -- I'm not quite sure what "margin for error" refers to, but we did see a deviation in the rate of approximately plus or minus .5 gallons per hour.

MS. BRADFORD: The reason I asked the question is I have heard about other things, that with the reactor coolant system there is a difficulty with so much inventory to obtain a gallons per minute calculation. I wonder if the same condition applied to your calculations on the steam generator.

WITNESS SLEAR: No, it does not.

MS. BRADFORD: On page 18 of the TER, which is an attachment, Attachment 6, to the SER, the 18th of February report, it is stated that, "Industry experience with" -- excuse me.

"Industry experience with high quality expanded, unwelded tubes and tubesheet joints would indicate a low probability that this leak tightness, that is one pound an hour, will be obtained in these steam generators."

Do you interpret the term "high quality" as it refers to the joint to mean an as-manufactured joint rather than a repaired joint?

WITNESS SLEAR: You are referring to page 18 of

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the Third Party Review Report?

MS. BRADFORD: Yes.

WITNESS SLEAR: Could I have it to read?

MS. BRADFORD: Yes.

(Document handed to Witness Slear by Counsel Bradford.)

(Pause.)

WITNESS SLEAR: Could you either repeat the question or ask the reporter to read it back, please?

MS. BRADFORD: Would you read that back, the last question, to the panel please?

(Whereupon, the reporter read from the record as requested.)

WITNESS SLEAR: The answer is no; I do not interpret high quality in that fashion.

MS. BRADFORD: How do you interpret the term "high quality"?

WITNESS SLEAR: High quality, in my mind, refers to a control process that is well understood with quality control to document that the process was implemented as intended.

MS. BRADFORD: But the TPR continues in that same paragraph, "Each repaired steam generator will depend upon several thousand expanded tube joints. Even if the leak tightness is initially obtained, leakage will tend to

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1 increase with future operations."

2 Do you agree with that statement?

3 WITNESS SLEAR: I think there is a possibility

4 that for some joints the leakage may increase slightly, and

5 that for other joints, as I have previously discussed, there

6 is a tendency for the leaks to seal themselves with time. In

7 the qualification program the tendency that we noted was for

8 the leakage to decrease slightly with time.

9 MS. BRADFORD: How do you explain -- any of the

10 panel -- how would you explain this sealing that occurs over

11 time?

12 WITNESS SLEAR: The sealing that occurs over

13 time, as I believe is written up in the testimony, has to do

14 with the fact that it is a long, tight crevice, and a part of

15 the crevice is a carbon steel surface, the tubesheet, and

16 part of the crevice is inconel tube, that there is a propensity

17 for carbon steel to corrode and create corrosion products, and

18 there is a possibility when you have long, very tight crevices

19 like this that the corrosion products can, in fact, block,

20 i.e., self-seal some leakage through that crevice.

21 MS. BRADFORD: Could you repeat that term that

22 you used? Are you saying long-term?

23 WITNESS SLEAR: Long, very tight crevice.

24 MS. BRADFORD: Have you reviewed industry experi-

25 ence to determine if nuclear plants using this method of repair

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that is kinetic expansion, have experienced leakage of the joints as a function of time?

WITNESS SLEAR: I am not aware of any nuclear plant steam generators that have been repaired with the kinetic expansion process. I am aware of nuclear plant steam generators which have rolled joints, which are similar to kinetic expansion in the context that there is a very tight crevice. In the case of a roll perhaps only one to one and one-half inches long, there is experience where those type of very tight crevices, even shorter than the crevices we would have in our steam generator, have had tendencies to seal even though they had a leak at one point in time.

MS. BRADFORD: The original seal, the original joint at the Unit 1 steam generator tubes was a one-inch joint; is that correct, a one-inch rolled joint?

WITNESS SLEAR: The original configuration of the upper tubesheet and lower tubesheet and the connections of the tubesheets were as follows: the tubesheet, itself, was 24 inches thick. The tubes were inserted through the tubesheet and rolled. The roll length was between one and, I believe, one and one-quarter inches.

Once the tubes were rolled in place, there is an additional weld, a filip weld geometry, around the outer circumference of the tube welding under the tubesheets.

MS. BRADFORD: Is that standard for steam

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1 generators?

2 WITNESS SLEAR: That is standard for a once-

3 through steam generator.

4 MS. BRADFORD: Do you know what the rationale

5 is within the tubesheet, the 24-inch tubesheet, to have only

6 a one-inch joint at the very top?

7 MR. CHURCHILL: Your Honor, this seems to be

8 going far afield of this testimony, which is the reliability

9 of leak rate measurements. We are not here discussing the

10 rolled joints. I thought the last question was going to deal

11 with leak rate measurements.

12 MS. BRADFORD: Exactly. Mr. Wilson was discussing

13 the crevice and corrosion products in the crevice. I wanted

14 to know and have an understanding of why initially there was

15 a one-inch roll or seal, and now they have a 24-inch, and what

16 difference this would make to the current seal, the current

17 joint. The manufacturer must have had some rationale for

18 making a joint only one to one and one-quarter inches, and

19 the manufacturer must have had some rationale for making,

20 therefore, a 23-inch and a 23-inch crevice.

21 What I am trying to understand is what that

22 rationale was and how it has now affected the kinetic expansion.

23 JUDGE WOLFE: Mr. Churchill?

24 MR. CHURCHILL: I guess I still don't see how

25 that relates to the reliability of leak rate measurements.

1 MS. BRADFORD: Well, if indeed the original one
2 to one and one-quarter inch joint was -- the rationale was
3 that would give the best seal, and the changing of that joint
4 might not give quite so good a seal, that's just merely what
5 I'm trying to question, since it was brought up here.
6 JUDGE WOLFE: Would you address yourself to Mr.
7 Churchill's objection that your question does not go to the
8 subject matter, the adequacy of the leak rate measurements,
9 or reliability, I should say, of leak rate measurements.
10 How is that question at all connected to what
11 we have at issue here?
12 MS. BRADFORD: I will withdraw the question and
13 merely ask Mr. Wilson, since he was talking about the crevice.
14 WITNESS SLEAR: I would like to point out that
15 I am Mr. Slear. Mr. Wilson is on my right.
16 MS. BRADFORD: I'm sorry.
17 Excuse me, Mr. Slear. You have said that you
18 have not reviewed industry experience with leakage past the
19 joints as a function of time because the nuclear power industry
20 has not used this method of repair? Is that what you are
21 saying?
22 WITNESS SLEAR: No, what I indicated was as far
23 as the kinetic expansion joints, I have not reviewed industry
24 experience because I am not aware of the use of the kinetic
25 expansion repair technique in the nuclear industry steam

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generators. However, I tried to draw a parallel between the fact that what I am aware of is that in crevices created by the one to one and one-half inch roll there is an experience of self-sealing with that type of geometry. That is the discussion I had with the ACR several years ago concerning the possibility of joints self-sealing even if there is leakage slightly.

MS. BRADFORD: Thank you.

Since the kinetic expansion, how many fault tests has the licensee conducted?

WITNESS SLEAR: I believe the answer to your question would be three to four bubble tests. I am not sure of the exact number. We have done several bubble tests of the steam generators since the repair.

MS. BRADFORD: Would that involve the 100 percent; is that a 100 percent test of the kinetic expansion?

WITNESS SLEAR: That is a 100 percent test of kinetic expansion repair area, yes.

MS. BRADFORD: Of the four, how many of those four were before the discovery of the recent leakage that is the subject of investigation at this point?

WITNESS SLEAR: Well, if there are four, then three of them would have been before. The most recent is obviously the latest one we have done.

MS. BRADFORD: Is this an extremely sensitive

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1 test?

2 WITNESS SLEAR: Extremely sensitive, exception-

3 ally sensitive, yes.

4 MS. BRADFORD: How do you account for the fact

5 that the bubble test failed to detect the leak in the tubes

6 that were recently uncovered?

7 WITNESS SLEAR: I think it could easily be the

8 discussion we previously had on some degree of self-sealing.

9 At the end of the discussion in the TPR we broke down that

10 in some cases you may see an increase in leakage in these type

11 of mechanical joints.

12 MS. BRADFORD: Have you recently conducted a

13 drip test?

14 WITNESS SLEAR: Yes, we have.

15 MS. BRADFORD: Was this prior to the most recent

16 --

17 WITNESS SLEAR: No, the drip test is usually

18 conducted after the bubble test because in order to conduct

19 the drip test you have to put someone in the lower end of the

20 steam generator, which means it has to be drained down, whereas

21 with the bubble test the steam generator is filled with water

22 on the primary side. So usually you drain it down to a level

23 several inches above the upper tubesheet on the primary side,

24 conduct the bubble test, and then drain it down the rest of

25 the way so that you can enter the lower end of the steam

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generator and conduct the drip test.

MS. BRADFORD: Is the drip test the best, or a better indication of leaks in the lower part of the generator?

WITNESS SLEAR: The drip test does test 100 percent of the steam generator in the section of the steam generator not exposed to the nitrogen pressure. It is the cold leak test, if you will, that is utilized for those sections of the generator.

MS. BRADFORD: I don't understand. What sections are not exposed to the nitrogen?

WITNESS SLEAR: The nitrogen bubble test is typically done with the secondary side water level at perhaps the ten tube support plate, which tests the top 18 feet of the steam generator. That includes 100 percent of the repaired area. The tubes, themselves, are 56 feet long, so it does not test the lower, say, 40 feet of the tubes and the lower tubesheet, itself.

MS. BRADFORD: There was damage in that area, however; is that correct?

WITNESS SLEAR: There was some eddy current indication in the area; that is correct.

MS. BRADFORD: When you did the most recent drip test, was there any leakage detected that is prior to the most recent leakage?

WITNESS SLEAR: You are asking about the

1 drip tests done before the most recent drip tests?

2 MS. BRADFORD: Yes.

3 WITNESS SLEAR: Yes, there were drips identified,

4 and I would have to go back to get the breakdown of exactly

5 what tubes and what plugs might have been involved, but there

6 were corrective actions taken based on that drip test, due to

7 the fact that drips were identified as coming from some plugs

8 and/or tubes.

9 MS. BRADFORD: Does this test lose its sensitivity

10 the higher in the steam tube that the leak is?

11 WITNESS SLEAR: Yes. As I believe I indicated

12 in the write-up, if the leakage is from higher in the steam

13 generator, before the leakage can travel out the bottom of

14 the tubesheet and be identified visually, it takes time for

15 the drops, if you will, to travel to the lower tubesheet; and,

16 in fact, there is some time for evaporation.

17 MS. BRADFORD: How do you calculate that evapora-

18 tion?

19 WITNESS SLEAR: We have not calculated that

20 evaporation.

21 MS. BRADFORD: So at some point in the tube --

22 I believe you said about ten feet up in the tube -- if there

23 were a crack in that portion of the tube, you would not be

24 able to assess accurately the size of the crack?

25 WITNESS SLEAR: Well, the size of the crack --

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MR. CHURCHILL: Excuse me; I have an objection. Are we talking about the repaired expansion joint and the reliability of leak testing measurements with respect to that? We seem to have gotten into the detection of cracks in some other part of the tube, which doesn't seem to relate to either this hearing or the contention or this issue.

MS. BRADFORD: I am asking Mr. Slear and the panel about the drip test, which is part of their leak detection system. Mr. Slear indicated that the drip test is most useful in the lower portion of the steam generator. I was merely testing him on that information.

JUDGE WOLFE: And your question?

MS. BRADFORD: I asked him about the sensitivity of the drip test from as high up -- or from higher than ten feet up in the tube; or does the sensitivity of this drip test decrease with elevation in the tube?

JUDGE WOLFE: Objection overruled.

WITNESS SLEAR: As I indicated in the testimony, at three drops per second coming through the crack, that's a sensitivity equivalent to about .002 gallons per minute, which is quite a low sensitivity. And although there is some reduction in sensitivity, as I indicated, we still have a very low, if you will, and, in our judgment, quite good sensitivity via the drip test in that section of the steam generator. I don't recall saying exactly ten feet, but --

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MS. BRADFORD: Thank you.

Mr. Slear, at page 11 of your testimony -- of the licensee's motion for summary disposition, you say that the loss of pretension will result in additional compressive load of only 30 to 65 pounds. Yet at page 13 of your pre-filed testimony you state the loss of pretension resulted in a reduction of axial tube load of several hundred pounds.

How do you account for the difference -- and I do have your affidavit here.

WITNESS SLEAR: Could I have the affidavit so I could read it?

MS. BRADFORD: Certainly.

MR. CHURCHILL: What was the reference?

MS. BRADFORD: Page 11.

(Witness perusing document.)

WITNESS SLEAR: The reference on page 11 of the Affidavit, Licensee's Motion for Summary Disposition of Each of TMIA'S and Joint Intervenor's Contentions, which is dated February 24, 1984, has to do with the effect of kinetic expansion itself on the pre-load that was put in the steam generator when the steam generator was manufactured by Babcock and Wilcox.

The discussion on -- what was your other reference? It was one of the pages in my testimony, wasn't it?

MS. BRADFORD: Thirteen.

WITNESS SLEAR: The discussion in my testimony has to do with the fact that before some of the tubes were kinetically expanded in the TMI-1 steam generator, they apparently slipped down slightly, and that also would result in some loss of pre-tension.

In order to quantify the amount of pre-tension we may have lost in our steam generator, we measured the distance that the tubes slipped down. That distance can be equated to a pre-load of several hundred pounds.

So, really, it is two different things. Page 11 was referring to kinetic expansion on a tube that has not slipped down slightly; page 13 is referring to a tube which has slipped down slightly in the steam generator prior to kinetic expansion.

MS. BRADFORD: I'm afraid I'm still not quite

1 clear. It says, at page 11 in your Affidavit, that "During
2 manufacture of the steam generators, the tubes were stretched
3 slightly so that they would be under small axial tensile load
4 of about 65 pounds with the steam generator's ambient tempera-
5 ture, although the 65-pound load (pre-load) is small in com-
6 parison with other operating tube loads."
7 Now, what I'm asking you is: are you saying that
8 the loss of pre-load, as you indicated there, results in an
9 additional 65-pound load on the tubes?
10 WITNESS SLEAR: No. What I said on page 11 was
11 that based on the measurements taken during the qualification
12 program, when we expanded steam generator tubes, we predicted
13 that the reduction in pre-load would be less than 30 pounds
14 due to the change in length of the tubing, such that kinetic
15 expansion of a tube would reduce the pre-load by less than 30
16 pounds.
17 MS. BRADFORD: So you were not talking about
18 those tubes which lost all pre-tension?
19 WITNESS SLEAR: No, I was not.
20 MS. BRADFORD: On page ten of your Affidavit,
21 paragraph 27, you say "The effects of relieving pre-load with
22 respect to the limited transient maximum loads on the tubes were
23 examined. The maximum compressive load under FSAR accident
24 conditions is a 620-pound load associated with a postulated
25 feedwater line break accident.

"This is less than the approximately 775-pound generic design basis compressive load conservatively associated with a 100 degree Fahrenheit-hour heatup, which is the limited case."

You go on to say that "The loss of pre-load would add 65 pounds to the 775-pound compressive load. Thus, for a tube with no pre-load, 840 pounds is the conservative maximum compressive load postulated."

WITNESS SLEAR: Based on the design basis assumptions that went into the steam generator. The design basis assumptions had to do with compressive load generated during a 100 degree per hour heatup, which is calculated at 775 pounds.

The pre-load that was installed or intended to be installed in the tube stretching during manufacturing was a 65-pound pre-load.

Loss of all of that pre-load, from a design basis point of view, would have increased the pre-load, maximum compressive pre-load, to 840 pounds.

MS. BRADFORD: I see. What you're saying in your pre-filed testimony is that you found that the actual increase in compressive load would be on the order of several hundred pounds?

WITNESS SLEAR: The evidence available for the TMI-1 steam generator has to do with the distance the tubes moved down, which in some tubes equated to apparently several

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hundred pounds of pre-load.

MS. BRADFORD: On page 12 of your Affidavit you continue by saying that -- excuse me; on page 11 you have said that 800 pounds of compressive load would initiate bowing; is that correct?

WITNESS SLEAR: Yes; we indicated that it would take 800 pounds to initiate bowing and 1,025 pounds would be necessary to have sufficient lateral displacement to contact adjacent tubes.

MS. BRADFORD: I see; thank you. I needed that clarified.

Have you done any tests other than -- maybe I should ask another witness or a later witness.

Is the 16th span of the steam generator an area of high turbulence?

WITNESS SLEAR: I would say there is probably fairly high turbulence throughout the steam generator. I'm not quite sure what your definition of "turbulence" is.

MS. BRADFORD: Is there greater turbulence at the upper tubesheet?

WITNESS CRONEBERGER: The area of the steam generator that you're discussing is where there would be maximum steam cross flow normal to the tubes as it exits the steam generator via the shroud.

MS. BRADFORD: Does that cause more turbulence in

1 that area than in the others?

2 WITNESS CRONEBERGER: When you say "turbulence,"

3 there are greater lateral forces and bumping of the tubes

4 occurring in that region as compared with other regions of the

5 steam generator.

6 MS. BRADFORD: Any member of the panel: does

7 corrosion continue under all conditions in the steam generator?

8 MR. CHURCHILL: Objection. We're on reliability

9 of leak tests, and that's irrelevant.

10 MS. BRADFORD: I wanted to test Mr. Slear --

11 WITNESS SLEAR: I think the question is in the

12 area --

13 MR. CHURCHILL: I have an objection.

14 JUDGE WOLFE: Just a moment.

15 MS. BRADFORD: Mr. Slear had talked earlier that

16 the -- his testimony goes to the fact that corrosion could

17 limit the leakage, and I really want to test if it could also

18 mask the amount of leakage that's in the steam generator.

19 MR. CHURCHILL: Your Honor, this witness testified

20 that there was a certain amount of self-sealing of leaks past

21 the joint. The phenomenon of the self-sealing was there; that's

22 the only place in the tube it was. He explained the mechanism

23 for it.

24 JUDGE WOLFE: Your question once again, Ms.

25 Bradford?

MS. BRADFORD: I asked: does corrosion continue under all conditions; that is both service and --

JUDGE WOLFE: Does what?

MS. BRADFORD: Corrosion.

JUDGE WOLFE: I'm sorry, Ms. Bradford; you haven't shown wherein this is related to the reliability of leak rate measurements.

MS. BRADFORD: I just need to know, since the plant has been closed down for several years, for five-and-a-half years, if the rate of corrosion has been continuing at the same or a lesser rate or increased, can we expect more corrosion products in that crevice or in the cracks which would, in fact, mask leakage and affect their leak rate, the Licensee's leak rate.

MR. CHURCHILL: If the question is limited to the question of corrosion in the area of the joints that's relevant to this panel's testimony on the self-leaking phenomenon of the joint, I have no objection.

MS. BRADFORD: I believe, in fact, you have in your testimony, that corrosion can cause cracks to be self-sealing. I'm testing how much corrosion can be expected; that is, how much corrosion product can be expected since the plant has been closed down for five-and-a-half years?

Does corrosion occur at a faster rate when it's operating or when it's in a maintenance condition?

JUDGE WOLFE: I think the question is a fair one and is related to the reliability issue. Answer the question.

WITNESS SLEAR: If there is no objection, I would like to ask Dr. Giacobbe, who is involved on a day-to-day basis with corrosion, to attempt to answer the question.

JUDGE WOLFE: Is that all right, Ms. Bradford?

MS. BRADFORD: Yes, any member of the panel can answer.

MR. CHURCHILL: That's all right with us. I would just like to point out that Mr. Giacobbe is not a sponsoring witness of this testimony, but I don't think there would be any problem with his answering that.

WITNESS GIACOBBE: In regard specifically to corrosion in the crevice formed between the tube and tubesheet. during this lay-up period we have taken great precautions to preclude corrosion in the secondary side of the steam generator such that we would not anticipate any accelerated corrosion in that region during this lay-up period.

So I would say the answer to your question is no, corrosion would not be occurring any faster.

MS. BRADFORD: Will cracks filled with corrosion products go undetected? Is that possible, anyone on the panel?

WITNESS SLEAR: Could you be more specific about what cracks or where the cracks are that you're talking about? Are you talking about cracks that are up in the kinetically

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1 expanded area?

2 MS. BRADFORD: I'm talking about all cracks that

3 would provide leakage that would go into your leak rate. If

4 there are specific cracks in specific locations that respond

5 differently to corrosion products, perhaps you could --

6 MR. CHURCHILL: Your Honor, the testimony on

7 page 12 is that "there may be a tendency for some leaks to be

8 self-sealing, but only for leakage pathways between the expanded

9 portion of the joint and the tubesheet."

10 She keeps talking about cracks. I don't know if

11 you call that cracks or not, but the testimony is that the only

12 self-sealing leakage you get is around the joint.

13 If it is clear that the question is related to

14 that, I have no objection. Or, if she wants to try to lay a --

15 she would have to do that.

16 MS. BRADFORD: Judge Wolfe, I would not --

17 JUDGE WOLFE: Or if not, why not?

18 MS. BRADFORD: Beg your pardon?

19 JUDGE WOLFE: Mr. Churchill says that your ques-

20 tion must be directed to that area around the joint; and I'm

21 just saying if that is not your question, why are we getting

22 into it?

23 MS. BRADFORD: Because I think that it is clear

24 that the necessity for this method of repair would not have

25 existed had there not been damage on the steam generator; and I

j9

1 don't see how we can look at just the repair without looking at
2 how the damage itself impacts on the repair process. I don't
3 see how I can separate these out.
4 JUDGE WOLFE: Mr. Reporter, will you read the
5 question, please, the original question?
6 (Whereupon, the reporter read from the record, as
7 requested.)
8 JUDGE WOLFE: Is this the question you objected
9 to?
10 MR. CHURCHILL: I think so.
11 JUDGE WOLFE: I think it is a very reasonable
12 question.
13 WITNESS WILSON: Let me try to answer that ques-
14 tion. Leakage measurements for the steam generator during
15 operation involve measuring addition of products on the secon-
16 dary side. As such, the integral measurement of leakage, no
17 matter where it comes from, represents the totality of leakage
18 in the steam generator.
19 The specific testimony that you're referring to
20 about self-sealing related to leakage past the kinetically
21 expanded joint in the upper tubesheet only. To the extent that
22 represents a piece of or a portion of the totality of leakage,
23 then should there be corrosion which ends up in slowing down
24 or sealing leakage in that crevice, then it would result in a
25 measurement which is slightly less than the totality of the

leakage if it were measured in the absence of such self-sealing.

MS. BRADFORD: So if many cracks were sealed in that way or partially filled with corrosion products, this could affect the leak rate?

WITNESS WILSON: Again, cracks being defined as the crevice between the tube and the tubesheet, not other kinds of cracks.

MS. BRADFORD: There are also cracks in the walls of the tube, is that correct, and that is within the tubesheet? So it is feasible that corrosion could also be in those cracks?

WITNESS WILSON: I'm a little bit lost. I'm strictly talking about the long crevice behind the tube, adjacent to the tubesheet, which is anywhere from six to 18 inches long. In that crevice corrosion products, if they're transported through it and those crevices are extremely small, could, in fact, plug leakage through that crevice.

MS. BRADFORD: What amount of leakage would it take to remove the corrosion product? Do you know that?

WITNESS WILSON: I don't think anybody can ascertain that. Presumably, if the corrosion occurs and plugs the extremely small crevice, it will presumably stay there unless dislodged by something.

MS. BRADFORD: I don't believe I have any more questions on Contention 1.a.

jll

JUDGE WOLFE: This might be a good time for a five-minute recess.

(Recess.)

JUDGE WOLFE: You have finished with your cross-examination on Issue 1.a, Contention 1.a; is that correct?

MS. BRADFORD: Yes, that's correct.

JUDGE WOLFE: I think the procedure we will follow will be: we will proceed to exhaust your cross-examination, your redirect, and any more questions, and it will be in one part of the transcript.

So we will proceed with cross-examination on 1.a.

Mr. Au.

MR. AU: Yes; we have a few questions. I would like to request the Board's permission to have Mr. Dornsife ask the questions on this matter.

Mr. Dornsife has appeared before the Atomic Safety and Licensing Board in proceedings, particularly the Pennsylvania Power and Light Company's --

JUDGE WOLFE: Mr. Au, I really can't hear you. Please put the microphone close to your face and speak into it.

MR. AU: Mr. Dornsife has appeared in other proceedings before the Atomic Safety and Licensing Board; at the Pennsylvania Power and Light Company's Susquehanna Plant operating license proceeding and at the Metropolitan Edison Company's proceedings on restart before the Atomic Safety and Licensing

1 Board. So he is familiar with the rules of this Board.

2 In addition, I would like for him to state his

3 background for the Board, please.

4 MR. DORNSIFE: My name is William P. Dornsife.

5 I am Chief of the Division of Nuclear Safety, Bureau of Radia-

6 tion Protection, in the Department of Environmental Resources.

7 I have a Bachelor of Science Degree in Chemistry

8 from the Naval Academy and I went to the Naval Nuclear Program,

9 a three-year training program -- I'm sorry; a year-and-a-half

10 training program, Nuclear Navy. I spent three years on a fast-

11 attack reconstruction submarine.

12 I have a Master's Degree in Engineering from Ohio

13 State University. I worked for a few years for Burns and Roe

14 designing nuclear power plants.

15 I've been with the Commonwealth since 1976. I

16 now supervise a staff of nuclear engineers assigned to indi-

17 vidual sites, and we have an oversight role for NRC regulatory

18 requirements. We oversee the NRC's regulatory role.

19 We also have primary responsibility for responding

20 to accidents at nuclear facilities in the Commonwealth.

21 I am also a part-time instructor teaching graduate

22 courses here at the Capitol Campus in nuclear engineering.

23 JUDGE WOLFE: All right, Mr. Dornsife, you may

24 proceed with your cross-examination.

25 MR. DORNSIFE: Thank you, Your Honor.

CROSS-EXAMINATION

MR. DORNSIFE: Gentlemen, it appears from your testimony on Contention 1.a that the primary means of detecting leakage during operation is from the condenser off-gas monitor; is that correct?

WITNESS SLEAR: That is correct. It is called RM-A5 low.

MR. DORNSIFE: Does this monitor have any degree of redundancy?

WITNESS SLEAR: Could you repeat the question, please?

MR. DORNSIFE: Does this monitor have any degree of redundancy?

WITNESS SLEAR: There is another monitor that also measures off-gas activity. I need to ask Gary Broughton to respond to the ranges, but I believe there is overlap between the other monitor and RM-A5 low.

Do you recall, Gary?

WITNESS BROUGHTON: There are additional radiation monitors which monitor the condenser off-gas; they don't have the same range as the primary monitor, but there is overlap between ranges.

MR. DORNSIFE: Are these other monitors capable of detecting leakage at the Tech Spec limit?

WITNESS BROUGHTON: At least one of the other

j14

monitors does come on scale before the leak rate would reach the Tech Spec limit.

MR. DORNSIFE: Are there any limiting conditions for operation on the off-gas monitor?

WITNESS BROUGHTON: I'm not aware of any limiting conditions for operations as that term is used by the Technical Specifications. There are provisions for evaluating the activity in the off-gas even if the on-line monitors are not functioning. Those provisions include taking what are termed grab samples, which is a sample of the off-gas, and then measuring that in the counting lab and determining what the activity is using that method.

If the primary monitor is not functioning, then those grab samples are taken to evaluate activity in addition to having backup monitors in service which may be not detecting the activity since the activity is below the range.

MR. DORNSIFE: I have no further questions. Thank you.

JUDGE WOLFE: Ms. Wagner.

MS. WAGNER: Staff has no questions on sub-issue 1.a.

JUDGE WOLFE: Any redirect?

MR. CHURCHILL: Yes, just a few questions, Your Honor.

JUDGE WOLFE: All right.

REDIRECT EXAMINATION

MR. CHURCHILL: Mr. Slear, the TPR -- there was a question you were asked that the TPR at page 18 of this report had suggested that perhaps with a kinetically expanded leak of this type, some leakage around the joint might be expected; and, in fact, sometimes you do -- is it true that you do sometimes expect a small amount of leakage around the joints?

WITNESS SLEAR: Yes, it is. We entered the program expecting to have some small amount of leakage, and the leakage that we saw was certainly not unanticipated at all.

MR. CHURCHILL: Could you explain to the Board what the safety implications are of this type of leakage around the joint?

WITNESS SLEAR: I don't believe there are any significant safety implications at all. The leakage does not relate to, for example, the load-carrying capability of the joint such that we would draw any link or inference that, from a load-carrying capability point of view, the joint might be greater due to the leakage.

I don't know of any safety significance associated with leakage around the joint.

MR. CHURCHILL: Would leakage around the joint, for example, indicate an increased potential for tube rupture at the joint, for example?

WITNESS SLEAR: No, it certainly would not.

j16

MR. CHURCHILL: Now, there were some questions about the self-sealing of leakage around the joint. Did you not testify that it was possible that the self-sealing phenomenon could, in fact, mask the identity of leaks around the joint?

WITNESS SLEAR: Yes, I did. Self-sealing in a joint would, in fact, perhaps mask the fact that that joint was leaking slightly; but, once again, that's a very, very slight leakage. Bubble tests test 100 percent of those joints and is exceptionally sensitive, so any leakage that is identified is very small indeed.

MR. CHURCHILL: Is it fair to say then that if such leaks were, indeed, masked by the self-sealing phenomenon, that there would be no safety significance to that?

WITNESS SLEAR: Yes, it is.

MR. CHURCHILL: I have no further questions, Your Honor.

JUDGE WOLFE: We will now proceed to the Board questions.

JUDGE LAMB: Mr. Slear, you were asked earlier in the questioning about the error in leak rate determination. Can you repeat what that is, the magnitude of the error in determination of leak rate?

WITNESS SLEAR: Yes. The question was, I believe, in regard to the leak rate measurements that we do using the condenser off-gas instrumentation. I indicated that during the

j17

test program, we had seen a statistical variation in the leak rate value obtained from that instrument of plus or minus .5 gallons per hour. That is a two sigma variation on the data that we obtained during the pre-critical test program. The result of that test program was to establish a base line leak rate of 1 gallon per hour.

JUDGE LAMB: So that is two standard deviations?

THE WITNESS: That's correct.

JUDGE LAMB: On page 12 of your testimony -- this would be to whoever feels best qualified to answer this; I would just like to fill in something to make the record complete -- you indicate in the middle of the page, in the beginning of Answer 12, "We believe there may be a tendency for some leaks to be self-sealing, but only for leakage pathways between the expanded portion of the joint and the tubesheet."

Would someone please explain why it is only for those leakage pathways?

WITNESS SLEAR: The discussion about self-sealing had to do with a leak which is leaking, and the logic or the rationale that because the joint itself, which is the very tight, almost non-existent crevice between the tube and the tubesheet, is very tight and, in fact, is made between inconel and carbon steel, with the propensity for carbon steel to create some amount of corrosion products, those corrosion products could, in fact, stop leakage through that type of long, very

j18

1 tight joint.

2 I hope that clarified it.

3 JUDGE LAMB: The reason this would be only for

4 such pathways is because in other areas you would not have the

5 tight joint, you wouldn't have the contact between the two

6 metals?

7 WITNESS SLEAR: In the other areas you do not

8 have the carbon steel, for example, and I guess you could have

9 contact between two metals.

10 WITNESS WILSON: Maybe I can elaborate a little

11 bit on that. If you were looking at a crack in just the tube

12 itself, in the tube wall, that crack length, nominally at

13 least, is 34 thousandths of an inch; so you have a very, very

14 small length of crack and you have a metal, painted now, which

15 is not susceptible to significant corrosion. Under those

16 conditions it would not self-seal. You could also have a high

17 pressure across that very short length of crack.

18 Just the opposite conditions exist in the crevice

19 itself. The crevice can be six inches to 17 or 18 inches long.

20 One of the materials in the crevice, carbon steel, is a feeder

21 to feed corrosion products; and the rate of flow, the pressure

22 drop for the length of that crevice is quite low. Those are

23 quite different conditions.

24 JUDGE LAMB: Thank you. I have a similar ques-

25 tion on page 14 with respect to Answer 14. You indicate that

"a tube without pretension would exhibit a lower leak rate than a tube with pretension for a circumferential through-wall crack of a given size. In practice, however, this phenomenon is unlikely to mask the detection of a critical size crack."

Could you explain the rationale behind that statement?

WITNESS SLEAR: I think the term "In practice" refers to the fact that we do have an operating steam generator that has now been subjected to a number of cooldowns, and although there would be some slight reduction in leakage, perhaps through a through-wall crack due to the loss of pretension, the cooldowns themselves apply axial tensile load, and the monitor for leakage during cooldowns and the evaluation of a leak rate during the cooldown allows us to make the statement that it is unlikely that lower leakage would in fact be masking detection of a critical size crack at TMI-1.

JUDGE LAMB: I thank you. That's all I have.

JUDGE WOLFE: This comment perhaps is directed only to Ms. Bradford. Our procedure here is to have first the direct written testimony, then cross-examination and, as here, redirect in response to the testimony.

I do not ask if anyone has any additional recross-examination. You are going to have to tell me that you want to ask a few additional questions on recross if that's what you want; because if I hear nothing from any of the cross-examiners

asking for recross, we just proceed to other questions.

Do you understand that?

MS. BRADFORD: Yes, I do.

JUDGE WOLFE: Go ahead.

JUDGE HETRICK: On page 9 of the testimony on Issue 1.a where you discuss the measurement of gaseous activity and its relation to leak rate, I understood you to say that this is a continuous readout in the control room; is that correct?

WITNESS SLEAR: Yes, sir; that is correct. The count per minute reading from the Beta scintillation counter that we defined as RM-A5L is continuously read out in the control room and, in fact, is alarmed in the control room at a pre-set level.

JUDGE HETRICK: Let me ask a hypothetical question. Suppose there is a sudden increase in leak rate, what is the response time for the readout in the control room?

WITNESS SLEAR: The response time is fast, in terms of minutes, but I'm not familiar enough with the instrument to tell you exactly what it is like; but I certainly have been there through the pre-critical test program, and as we changed plant conditions, which weren't necessarily changing the leak rate but rather might have been changing another parameter which affects the reading, which is condenser off-gas, very shortly after, within minutes of changing plant conditions, we

j21

would see a change in the count per minute reading on RM-A5L.

JUDGE HETRICK: So you think the response time is on the order of a few minutes?

WITNESS SLEAR: At most. And I guess when you say "response time," you would have to -- there is an instrument response time and then there is a transport time from the steam generator to the instrument itself. You have to add the two together, but I certainly believe, even added together, that the response time would be minutes, if not less than that.

JUDGE HETRICK: What's the criteria for setting the alarm level that you mentioned?

WITNESS SLEAR: To the best of my knowledge, the first alarm level on that particular instrument is based on the expected failed fuel percentage and the counts per minute as a result of that failed fuel percentage in the reactor coolant system, which would relate to a leak rate equivalent to the proposed licensing condition of about a six-gallon per hour increase.

JUDGE HETRICK: I have one further question on page 15 of the same testimony. As I understand, the first paragraph on page 15 is concerned with axial stress. The final paragraph mentions for the first time tube stress in the hoop direction.

Am I correct in assuming that we're talking about two different operating situations in these two paragraphs?

WITNESS CRONEBERGER: The last paragraph talks about normal operating conditions and what the stress state of the tubes would be. During normal operations the maximum stress, the principal stress, would be a hoop stress caused by the pressure differential.

The damage that occurred due to corrosion in this generator evidenced itself with certain fringial cracks. During cooldowns and when the steam generator is cold, the maximum stress is an axial stress; that is, the principal stress is axial. That is the topic for the first paragraph on that page.

JUDGE HETRICK: I think that answers my question. Thank you.

JUDGE WOLFE: Cross-examination on Board questions; Ms. Bradford?

MS. BRADFORD: Yes, I have one question for Mr. Slear.

RECROSS-EXAMINATION

MS. BRADFORD: On page 14 you said, in response to Judge Lamb's question whether compressed forces would mask leaking -- you said that because of the cooldowns that occurred since the damage to the steam generators, that you feel that any cracks that are going to open have already opened; am I paraphrasing it correctly?

WITNESS SLEAR: That's not quite correct. What I

1 indicated was that during the pre-critical testing program,
2 part of the test included an overt attempt to apply an axial
3 tensile load to these tubes. That was done by having a cool-
4 down during the test program that maximized, if you will, the
5 tube toshell differential tension which was tending to try to
6 stretch these tubes.
7 The leak rate indication during that test period
8 proved to us what we already expected, and that was that we
9 did not have any large cracks and certainly no cracks of a pre-
10 critical nature remaining in the steam generator.
11 Our calculations indicated that all tubes, even
12 those that have lost pre-load, would have had sufficient axial
13 tensile load on them to cause much, much more leakage than we
14 saw during the test program.
15 MS. BRADFORD: What assurance do you have that
16 that very axial strain on the tubes did not cause cracks that
17 were partially through-wall to continue through and then the
18 compressive force on the tube would then mask that? Is that a
19 possibility?
20 WITNESS CRONEBERGER: During the steam generator
21 testing, again, the steam generator experienced a number of
22 cooldowns. What we were trying to do during the cooldowns was
23 to maximize tension on the tubes and, therefore, maximize the
24 leakage if, in fact, there were any in-dwelling through-wall
25 defects. And, in fact, during the cooldown we were measuring

j24

1 leak rate in real time. So the leak rate that we did measure,
2 we tried to analytically predict what would have been the
3 maximum size crack that could potentially have been there and
4 produced that leak rate. That prediction indicated that if all
5 of the leakage -- again, this is very conservative -- if all
6 of the leakage was simply from one defect, it still would have
7 been a very small defect, substantially smaller than that which
8 would have been associated with our design basis.

9 MS. BRADFORD: I understand. But my question
10 was: in putting those axial loads on the tube, is it possible
11 that pre-critical cracks which existed in the tube wall could
12 have been strained to a point that, as a compressive load was
13 reached and the tube wall was weakened and as the crack is
14 progressing through the wall of the tube, then a compressive
15 load is applied and that new cracks, in fact, would have
16 occurred during your cooldown testing, which would then be
17 masked by this compressive load?

18 MR. CHURCHILL: Your Honor, I'm fairly certain I
19 have to object to that. It seems to me we are talking about
20 mechanisms of crack propagation, and it seems that we have
21 strayed.

22 Now, I'm hedging a little bit because maybe I
23 didn't hear quite the last phrase or I didn't hear the punch
24 line of the question, but I think she was not talking about
25 reliability of leak rate measurement. I think what she was

1 asking about is mechanisms for crack propagation, which is
2 beyond the scope now of both the hearing and this issue.
3 MS. BRADFORD: I was following up on Judge Lamb's
4 question on the likelihood that compressive forces will, in-
5 deed, mask cracks; the witnesses' response to that was that
6 they felt it was unlikely because they had applied axial loads
7 which would open any tight cracks.
8 My question was: would it also cause propagation
9 or continued growth of pre-critical cracks, and then those pre-
10 critical cracks would be disguised by the compressive force
11 which was later applied?
12 MR. CHURCHILL: I will object to that, Your Honor.
13 That seems pretty far afield. We are now talking about specu-
14 lative mechanisms for future growth in cracks, which is clearly
15 beyond the scope of this issue.
16 JUDGE WOLFE: The question is proper and within
17 the scope of Judge Lamb's question.
18 Answer the question.
19 WITNESS CRONEBERGER: Would you repeat the ques-
20 tion one more time, please?
21 MS. BRADFORD: The axial load that you applied to
22 the tubes, you indicated that you did that on a number of
23 occasions.
24 My question is: could that cause growth of pre-
25 critical cracks that existed, and could subsequent compressive

j26

forces mask that new growth and, therefore, mask --

MR. CHURCHILL: All due to the loss of pretension?

MS. BRADFORD: Yes.

WITNESS CRONEBERGER: We did investigate, as I answered earlier, what the lowest force might be during these cooldowns and for this lowest axial load in the tube, what it might mean if, in fact, all of the leakage was released from one defect.

We also then, for the same load, which was a low load, a low-tension load, tried to understand if, in fact, such a small defect could mechanically grow by fatigue as was sited before the cooldown, heated up and recycled.

Our conclusion was, with the very low tensile axial load, there should be no fatigue damage. So, if you have a low load with a small defect, you would predict no or virtually no fatigue damage on a defect; that is, crack extension.

MS. BRADFORD: Is this low load that you're talking about, low axial load, what would be seen by the steam tubes during normal operation?

WITNESS CRONEBERGER: I understood the question to deal with the tubes that have no pre-load; therefore, a tube which would see the lowest axial force during cooldowns.

One could estimate what the size of the defect might have been if it contributed all of the leakage; that is that one tube. But the force in that tube, that is one with a

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1 loss of pre-load, is so low that one would not predict fatigue
2 damage during that same loading cycle.
3 When I say "fatigue damage," I'm talking in terms
4 of a mechanical extension of that crack.
5 MS. BRADFORD: Let me just go over this and see if
6 I have it correct. The axial load that you apply to the tubes
7 in your testing, which you predicted would open any cracks, was
8 the normal operating load, but it would not have an axial load
9 pressure on the tubes without loss of pretension; is that what
10 you're saying? It was an actual normal load that the tubes
11 would see during normal operation?
12 WITNESS CRONEBERGER: During a performance test,
13 we expose the steam generator to a cooldown, which is more
14 severe than that which would be anticipated during normal oper-
15 ation. So what I am talking about is a case that would be
16 a worse cooldown than what we would expect for a normal
17 operation.
18 MS. BRADFORD: Thank you. I have nothing further.
19 JUDGE LAMB: Let me just follow up on that with
20 one quick question. If, in spite of the calculations and pre-
21 dictions, such a crack did occur, would your leakage test pick
22 this up during that incident?
23 WITNESS CRONEBERGER: I'm sorry, would you repeat the
24 question?
25 JUDGE LAMB: You predicted that the tension that

j28

you applied during this cooldown would not be enough to open a crack; that is, to cause a crack to expand.

WITNESS CRONEBERGER: To mechanically grow, yes.

JUDGE LAMB: Assuming that it had grown, would your measurement of leakage pick that up?

WITNESS CRONEBERGER: During that cooldown?

JUDGE LAMB: During that cooldown.

WITNESS CRONEBERGER: Yes, sir, it would have.

JUDGE LAMB: Did you observe such an increase in leakage during the cooldown?

WITNESS CRONEBERGER: During the cooldown there was an increase in the leakage, which was consistent with our expectations. During the cooldown, fundamentally there were two effects. One is a delta T between the shell of the steam generator and the tubes, and this temperature differential would tend to cause some stretching of the tubes which are cooling down.

In addition, one has a pressure differential from primary to secondary side that is increasing during the cool-down. So any leakage which would be a function of the delta T would also be increasing during the cooldown. So, as we anticipated, we did see some minor increases in the leakage during the cooldowns.

JUDGE LAMB: Did you see any that gave you cause for concern, that caused a critical size crack?

j29

WITNESS CRONEBERGER: No, sir.

JUDGE LAMB: Thank you.

JUDGE WOLFE: Thank you.

Ms. Bradford?

MS. BRADFORD: I have no further questions.

JUDGE WOLFE: Mr. Dornsife?

MR. DORNSIFE: No questions.

JUDGE WOLFE: Ms. Wagner?

MS. WAGNER: No questions.

JUDGE WOLFE: Is there redirect, Mr. Churchill, on Board questions?

MR. CHURCHILL: No, Your Honor.

JUDGE WOLFE: It is now 12:30. We will recess until 1:45.

(Whereupon, at 12:30 p.m., the hearing was adjourned, to be reconvened at 1:45 p.m., this same day.)

AFTERNOON SESSION

(1:45 p.m.)

JUDGE WOLFE: Mr. Churchill, we are proceeding to the next sub-issue.

MR. CHURCHILL: Yes, sir. Messrs. Slear, Wilson and Giacobbe at the witness table are prepared to answer questions on Issue 1.b, Contention 1.a unless -- excuse me; were you going to do 1.c? Were you going to take it out of turn?

MS. BRADFORD: I would prefer not.

MR. CHURCHILL: They are all there for either one.

JUDGE WOLFE: All right; which one are you proceeding with then, Ms. Bradford?

MS. BRADFORD: Issue 1.b, Contention 1.a. But at this time, I would like to have entered the two exhibits I had marked TMIA Exhibit 1 and TMIA Exhibits 2-A through 2-E.

JUDGE WOLFE: Any objection?

MR. CHURCHILL: Yes, sir. Your Honor, I think an exhibit like this out of a technical document would require a witness to sponsor it.

JUDGE WOLFE: Which one are we speaking to?

MR. CHURCHILL: All of the exhibits, 1 through 2-E. A party with no witnesses cannot come into the hearing, identify some documents that they got on discovery and simply enter those into evidence. I presume Ms. Bradford is going to use the

1 documents for cross-examination. And to the extent that that
2 use is proper -- that is they are questions which are within
3 the framework of the testimony -- we would have no objection
4 to her using them for cross-examination, and I am not objecting
5 to that at this time. Although, I suspect I will be, because
6 I'm not even sure how they would be relevant. I will have to
7 wait and see on that. But I would have to object to the
8 admission of these documents into evidence.
9 JUDGE WOLFE: Any other objections?
10 MS. WAGNER: Yes, Judge. The staff would also
11 object to the admission of these documents at this time. We
12 don't see any link between anything in these documents and
13 Issue 1.b.
14 Similarly, we would not mind cross-examination
15 based upon the information in these documents if the relevance
16 can be shown.
17 JUDGE WOLFE: Any comments, Mr. Au?
18 MR. AU: The Commonwealth has no comment.
19 JUDGE WOLFE: Let's take the Staff's objection
20 first. Ms. Bradford, they object on the grounds of relevancy.
21 Is it correct that there has been no showing that these two
22 documents bear upon any matter that is in contention? Isn't
23 that your point?
24 MS. WAGNER: That is correct, but there also is
25 no sponsor of the documents.

JUDGE WOLFE: Let's consider the relevancy first.

MS. BRADFORD: The documents that are TMIA proposed Exhibits 2-A through 2-E are a series of test results of the eddy current inspection that I excerpted from a document that was available during discovery. I would use some of these documents in an effort to determine the correlation in current testing and the actual cracks and size and measurement of the cracks that were found during later lab testing.

In that regard, TMIA proposed Exhibit 2-B shows a series of figures, some of which have been taken in the steam generator and some which were eddy current communications which were made in the lab testing using the eddy current and then the results of some destructive testing.

JUDGE WOLFE: Let me ask you this, Ms. Bradford: forget that we have a panel of witnesses on the stand and you tender TMIA Exhibits 2-A through 2-E and you are asked what does your proposed exhibit show, what does it prove. What would be your answer?

In other words, I'm concerned about this document, because I don't know really what it intends to prove. Now, you say it relates to eddy current testing, but so what. There are a lot out there that relate to eddy current testing.

What does this document prove? What does it intend to prove without cross-examination, just on its face?

MS. BRADFORD: I am trying to determine the

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efficiency of the eddy current test probe.

JUDGE WOLFE: On its face, this document indicates discrepancies in the eddy current testing?

MS. BRADFORD: It appears to.

JUDGE WOLFE: You have also offered TMIA Exhibit No. 1. On its face, what does it purport to establish?

MS. BRADFORD: This is an evaluation of the tubes in mockup tube sheets, which is a report prepared for licensee.

In this testimony that has been offered, licensee refers to the qualification program which this document describes in part.

JUDGE WOLFE: This document relates to the qualification program, TMIA Exhibit No. 1?

MS. BRADFORD: Yes.

MR. CHURCHILL: Your Honor, may I comment?

JUDGE WOLFE: Just a moment, Mr. Churchill.

(Pause.)

JUDGE WOLFE: We are not taking up frequency of eddy current testing. I certainly don't see where in TMIA Exhibit 1 marked for identification, of your own description, how it relates to ECT. Is that correct?

MS. BRADFORD: Excuse me. I was in error. This relates to a corrosion in the test rather than performed by Battelle.

JUDGE WOLFE: All right. We are going to deny,

without prejudice, your offer of TMIA Exhibit 1, because it doesn't on its face certainly relate to eddy current testing.

Do you have something to add with respect to TMIA 2-A through 2-E, Mr. Churchill?

MR. CHURCHILL: Yes, a couple of points. First, I would like to reiterate that she is offering the exhibit without a sponsor which is improper and inappropriate.

JUDGE WOLFE: What is the purpose behind having a sponsor, Mr. Churchill, so Ms. Bradford will understand the nature of your objection?

MR. CHURCHILL: When an exhibit is offered by a party, that's in the nature of the party sponsoring or putting in direct evidence into the case. We were supposed to have identified our direct evidence and actually put in the testimony ahead of time, two weeks ago, if there was going to be direct. We understood you weren't going to have a direct case.

Beyond that, the reason for a sponsor to an exhibit is because if you are putting that forward as a document for which you are asserting the truth of the matter, the author should be there for us so that we can challenge it.

Now, if you're moving it in simply to show that somebody said that at one time or another without saying whether it is true or false -- that is you could say: this is a licensee document. In this case, I believe it's a B&W document -- I don't know whether it's true or whether it's

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1 false, but they once said it. You could ask the Board to put
2 it in for the limited purpose of showing that someone said it.
3 However, in this particular case I'm not sure that that would
4 serve any purpose since you can't use it to cross-examine if
5 it's relevant to that. You can point out on the record that
6 this is from a document. You've identified the document. You
7 can ask the witnesses if they agree with you and so on. But
8 that is my argument, Your Honor, against introducing this
9 document without a sponsor.
10 Beyond that, I would like to point out that this
11 issue, 1.b, is within the context of Contention 1.a.
12 Contention 1.a had to do with post repair and plant performance
13 testing analysis. We asked on discovery many, many times what
14 post repair and plant performance testing analysis meant, what
15 they meant by that. Eddy current was not anything that was
16 ever communicated to us. We did not know we were defending
17 against eddy current testing under this contention.
18 Secondly, going back into past history, the
19 joint intervenors, who are no longer a party, at one time
20 attempted to raise a contention on the accuracy of eddy current
21 testing. That for one reason or another was disallowed by the
22 Board. Maybe it's irrelevant that another party who is not
23 here happened to raise that. The point is that this party who
24 was here did not advance that as a contention.
25 Finally, it does seem to go toward the question

of accuracy of eddy current testing from what you've said. And indeed the contention itself specifies only the license condition -- it is only questioning the license condition -- or the proposed license condition on the frequency of eddy current testing. A challenge has not been raised as to the accuracy or the adequacy of the eddy current testing.

Therefore, in addition to everything else, I believe that this document is irrelevant to Issue 1.b of Contention 1.a.

JUDGE WOLFE: Your final crack, Ms. Bradford.

MS. BRADFORD: I knew I should have worn my button that says, "I am not a lawyer."

JUDGE WOLFE: Let's start from ground zero or point one, whatever you want to call it. Issue 1.b of Contention 1.a does address the frequency of the ECT test; is that correct, Ms. Bradford.

MS. BRADFORD: That's correct.

JUDGE WOLFE: And you already indicated that this document 2-A through 2-E is offered to establish possible errors in eddy current testing; isn't that correct?

MS. BRADFORD: And the reliability; that's correct.

JUDGE WOLFE: All right. TMIA Exhibit 2-A through 2-E is not admitted into evidence. The most important point is that it does not relate to the subject matter of this contention that we are now addressing. And further, when such

a document is tendered, it should be tendered through someone that can describe, for example -- and if the document was relevant in the first place -- what procedures were followed and how these figures appearing on this document were arrived at. That has not been done in this case with respect to this exhibit. So we will not admit this document into evidence.

(Whereupon, the documents marked as TIMA Exhibits Nos. 1, 2-A, 2-B, 2-C, 2-D and 2-E were rejected.)

JUDGE WOLFE: All right. You may cross, Ms. Bradford.

Whereupon,

RICHARD D. WILSON
DAVID G. SLEAR
DON K. CRONEBERGER

having been previously duly sworn, testified further as follows:

CROSS-EXAMINATION (Continued)

MS. BRADFORD: On page four of your testimony, you mentioned an NRC requirement that at least three percent of the total number of tubes be examined in each inspection.

Considering the extent of the damage to the TMI-1 steam generators, do you intend to increase this percentage?

WITNESS WILSON: The three percent inspection criteria, as in the standard general technical specifications, would require us to inspect three percent of about 30,000 tubes, which is about 900 tubes approximately.

The reason that that sampling size is adequate is that if there is extensive damage in the generator, you will find it in one or more places. And as you find one or more defects in the generator, the technical specifications require you to expand the sample size continuously. If you keep finding defects, you will ultimately expand the sample size to a 100 percent inspection. A 100 percent inspection was performed as part of the investigation of the Generator 2 two years ago.

MS. BRADFORD: And you are not now required to perform another such test until -- let me ask you this: the recent leakage, did you perform such a test?

WITNESS WILSON: We performed a limited inspection of some tubes after the last leakage. But that was not the examination of record for the generators. And as a matter of fact, we saw no change in the limited eddy current work that was done just recently.

MS. BRADFORD: What does the proposed scope of the inspection refer to at the top of page 5?

WITNESS WILSON: At the top of page 5, what is referred to is eddy current examination of the generators after operating either 90 days at full power or for 120 days at 50 percent or greater power. In that case, we would shut down and we would perform the standard technical specification eddy current examination which is the three percent tube

sample. In addition to that, we have reference tubes in the generator, and we would examine those tubes also. I don't remember the exact numbers of those tubes, but they were selected because of characteristics of the tubes from the prior examination. So in total, there would be three percent plus additional tubes.

MS. BRADFORD: Are those the tubes that you have sampled tested seven times?

WITNESS WILSON: I can't relate anything to sampled seven times. I don't understand your question.

MS. BRADFORD: On what basis did you select these 800 tubes that you refer to on the bottom of page 5?

WITNESS WILSON: Those were the tubes that have some indication or some known defect in the tube which we wanted to track especially and examine at the time interval which was indicated at the top of page 5. In other words, at 90 to 120 days, those were tubes that had something showing; not necessarily a defect, but would allow us to examine them.

MS. BRADFORD: How are these 800 tubes distributed throughout the steam generators?

WITNESS SLEAR: I'm not exactly sure. I believe these are a fairly random sample. If you're talking about the absolute probe data on over 800 tubes, that's primarily an inspection of the kinetically expanded area of tubes where we obtain a base line after kinetic expansion and want to be

able to compare eddy current signals from the expanded area of the tube taken in the future to this base line.

My recollection is these 800 tubes basically provide a random sample of the kinetically expanded area of tubes in the steam generator.

MS. BRADFORD: Then this special probe data does not include the full length of the tube outside of the tube sheet?

WITNESS SLEAR: This special absolute probe data, to the best of my knowledge, is the kinetically expanded portion of the tubes. There may be absolute probe data on the full length of some numbers of tubes, but I don't believe they are in this data set of 800 tubes that are specifically described here.

We have done and can do an absolute probe inspection of the full length of the tube if we desire. There have been instances where we have done absolute probe examinations of the full length of some tubes or special locations in tubes. But for this specific 800 tube sample, I believe it was in the kinetically expanded area.

MS. BRADFORD: Does the general understanding referred to at the top of page 6 include nuclear power plants with a history similar to that of TMI and to damage as extensive as that experienced at TMI?

WITNESS WILSON: I think it was testified before

by Mr. Slear that we are not aware of explosively or kinetically expanded tubes in steam generators in nuclear power plants. It principally refers to explosively expanded tubes in other kinds of heat transfer equipment.

MS. BRADFORD: On page 5, you state that you have a clear understanding of the damage mechanism. Can you explain the grade of damage to the A generator in light of the fact that water samples indicated a higher concentration of sulphur in the B generator.

MR. CHURCHILL: Objection. Irrelevant to the issue, which is the frequency of eddy current testing as specified in the proposed licensing condition.

JUDGE WOLFE: What page were you reading from of the testimony?

MS. BRADFORD: I was referring to page 5.

JUDGE WOLFE: Since the question is derived from direct testimony of the witnesses, we deem the question relevant.

Objection overruled.

WITNESS WILSON: Will you repeat the question, please?

MS. BRADFORD: Yes. The documents show that water samples were taken after the damage was discovered and that a higher concentration of sulphur was found in generator B than in generator A, and yet it seems that there was a greater

amount of damage in generator A.

MR. CHURCHILL: Your Honor, could we have some clarification. She seems to be referring to some documents, and I'm sorry --

MS. BRADFORD: That is licensee's document TER 341.

MR. CHURCHILL: I don't know the name of that document or what it's about. I also am still puzzled as to how this relates to the testimony. She said page 5, and I don't know where on page 5 she's referring to, and I doubt that the witnesses do either.

MS. BRADFORD: I'm sorry. It's the third line up from the bottom of the page, which states, "We had a clear understanding of the type of damage which occurred in the generator."

MR. CHURCHILL: Okay. And the document is?

MS. BRADFORD: The Technical Data Report 341.

MR. CHURCHILL: May the witnesses see the document before the question is asked on this?

MS. BRADFORD: Give me one moment, please.

(Pause.)

JUDGE WOLFE: What page of that document do you have reference to, Ms. Bradford? The witnesses will read it to themselves and then answer your question.

MS. BRADFORD: It is page V-1.

MR. CHURCHILL: Your Honor, this document goes

1 to investigating the failure of the tubes to identify the
2 damage mechanisms. Now, the damage mechanism was the source
3 of contention to the summary disposition. The summary
4 disposition has already been established on the record and
5 what the damage mechanism was. This reference in the testimony
6 is merely referring to the facts which have already been
7 established and accepted on the record; that is what the
8 damage mechanism is.
9 A contention on the frequency of eddy current
10 testing cannot be bootstrapped into another issue which has
11 already been disposed of.
12 MS. WAGNER: The staff joins in licensee's
13 objection.
14 MS. BRADFORD: The statement in licensee's
15 testimony states that they have a clear understanding of the
16 type of damage which occurred and the reasons therefor. I'm
17 just really testing that statement.
18 MR. CHURCHILL: Your Honor, that clear understanding
19 that type of damage and the reasons are on the record. They've
20 already been established in this proceeding in summary dispo-
21 sition.
22 (Pause.)
23 JUDGE WOLFE: All right. Pressing this a little
24 further, Ms. Bradford, since the witnesses have spoken to
25 their understanding of the type of damage, how does that bear

on the subject matter of this contention which is questioning the method of determining the frequency of ECT tests?

MS. BRADFORD: It seems to me through this testimony they are basing some reliance on the fact that they have determined with a degree of certainty the method or the mechanism of the damage. And for that reason, they are saying then that they are justified in conducting the eddy current test with the frequency which they are stating here.

JUDGE WOLFE: Are you saying that the frequency of EC testing should be different in quality and volume between Unit A and Unit B?

MS. BRADFORD: No, I am not. I am saying that if they are saying they have a clear understanding of the mechanism and based upon that statement they are justifying their frequency of eddy current testing, what I'm asking is: have they really understood the mechanism because of the statement which appears in this document.

JUDGE WOLFE: Objection overruled.

WITNESS GIACOBBE: In looking at the statement on page 5 and its relationship to our eddy current test program, what we are establishing here is that the type of mechanism that caused the cracking is one that required a very specific corrodant source, disulphate, required a certain material, required a certain stress state.

In addition, we understand the cracks were

1 primarily located in the upper tubesheet region, that the
2 vast majority of those defects were up there and not down free
3 span, and also that they were circumferentially oriented.
4 So to the extent that that impacts our knowledge
5 of what the defect looks like in the generator and the types
6 of defects that we're specifically trying to address, we have
7 a very clear understanding. The things that you referred to
8 were part of an overall program, swipe samples, for us to
9 gain insight into what a corrodant was and how, in fact, it
10 might have participated in corrosion reaction.
11 So I think we do have a very clear understanding,
12 and that understanding is that we have circumferentially
13 oriented cracks. The cracking mechanism is one that is very
14 rapid. If it was to occur, it would occur in a very short
15 time. Consequently, 90 days is sufficient to allow such things
16 if they were to occur -- which we do not believe they will --
17 but we have eliminated the sources of contaminant in the steam
18 generator such that we feel that is an adequate time frame to
19 go in and do an examination.
20 MS. BRADFORD: But then what you're saying is
21 that you do not understand why -- or you haven't addressed why if
22 the sulphate was the mechanism for cracking, why if there was
23 more of it found in steam generator B why there wasn't more
24 damage or at least --
25 WITNESS GIACOBBE: I think you have to take a look

at the swipe sample itself and try to understand that first of all when we do a swipe sample, although we try to report it in quantitative measures such that we can try to assess a quantitative distribution, it's really more of a qualitative assessment, because there are a number of factors that affect that particular number: the amount of loose particulate on the surface; how hard one swipes. It's more of a qualitative assessment that we use to make broad generalizations as to where our contaminant was.

So you can see that there was a large difference between the upper areas and the lower areas. But the difference between the two generators was small in comparison.

MS. BRADFORD: So you're saying it might be a random --

WITNESS GIACOBBE: In actuality, the differences between the two generators are small enough that one couldn't conclusively say, "I have something of a significant difference there."

MS. BRADFORD: Did you go back and take another sample?

WITNESS GIACOBBE: I think you have to look at the overall program to try to understand the fact that we removed tubes, that we did surface analyses on tubes and that the differences from generator to generator, when you did a very detailed investigation as we did, did not show

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1 differences between the two steam generators. The more
2 quantitative, more detailed evaluations tend to help us
3 home in on that we did not have a broad difference between
4 the two generators.
5 MS. BRADFORD: Did the leakage that was discovered
6 since your last hot functional test exceed licensee's
7 administrative limits?
8 WITNESS WILSON: The leakage that was discovered
9 in the last test was conducted with steam generators in
10 different conditions than there would be if the plant was
11 in operation. The pressure on the primary system was about
12 350 pounds and on the secondary was roughly atmospheric, and
13 the plant was essentially cold. That leakage was measured
14 about a gallon-and-a-half per hour.
15 When you try to extrapolate that to equivalent
16 operating conditions, it would be in the three to four gallons
17 per hour range and, therefore, was less than the proposed
18 license conditions for shutdown and examination.
19 MS. BRADFORD: Is that the --
20 WITNESS WILSON: That's the seven gallon per hour
21 figure.
22 MR. BRADFORD: Had you not set a limit -- maybe
23 we're talking about different things here -- of .1 gallons
24 per minute -- was that the limit?
25 WITNESS WILSON: No, that was not a limit. That

was simply a measurement to ascertain the current leak rate of the generator.

MS. BRADFORD: I believe that under those conditions, if you exceeded that leak rate, you would locate the damage and reset the limit?

WITNESS WILSON: Not correct. If we exceeded that leak rate, it would be acceptable to operate it until we've reached seven gallons per hour, and then we would shut down and locate the leak.

MS. BRADFORD: And then reset the --

WITNESS WILSON: And then readjust the base line leak depending on what we found.

MS. BRADFORD: Have you reestablished an administrative limit?

WITNESS WILSON: No, we have not. The administrative limit is still one gallon per hour. A base line of one, a change of six, for a total of seven.

MS. BRADFORD: Can you tell me how much damage was identified on the outer tube wall using eddy current testing in your various tests?

WITNESS SLEAR: I can tell you about how much. I don't have the numbers in front of me. My recollection is that we perhaps found approximately 50 tubes that had OD indications identified by eddy current that required plugging.

This is not atypical. The TMI-2 steam generators

1 were eddy current tested after they were installed but before
2 they were operated, and we had a similar situation where we
3 eddy current tested them in the field and found what at that
4 time was proven to be manufacturing defects. And in fact at
5 TMI-2 before the generator was even operative, we took about
6 50 tubes out of service.
7 I think the reason for this is that the eddy
8 current testing that we're doing today, perhaps a decade or
9 more after the generators were built, is more sensitive than
10 the eddy current testing that was done when the generators
11 were originally built.
12 MS. BRADFORD: Is your new, more sensitive eddy
13 current test able to detect small pits and dents?
14 MR. CHURCHILL: Your Honor, I object to that
15 question on the grounds that this hearing is to investigate
16 the accuracy of the repair mechanism to the repair joints.
17 This issue is part of contention 1.a for whether
18 or not as a result of this repaired unit there is a likelihood
19 of rupture. I don't see how the sensitivity or pitting or
20 denting has anything to do with the repaired joints.
21 MS. BRADFORD: Within the documents, I have read
22 that small pits can frequently be sites for future corrosion.
23 In that case, it seems to me that you need to be able to
24 identify those small pits so that you will be alerted to
25 possible later damage.

MR. CHURCHILL: Your Honor, that may or may not be --

JUDGE WOLFE: Just a moment. How does that relate to this contention, even assuming there may be some problem there?

MS. BRADFORD: If, indeed, you cannot locate those small pits with eddy current testing until they have become corroded, then --

JUDGE WOLFE: What does this have to do with the method of determining the frequency of ECT tests? That's the contention now. Where are you going with that sort of question?

MR. BRADFORD: If there are indications that are not picked up yet by the eddy current testing, it seems to me that it would be prudent to set a frequency of eddy current testing so that you can determine when these problems are beginning.

JUDGE WOLFE: That would seem to be a qualitative -- a difference in the qualitative test, not the frequency. Is that correct, Ms. Bradford?

MS. BRADFORD: (No response.)

JUDGE WOLFE: Go ahead, Ms. Bradford.

MS. BRADFORD: My proposed --

JUDGE WOLFE: If you could address yourself the best you can, then we'll just --

MS. BRADFORD: It's just that my proposed TMIA Exhibit 2 showed that there are indeed small pits and dents in tubes that were taken out for destructive testing.

(Pause.)

JUDGE WOLFE: The Board has considered the objection. Possibly the objection is well taken. There is some question in our minds where you are going with this. To get out the facts, we will allow the question. Objection overruled.

Could we have the question read back?

(Whereupon, the reporter read from the record, as requested.)

JUDGE WOLFE: Ms. Bradford?

MS. BRADFORD: The pits and dents I was referring to are in the outer dimension.

WITNESS SLEAR: The first comment I would like to make is that the Exhibit 2, which was not allowed, was referred to as indicating that there were small pits and dents that were not detected. I would point out that that eddy current probe -- the time frame of this report is like February of 1982, which was very early in the program. This is a 5-10 standard differential probe not using the high gain. It is significantly different than the probes we currently use and have used to determine 100 percent of the generators. We currently use a bigger diameter probe which increases our

1 sensitivity. We have increased the gain setting on the
2 standard differential probe to improve our sensitivity and
3 we have a two-probe inspection where if we find an anomaly
4 that we cannot decipher or understand by the 5-40 standard
5 differential, we use the 8 by 1 absolute probe to further
6 interrogate the tube and to find whether or not it is defective.
7 So I think it is in error to draw a parallel
8 between what we're doing today and this report which is over
9 ten years old.
10 To answer the question concerning: is your more
11 sensitive ECT probe able to detect small pits and dents from
12 the outer dimension of the tube, the answer is -- and perhaps
13 twofold -- we are certainly sensitive to dents. The standard
14 differential probe is a very good probe for responding to
15 dents, whether OD or ID. It gives a very large signal which
16 is very easy to differentiate.
17 I don't have in my mind any relationship between
18 dents and the potential for safety significance. But the
19 answer to the question is: yes, we can detect dents. With
20 regard to small pits, we have shown the sensitivity of the
21 eddy current probe in relationship to defects that require
22 plugging and have shown that it is adequate to detect defects
23 that require plugging by our existing tech specs.
24 There are undoubtedly small pits, very small pits
25 that are below the threshold of sensitivity for eddy current

in our steam generator, as they are in every steam generator in this country. Therefore, there certainly would be small pits that we may not detect because they are below the threshold of sensitivity. But any pit of the size or degradation of the size requiring plugging is easily detectable by our sensitive eddy current probe.

MS. BRADFORD: Did the judgment regarding the frequency of eddy current testing take into account the damage to the outer dimension of the tubes, the pitting?

MR. CHURCHILL: Your Honor, I suppose there is no harm in allowing the question to go, but I think it is important that I get on the record that once again this issue on the frequency of eddy current testing is encompassed within another issue which is within the hearing, which has to do with the repair process.

Somehow or another Ms. Bradford's questions have got to be related to the direct consequences or the results of these tubes having been repaired and the repair process itself.

Talking about looking for pits, dents or anything else on the outer surface of the tube, I see absolutely no relationship between that and the repair process which took place up inside the tubesheet, the outer surface of which the joint is smashed against the inner hole of the tubesheet.

MS. BRADFORD: I'm not sure if that was an

1 objection to my question or not.

2 MR. CHURCHILL: It very much is an objection, yes.

3 MS. BRADFORD: I am asking about the judgment of

4 frequency of eddy current testing, which is what I thought this

5 testimony concerned. I am asking the witnesses --

6 JUDGE WOLFE: But this does not relate to the

7 eddy current testing for the tubes in the tubesheet; isn't

8 that correct?

9 MS. BRADFORD: It relates to the eddy current

10 testing of all of the tubes.

11 JUDGE WOLFE: Objection sustained.

12 MS. BRADFORD: Were the detailed technical

13 assessments referred to on page 8, item 4 extended to areas

14 outside the tubesheet?

15 WITNESS WILSON: There was no repair outside the

16 tubesheet.

17 MS. BRADFORD: How long do you predict it will

18 take for TMI's Unit 1 steam generator to reach chemical

19 equilibrium?

20 WITNESS SLEAR: Chemical equilibrium, as it's

21 referred to in this testimony, lends itself to looking at

22 where we're trying to go with the steam generators prior to

23 going in for the eddy current test.

24 What we're trying to achieve is allowing a period

25 of time in which perhaps any residual sulphate that might

1 remain on the surface goes into solution and is removed by
2 our cleaning process, the ongoing line exchange process. It
3 also refers to the fact that we have looked at what our steam
4 generators have been in, a long-term layoff, haven't been
5 operated for a number of years. We wanted to allow a certain
6 period of hot operation such that the normal oxides typical
7 of a steam generator have been well formed and the surface
8 has been repassivated and that the system is in an equilibrium
9 state.

10 It also suggests that we considered the fact
11 that if, in fact, something were to happen that is unexpected,
12 that there needs to be a certain period of time for that to
13 occur. If one were to make the examination period too short,
14 certain things might be overlooked. So it is a number of
15 reasons that went into assessing when to do the examination.

16 And to say what is the exact time for chemical
17 equilibrium to occur, it is possible it could occur in a matter
18 of hours. But to be conservative, we set a longer period of
19 time to allow for a longer operation under normal reactor
20 operating conditions.

21 MS. BRADFORD: When you say there are unexpected
22 factors that you factored into this, is that in the chemistry?

23 WITNESS GIACOBBE: There's nothing unexpected
24 in the chemistry. We have established very conservative
25 chemistry limits for this plant, and we have the on-line

capability of analyzing for that chemistry. So we don't expect chemistry upsets or anything unexpected in that region.

MS. BRADFORD: I don't understand your reference of waiting for something unexpected.

WITNESS GIACOBBE: Anytime you change a system, you go hot, you go cold, you add oxygen, you remove oxygen, there's a certain amount of chemical equilibrium that changes. Through hot functional testing, we have established that nothing detrimental has occurred, nor do we expect that, because we have tested it. We have put in limits which preclude that.

But to be conservative and to look at what is the best for this steam generator, what is the best for safety, an extended period of operation allows us the best possible combination of operating conditions to establish equilibrium plus optimizing when you should go in and do eddy current testing. It is really a balance when you look at the whole thing.

MS. BRADFORD: I have no more questions.

JUDGE WOLFE: Mr. Au?

MR. AU: Commonwealth has no questions.

JUDGE WOLFE: Ms. Wagner?

MS. WAGNER: Staff has no questions.

JUDGE WOLFE: Redirect?

MR. CHURCHILL: Yes, sir.

REDIRECT EXAMINATION

MR. CHURCHILL: Mr. Wilson, earlier on cross-examination by Ms. Bradford, she asked something about kinetically expanded tubes, and I believe your reply was that Mr. Slear testified earlier there are no kinetically expanded joints in steam generators in nuclear plants.

My recollection of Mr. Slear's testimony is that he was referring to repairs as opposed to original manufacture. Was that your reference, too?

WITNESS WILSON: Yes, that was my reference.

MR. CHURCHILL: You also in response to the question said that a new baseline sensitivity has not been established for the steam generators. In your opinion, would that proposed license condition require the establishment of a new baseline before you go up to power?

WITNESS WILSON: No. The axial leak that was referred to has been plugged, and we consider the baseline still valid as a conservative upper limit, and would not change it.

MR. CHURCHILL: So, that's in accord with the proposed license condition?

WITNESS WILSON: I believe it is, yes.

MR. CHURCHILL: I have no other questions.

JUDGE WOLFE: All right, we will proceed with the Board's questions.

JUDGE LAMB: Could someone on the panel explain for the record briefly the difference between differential probe characterization and an absolute probe ECT measurement?

WITNESS SLEAR: Yes, sir, I believe I can.

Standard differential refers to the characteristic of a probe where the coils that are carrying the electricity which is inducing eddy currents in the tube are wound circumferentially. There are two of them.

We compare one coil's signal to the other and get a differential signal. As the coils are passing down through the tube and pass a defect indication, they become unbalanced.

As the first coil passes the defect, it unbalances the signal when compared with the second coil. That results in the indication that you can see on an oscilloscope. So that's the characteristic of a standard differential probe, is a circumferentially wound coil, two of them, one being compared to the other.

In an absolute probe, the coils, instead of being

wound circumferentially, are essentially axially wound. Looking at sections of the tube, looking out like this, if the tube is running down in front of me, you are looking out at sections of the tube.

They are not compared to other coils, but rather the upset in the signal from that individual coil itself results in an indication which could be characterized as a defect.

That's where you get the term "absolute," and it is not a differential type of comparison between two coils, but rather it is one coil and the characteristic of the geometry of the coil is such that it is axially oriented looking out at various sections of the tube.

The reason we call the probe an 8 by 1 probe is, we found early in the program that in order to get 360 coverage you basically have to put eight coils around the circumference because each one looks at an arc length of the tube. Therefore we ended up calling the study an 8 by 1 absolute probe.

We didn't uniquely develop absolute probes for TMI-1, but the 8 by 1 probe was in fact developed for us to get 360 degree coverage.

JUDGE LAMB: I was looking at your testimony on page five and wondering about the significance of the difference between having the differential probe characterization on all of the tubes and the absolute probe data on 800 of them.

WITNESS SLEAR: I think I can explain the difference fairly easily. In the area of the kinetic expansion, the tube itself is essentially coined into the face of the tubesheet, so if there is a ripple on the tubesheet there will be a ripple on the tube.

As I mentioned when we were talking about the sensitivity of the standard differential probe to dents, it is very sensitive to dents. A ripple on the tube is similar to a dent.

Therefore, the standard differential probe sensitivity is reduced significantly in the expanded area because of all the signals that you're getting from these unimportant but present dents and ripples in the tube.

The absolute probe, on the other hand, its background noise level, if you will, is not significantly affected by these ripples, and therefore it is a better -- i.e., more sensitive -- probe to use in the area of kinetic expansion.

That is why we took 800 tubes and got a baseline on them, put the absolute probe in the area of the kinetic expansion to ensure we would have something to compare it to in the future to make sure we didn't have ongoing degradation.

JUDGE LAMB: The future tests will be which type?

WITNESS SLEAR: The future tests would include, for these 800 tubes where we have some absolute probe eddy

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current data -- some number of those would be examined on a periodic basis to insure that there is no degradation, and for the other tubes, and certainly for the free span of the tube, the record inspection would be the standard differential 5-40 probe. But I would point that when the standard differential 5-40 probe gives us a signal that we cannot clearly interpret as a defect, we go in with the second probe, the 8 by 1 absolute, even in the free span to further characterize and understand that indication.

JUDGE LAMB: At the top of that page you mention that -- let me see if I can try and reconstruct this -- you would conduct ECT at the subsequent shutdown refueling. My understanding is that you would do three percent of the tubes at that time.

WITNESS SLEAR: Yes, as a minimum; that's what is required by the Tech Specs.

JUDGE LAMB: Do you mean that you would only do this once, or you would do this on each refueling?

WITNESS SLEAR: My recollection of the table in our safety evaluation indicates that not only the three percent examination, but all the other special examinations--there is about a two or three-page table that talks about all the special exams, and they include some discussion about these 800 tubes in absolute data. But that would be done, at the minimum, at the 90/120-day outage and at the next refueling. Then,

obviously, as you do with any program, you continue to evaluate the data and conclude whether or not it needs to be continued to be examined or if there is no need to continue the examination.

JUDGE LAMB: So what would happen after that has not yet been determined?

WITNESS SLEAR: It would be something that we, in conjunction with the NRC, would continue to work on.

WITNESS WILSON: I would make one comment. In any event, the standard Tech Specs require examination frequency of 12 to 24 months. Most plants, depending upon the fueling cycle that they're on, really, in fact, examine at every refueling cycle the minimum three percent sample size.

JUDGE LAMB: At the bottom of page five and the top of page six you indicate that you have an extensive qualification program on the repair which has tested kinetically expanded joints out to five years of load cycling and 15 years of thermal cycling.

I am not clear on the basis for that, what that refers to.

WITNESS SLEAR: If you look at the operating history of a steam generator, it is subject to various cycles, startup, shutdown, cooldowns and heatups.

In developing the qualification program for the kinetically expanded joints, we basically took a look at the

1 design basis, heatup and cooldown cycles, for example, and I
2 believe there the design basis is 38 per year.
3 We took that number and we multiplied it by 15
4 and subjected the joint to almost 600 heatup and cooldown
5 cycles as part of the qualification program. The obvious in-
6 tent was to insure not only that we had a joint which was per-
7 forming exceptionally well right after kinetic expansion, but
8 a joint that we could expect to, over the years, continue to
9 perform well.
10 So we basically took a look at the operating
11 cycles a steam generator is designed for and tried to model
12 them as best we could in the qualification program.
13 JUDGE LAMB: You do not have this information
14 based on actual time, but based on the number of cycles involved?
15 WITNESS SLEAR: That is correct. It is based on
16 the number of cycles.
17 JUDGE LAMB: On page seven and at the top of page
18 eight, your item 1 -- the bottom of page seven and the top of
19 page eight, I'm not clear on why equilibrium must be reached in
20 order to get full benefits from eddy current testing. Could
21 you clarify that for me?
22 WITNESS GIACOBBE: In order to derive full benefit
23 from the eddy current examination we wanted to assure that we
24 had the system hot and operating for some minimum period of
25 time. That period of time is not one that you could put a

1 quantitative hard number on; but conservatively we felt that
2 the time frame which we were looking at was one in which the
3 sulfur, the chemistry, the tubes, everything, had a chance to
4 go into that chemical state, which is representative of a long-
5 term normal operating kind of state.
6 We felt that three months would be conservative
7 and that is why that was chosen. It just allows the system to
8 achieve the chemistry and equilibrium such that eddy current
9 testing is most meaningful. We didn't want to go in too soon
10 in the event that something was going on which was totally un-
11 expected to us; that we had an agenda operating sequence there.
12 JUDGE LAMB: But between eddy current testing --
13 I'm trying to clear this up in my mind. Between the measure-
14 ments that you make in your eddy current testing, the system
15 presumably would be out of chemical equilibrium for part of each
16 of those cycles, wouldn't it, and in equilibrium for part?
17 WITNESS GIACOBBE: I think in the terms in which
18 we have used chemical equilibrium here, it describes coming
19 back from the long-term lay-up.
20 Once you've come back, the steam generator has
21 developed its oxide films that are typical of all steam genera-
22 tors. We don't anticipate and initially it would not show
23 if anything else was going to occur.
24 We felt that we were in a situation where we
25 could have these tubes laid up for five years, and it was

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1 appropriate to have a certain break-in period, if you will,
2 that allowed system equilibrium to be achieved so that the
3 steam generators were in a normal oxidized, passive state.
4 JUDGE LAMB: In other words, you would anticipate
5 during the first cycle, it would require some time to get
6 equilibrium, but that thereafter you wouldn't destroy the
7 equilibrium when you conducted the eddy current testing?
8 WITNESS GIACOBBE: That's correct. Equilibrium
9 really refers to coming back from this particular long-term
10 outage.
11 JUDGE LAMB: That's all I have.
12 JUDGE HETRICK: To follow up on the last ques-
13 tion, am I correct that you are not saying that the results of
14 eddy current examinations after a short time would be inaccurate
15 or inappropriate; is that correct?
16 WITNESS GIACOBBE: No. No way is that a reflec-
17 tion on the results of the eddy current exam. It is strictly
18 to allow a sufficient period of operation. One doesn't want to
19 be too short in the time frame, nor does one want to be too
20 long in the time frame. We felt that this was optimized for
21 the conditions of our generator.
22 JUDGE LAMB: Would you be able to determine when
23 you have reached equilibrium and, if so, how?
24 WITNESS GIACOBBE: As I stated, in reality
25 equilibrium is probably going to be achieved very quickly. We

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have gone through extensive corrosion tests; we have gone through a number of hot functional tests. What we are looking at primarily is the fact that there is some small amount of residual sulfur perhaps remaining on those tubes; and this allows that residual sulfur to be slowly removed under protective conditions that are afforded us by being hot and being de-aerated. And so, we, from our own hot functional test, we have learned that you can put the system on line, you can go hot, and there is no problem in achieving chemistry within the specifications we've established.

So, therefore, equilibrium for all practical purposes has been achieved, although we still felt conservatively the longer -- the three-month period would allow additional sulfur removal, additional passivation; and that was a conservative approach on our part.

JUDGE WOLFE: Cross-examination on Board questions.

Ms. Bradford?

MS. BRADFORD: Yes, I just have a few questions.

RECROSS-EXAMINATION

MS. BRADFORD: On the qualification program, how did you factor in the history of TMI to that program?

WITNESS SLEAR: What qualification program?

MS. BRADFORD: The qualification of the joints which -- I assume that's what you are referring --

WITNESS SLEAR: The qualification of the kinetic

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1 expansion repairs?

2 MS. BRADFORD: Yes.

3 MR. CHURCHILL: Excuse me, Your Honor; I would

4 have to object to that. I believe she may be referring to the

5 long-term corrosion testing that the question was asked about,

6 with the 15 years of simulated operating experience. Excuse

7 me; if I could just find that.

8 (Pause.)

9 MR. CHURCHILL: Your Honor, I withdraw the

10 objection.

11 MS. BRADFORD: Would you like me to repeat the

12 question?

13 WITNESS SLEAR: Yes, please do.

14 MS. BRADFORD: I asked: how would the qualifica-

15 tion test of the expanded joint factor in the load time history

16 and so the down-time five-and-a-half year history of the

17 steam tubes into that testing?

18 WITNESS SLEAR: If you look at the kinetic expan-

19 sion repair itself, there are a number of key parameters which

20 are the subject of another testimony, specifically Dr. Pai's

21 testimony, that can affect the kinetic expansion and its per-

22 formance.

23 What we did was examine the TMI-1 steam generator

24 tubes as they exist today and confirmed that there is no change

25 in those key parameters as a result of either age or the

1 corrosion process, what-have-you, and, therefore, concluded
2 that it was acceptable to use archive tubing in the qualifica-
3 tion program; archieve tubing in the sense that it was tubing
4 available on the shelf that is from the same heats that were
5 installed in TMI-1 but not tubing that had actually operated in
6 TMI-1. The tubing allowed us to bracket such things as yield
7 strength, which are important to the performance of the kinetic
8 expansion process.
9 MS. BRADFORD: I'm sorry; are you finished?
10 WITNESS SLEAR: I believe that's the answer to
11 your question.
12 MS. BRADFORD: So it did not take in the history
13 of the tubes, but the geometry of the tubes?
14 WITNESS SLEAR: The answer is that it took into
15 account the history in terms of we examined tubes as they exist
16 today in the TMI-1 steam generator for the properties which are
17 important to the performance of the kinetic expansion, and we
18 showed that those properties have not changed with time; and,
19 therefore, we essentially factored in what we had to the
20 qualification program and utilized tubing in the program from
21 heats that are installed at TMI-1, which allowed us to bracket
22 such key parameters as yield strength.
23 MS. BRADFORD: That did not factor in -- let me
24 ask you this question: does the loss of pretension have an
25 effect on the joint?

WITNESS SLEAR: No; loss of pretension has no effect on our ability to make a kinetically expanded joint.

MS. BRADFORD: But it does add compressive load to the tube, and that would be distributed evenly over the length of the tubing, including that portion within the tubesheet; is that correct?

WITNESS SLEAR: No, I don't think that's true at all. As you think about a friction joint, which is what the kinetic expansion process does, gives you a mechnical joint that's fairly long; the joint itself, the six-inch qualification length within a fraction of an inch, several hundred pounds, is essentially held by that joint. Therefore, a several hundred pound change in preload wouldn't even be noticed by the top inches of the kinetically expanded joint. You can't transfer the load up there. The load is essentially transferred within the first portion of an inch of the kinetically expanded joint to the tubesheet itself, and the rest of the kinetically expanded joint doesn't even see the presence or the absence of several hundred pounds of load.

MS. BRADFORD: And the transition zone.

WITNESS SLEAR: The transition zone is, in fact, below the friction fit area, and, yes, it would see whatever change the rest of the tube does, which is as you described, the load is distributed over the length of the tube.

MS. BRADFORD: So there would be extra compressive

force applied to that, to the transition zone?

WITNESS CRONEBERGER: If I could, the qualification basis from a load standpoint of the joint was the tension load. The tension load was based upon an axial condition.

We are now talking in terms of loss of preload. So the loss in preload simply is a delta reduction in tension force which would be used for the qualification basis. The loss of preload helps; it does not hinder.

MS. BRADFORD: I don't understand. Does the loss of preload add the compressive force to the --

WITNESS CRONEBERGER: The force concerned with the qualification of a joint is a tension force. The tension force is as a result of, among other things, the temperature differential I discussed between tube and shell.

That force, as we have said in the testimony, for the main steam line break is some 3,100 pounds.

The loss of preload is simply a small change in the tensile load that would be applied to the tube. In no case under those cooldowns, which are the design basis, do we ever see compressive load.

MS. BRADFORD: But when you're in a steady state there is a compressive load on the tube, and this could be an additional --

WITNESS CRONEBERGER: Yes, that's correct, but that is a small number in comparison to the design basis for

1 the tube.

2 MS. BRADFORD: I see. On the three percent

3 sampling on every shutdown, how do you select the sample?

4 WITNESS SLEAR: The tubes are intended to be and

5 are a random sample of the steam generator, with the further

6 consideration that it is more efficient to perhaps do one row

7 at a time.

8 So in the past we have historically picked alter-

9 nate rows and essentially gone completely across the steam

10 generator, and then gone to another portion of the steam genera-

11 tor and gone completely across it. But, in general, it is

12 intended and it is a random sample of tubes throughout the

13 steam generator.

14 Certainly, one key aspect of any future eddy

15 current examination is, if you have a tube that has an indica-

16 tion from a previous exam that it did not require to be plugged

17 or taken out of service, that tube is also part of the future

18 examination.

19 So you would clearly, on any future examination,

20 not only get a random sample of the steam generator, but you

21 would get a reinterpretation or a reinterrogation, I should say,

22 and a reevaluation to insure the existing known indications

23 haven't changed with time, which is part of what we have just

24 completed in the last few weeks.

25 MS. BRADFORD: So that's in addition to this three

1 percent?

2 WITNESS SLEAR: Yes.

3 MS. BRADFORD: You would add -- I can't even

4 remember all the --

5 WITNESS SLEAR: If you knew a tube from before

6 had an indication in it, you would reexamine that tube in addi-

7 tion to the three percent random sample.

8 The three percent random sample is basically

9 looking for new problems on a statistical basis, whereas

10 examining known indications is the continued assurance that

11 whatever is there, number one, isn't required to be plugged,

12 and, number two, that it isn't getting worse so it's a problem

13 -- or in that case it's not a problem.

14 MS. BRADFORD: I have no more questions.

15 JUDGE WOLFE: Mr. Au?

16 MR. AU: No questions.

17 JUDGE WOLFE: Ms. Wagner?

18 MS. WAGNER: No questions, sir.

19 JUDGE WOLFE: Redirect, Mr. Churchill?

20 MR. CHURCHILL: No questions, sir.

21 JUDGE WOLFE: We will have a 15-minute recess.

22 (Recess.)

23 JUDGE WOLFE: Back on the record.

24 MR. CHURCHILL: Your Honor, I realize that we

25 have finished with Contention 1.b, but there is a statement

made by one of the witnesses that does require some clarification. I believe there was an error. It has to do with reestablishing the base line.

May I ask one or two questions?

JUDGE WOLFE: This would be on redirect.

MR. CHURCHILL: Yes.

FURTHER REDIRECT EXAMINATION

MR. CHURCHILL: Mr. Wilson, if you recall, I asked you on redirect a question of whether or not, after this latest leakage was discovered, whether the base line leakage rate would have to be reestablished in accordance with the proposed leak rate condition.

Could you tell me what the situation is on that, please?

WITNESS WILSON: Yes; I think I answered the question before saying that no, we would not reestablish the base line leak rate, which is the current one-gallon per hour leak rate.

In examining the Board notification, I was in error. In fact, we will establish a new base line leak rate on restart of the plant.

MR. CHURCHILL: Thank you.

JUDGE WOLFE: Ms. Bradford, anything with regard to that response?

MS. BRADFORD: No.

JUDGE WOLFE: Mr. Au?

MR. AU: No questions.

JUDGE WOLFE: Ms. Wagner?

MS. WAGNER: No questions.

JUDGE WOLFE: Where do we stand now with respect to the next issue?

MR. CHURCHILL: The next issue is Issue 1.c, and the sponsors of that issue are up there at the witness table. prepared for cross-examination on it.

This is the issue that includes Mr. Broughton, our witness, whose scheduling problems don't enable him to be here past the end of the day today, so I think it lookslike the timing may work out well.

May I ask, Ms. Bradford, if it looks like you may not finish this issue today, do you think you could at least finish with Mr. Broughton?

MS. BRADFORD: I think we'll be finished today. with Mr. Broughton.

MR. CHURCHILL: Thank you.

CROSS-EXAMINATION

MS. BRADFORD: On page four of your testimony, the first full paragraph, you say "The initial power ascension program was developed, prior to knowledge of the damage to the steam generators..." Was this slow power ascension -- was this planned prior to this knowledge of the damage in recognition

that five-and-a-half years of maintenance and cold shutdown would have an unknown and possibly damaging effect on all plant systems, including the steam generators?

MR. CHURCHILL: Your Honor, I would object to that question in all respects except with respect to the steam generator.

MS. BRADFORD: The Licensee has said that they already had a slow ascension to power program in place and that essentially it is unchanged.

I am querying whether that was a recognition that the extended time was damaging to plant systems.

MR. CHURCHILL: Your Honor, the testimony is that the power ascension program was in place already for other reasons.

The purpose of that testimony is that the Board has asked us how were the power ascension limits established? The first point the witnesses are making is that the program itself already was there without regard to the damage because we didn't know about the damage.

So the next step is, okay, that being the case, how, if at all, were the limits changed or modified because of the steam generators?

Any question, therefore, about how it was established originally as an admission that a lay-up of five to five-and-a-half years would be damaging to plants is totally outside

1 the scope of their testimony.

2 MS. BRADFORD: Am I to understand that the

3 Licensee is saying that this slow return to power is only be-

4 cause there was damage to the steam generator?

5 JUDGE WOLFE: What Mr. Churchill says is that

6 for you to pose a proper question, it should be whether, by

7 virtue of the stress corrosion cracking to the tubes, the

8 original plans for power ascension have been changed.

9 Is that your question, or are you going right

10 from ground zero and asking why power ascension limitations

11 were determined in the first place for the entire plant?

12 MS. BRADFORD: Yes, I am asking why the original

13 slow power ascension --

14 JUDGE WOLFE: That goes beyond the scope of the

15 contention. The objection is sustained.

16 You may query about in light of the repairs,

17 whether any changes were made to the original power ascension

18 limitations.

19 MS. BRADFORD: On the bottom of page four, the

20 paragraph that starts on the bottom of page four and continues

21 to page five, you discuss various pre-critical tests.

22 Did that include the hot functional test?

23 WITNESS BROUGHTON: Yes. The pre-critical tests

24 referred to here did include the period of hot operation to

25 test the steam generators.

MS. BRADFORD: And you end by saying the results confirm the adequacy of the repair process and the operability of the steam generators.

Has that been changed by the recent discovery of leakage?

WITNESS BROUGHTON: No, it has not.

MS. BRADFORD: On the bottom of page five you state that the 48 percent power point was chosen because, among other things, it follows the tests which load the steam generator tubes.

What are the tests which --

WITNESS BROUGHTON: There are two tests scheduled in the test programs to be run at 48 percent power. Those are the loss of feedwater test, which requires the use of emergency feedwater, and then immediately following that test there is a test which evaluates the transition to natural circulation, which also uses emergency feedwater but fills the steam generators to a different level.

Those two tests will cause different loads on the steam generator tubes than they would see if they were running at a steady state condition.

I don't know that we have quantified those loads, but those are tests which would cause the steam generator to see loads which are different from the previous operation during the test program.

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MS. BRADFORD: "Previous operation during the test program" meaning the ascension to 48 percent power, or --

WITNESS BROUGHTON: Those are actually run at 40 percent power, so it would be the first phase of the low power testing, in the zero to five percent range, and then the increased power up to the 40 percent point.

MS. BRADFORD: At the top of page 6, beginning five lines down from the top, starting "Experience from the steam generator pre-critical tests corroborated that 30-day hold periods would provide adequate time for stabilizing the plant and collecting statistically valid data," would you expand on that?

WITNESS BROUGHTON: In particular, when we did the hot test program and were monitoring the steam generator leakage, there were hold periods as part of that program which were placed after various cooldown periods.

During those hold periods we did everything we could to maintain steady conditions in the plant and frequently calculated the leak rate.

Mr. Slear spoke earlier about statistical data gathered with regard to the leak rate; it was gathered during that test program and allowed us to evaluate how repeatable the leak rate readings were.

So it is primarily the experience we gained from leak rate monitoring as part of that test program that we used

to assure ourselves that the period of 30 days would be more than adequate to allow a good evaluation of the plant leak rate.

MS. BRADFORD: And then the monitoring was the grab samples that you talked about earlier?

WITNESS BROUGHTON: Well, the monitoring is done both by looking at the on-line instruments that were mentioned earlier and also by taking grab samples.

MS. BRADFORD: The next paragraph on page six indicates that "Management reviews are scheduled prior to power increases following the 48 percent power hold..." I don't quite understand what that means.

How are you going to review -- first, what level of management; explain that.

WITNESS WILSON: It has been proposed that, in addition to the normal plant and engineering review of test data which will take place, there is a special senior management group which includes the plant vice-president, includes myself, includes a member of independent safety review groups, includes the president of the company, who will, in fact, sit down and review with the people who perform the test and review the data and render a judgment, and confirm the judgment, hopefully, of the plant staff engineering that the plant is behaving properly.

MS. BRADFORD: The independent safety review group is with the TPR, that group?

WITNESS WILSON: No. I think I said that on the senior management committee is one member from one of the company independent safety review groups. That member is chairman of what we call the GORB, the General Office Review Board, and he is a member of that panel.

MS. BRADFORD: At the bottom of that paragraph, the last sentence indicates that management will be reviewing open items at that time.

What items do you expect open at that time?

WITNESS WILSON: I don't know that we expect any, but if there are any, they will be reviewed.

MS. BRADFORD: On the same page, on page six, you have a quote from the February TPR report, and it seems in this report that the TPR was not sure that a month would be sufficient. They state that a hold period of perhaps a month or more at 40 percent power should be considered.

Have you knowledge of whether they have since changed their mind or more firmed up that hold period?

WITNESS WILSON: I think, as the testimony states in the following paragraph, that in its May 16, 1983 report the TPR stated that "The GPU Nuclear response is satisfactory." They agree with our current test recommendations.

MS. BRADFORD: I have no more questions. Thank you.

JUDGE WOLFE: Mr. Au?

MR. AU: I have no questions.

JUDGE WOLFE: Ms. Wagner?

MS. WAGNER: No questions.

JUDGE WOLFE: Redirect, Mr. Churchill?

MR. CHURCHILL: No redirect, Your Honor.

JUDGE WOLFE: Board questions?

JUDGE LAMB: Just a couple of quick questions. When you refer to a hold period, you mean holding at the specified power level; is that correct?

WITNESS BROUGHTON: That is correct.

JUDGE LAMB: Do you hold the entire 30 days at that level, if possible?

WITNESS BROUGHTON: Yes; the intention would be to hold at 48 percent power for a period of 30 days; then continue the test program up to 75 percent; hold at 75 percent power level for another 30 days.

JUDGE LAMB: If anything required shutdown during that period, would you repeat that for the entire 30-day hold?

WITNESS BROUGHTON: If we were unable to hold for 30 days due to plant problems, I think we would have to re-evaluate what the problems were and determine how much, if any, of the hold period needed to be recovered.

JUDGE LAMB: One other item. On page 5 you use a piece of jargon; I wonder if you would clarify it in normal language. Under item 4, "normal line-ups."

WITNESS BROUGHTON: Yes. Item 4 talks about gaining additional experience in operating the plant with systems in normal line-ups. By that we mean having the systems which are needed for plant operation, operating the way that they would be at full power.

So, for example, if a system had two pumps, both of which were required at full power, we would like to be at a high enough power level so that we could be operating both of those pumps and it would look to the operators as it should at full power.

JUDGE LAMB: Thank you.

JUDGE HETRICK: Page 6, where you mention the 100 percent turbine trip test, is this a test that is normally done at any plant after an outage, or is this special for this particular plant startup?

WITNESS BROUGHTON: With respect to the TMI, which is the plant I can address, the normal test program with a full power turbine trip test is one which might be done when the plant is initially started up for the very first time; but it is not the type of test which would normally be done after a refueling outage.

Now, in our case at TMI-1, we have changed the way the plant responds when the turbine trips are in full power for reasons independent of the steam generator repair; but because we had changed the plant response to that event, we felt it

1 proper to put that event in the test program.

2 Therefore, for this particular test program we

3 had already decided to include this before the steam generator

4 issue arose.

5 JUDGE HETRICK: Will there be any consideration

6 of decay heat removal after this turbine trip test?

7 WITNESS BROUGHTON: Certainly, after any trip

8 from power, decay heat removal is a primary concern. This par-

9 ticular test doesn't challenge the decay heat removal capabili-

10 ties of the plant very much, however, because the main feed-

11 water system and the condenser, which are normally used for

12 removal of heat generated power and decay heat removal, will

13 remain in operation.

14 JUDGE HETRICK: Will there have been enough opera-

15 tion to reach equilibrium in decay heat?

16 WITNESS BROUGHTON: There certainly will not

17 have been enough time and power to reach the maximum level of

18 decay heat generation that we might expect, say, at the end of

19 an operating cycle. Depending upon exactly how the power test-

20 ing goes, that will determine what the actual core decay heat

21 product inventory is at the time of the test.

22 With the hold periods we have added to the pro-

23 gram at the 48 and 75 percent plateaus, there will be more

24 decay heat present for this test than there would be if we had

25 just gone straight to power and then tripped the turbine the

first time we went to 100 percent.

JUDGE HETRICK: But it will not be a challenge to the system because the normal heat removal systems will be operating?

WITNESS BROUGHTON: That is correct.

JUDGE WOLFE: Cross on Board questions. Ms. Bradford?

MS. BRADFORD: No.

JUDGE WOLFE: Mr. Au?

MR. AU: No questions.

JUDGE WOLFE: Ms. Wagner?

MS. WAGNER: No questions.

JUDGE WOLFE: Any redirect?

MR. CHURCHILL: No, sir.

JUDGE WOLFE: All right. May some of the witnesses be excused?

MR. CHURCHILL: Yes; Mr. Broughton, as far as we are concerned, may be excused.

JUDGE WOLFE: All right; you are excused.

(Witness Broughton excused.)

JUDGE WOLFE: Are we prepared to proceed to the next issue?

MR. CHURCHILL: We are prepared, Your Honor.

JUDGE WOLFE: Ms. Bradford?

MS. BRADFORD: Yes, Your Honor.

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JUDGE WOLFE: That will be 1.d.

MR. CHURCHILL: Your Honor, may I make a comment? Perhaps it's in the nature of an observation.

This piece of testimony has had us a little bit puzzled and we are not quite sure how to deal with it. The question as posed by the Board was whether or not -- this was based on the intervenor's concern -- whether or not the long-term corrosion test program adequately simulated the operating conditions of the reactor.

Our problem came when we had our witness develop the testimony; the first thing he said -- and this is on page three -- actually, it starts at the bottom of page two and up on the top of page three -- is that the purpose of the program was to verify that the mechanism for the cracking which had occurred would not reinitiate under operating conditions. That issue had been dealt with extensively under Contention 2.b and all of the issues of the other intervening party which is no longer a party; and the facts establishing the mechanism and our assurance that it would not reinitiate were established on summary disposition.

The witness then went on to say that the only possible relationship of the long-term corrosion tests -- this is again on page three, the second paragraph -- the only relationship to the kinetic expansion repair process is to verify that the repair itself did not render steam generators

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1 susceptible to reinitiation of the corrosion; and, in fact,
2 that is exactly the issue that was established in summary
3 disposition.
4 We went along anyway, and we have provided the
5 answers to the questions. It is Licensee's position that every-
6 thing from page four on has really already been determined in
7 a ruling by the Board.
8 We, nevertheless, have offered the testimony and
9 do offer it.
10 JUDGE HETRICK: Mr. Churchill, are you saying
11 that the question we posed concerning the adequacy of separa-
12 tion of operating conditions by long-term corrosion -- do I
13 understand you to say that that issue itself was settled in
14 summary disposition?
15 MR. CHURCHILL: The summary disposition issues
16 that were settled were all of the contentions by this party and
17 the other one on the question of whether or not there was going
18 to be a likelihood of reinitiation of the intergranular stress-
19 assisted cracking that occurred. And, yes, those issues, it is
20 my position, were disposed of at some length. That was a very
21 large part of the whole summary disposition process.
22 It now turns out that this particular question --
23 and I confess, I admit that I didn't really realize it when I
24 first saw the question; but in developing the testimony it
25 became clear, when our witness told us the only reason for that

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1 program is to examine the question of reinitiation of
2 corrosion.
3 I think I can point out in the Board's Order it-
4 self, back in the second part of it, a couple of statements that
5 address directly these particular tests with respect to their
6 simulation of the operating conditions.
7 For example, on page 76, at the top paragraph,
8 the Board stated -- this is of your Board Order of Summary
9 Disposition -- that "Licensee is continuing the long-term corro-
10 sion tests on actual OTSG tube samples under conditions simu-
11 lating the environmental operating conditions with worst-case
12 chemistry conditions that could exist in the primary system
13 within technical specification limits," and it cites our
14 Statements of Fact Numbers 218 and 219.
15 On the top of page 79, -- and so the position
16 that we're in is we think the matter has been encompassed in
17 umbrella by an issue that's already decided.
18 We have, nevertheless, presented the testimony
19 in response to the Board's question. We do believe that, in
20 fact, the long-term corrosion test program has adequately simu-
21 lated the conditions by simulating worst case conditions,
22 chemical conditions, and the testimony so states.
23 I just would like to point that out to the Board;
24 that perhaps we are being redundant because this issue has
25 already been decided.

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JUDGE HETRICK: What do you propose; that we drop this issue because it has already been decided?

MR. CHURCHILL: We did not object -- perhaps this isn't timely and perhaps we are late in objecting; I don't know.

I believe we properly could drop this issue, but I don't believe that we have that strong of a leg to stand on to drop it, because I don't believe we, the Licensee, were timely in bringing this to your attention.

But I think, yes, it would be perfectly proper and probably the more reasonable thing to do to drop this issue as having been encompassed in an issue that has already been decided.

JUDGE HETRICK: Mr. Churchill, one more question. Are you saying that the adequacy of simulation is irrelevant, --

MR. CHURCHILL: No, sir.

JUDGE HETRICK: -- or that it has already been settled?

MR. CHURCHILL: I am saying that I believe that it has already been settled. I'm not saying it is irrelevant.

JUDGE WOLFE: On page 68 of our Memorandum and Order of June 20, we set out the TMIA Contention 2.b.1. Now, I see nothing in that contention addressed to the subject matter of Contention 1, Issue 1.d.

Granted, in our discussion of TMIA Contention 2.b.1

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1 we may have addressed what you have already pointed out to us
2 at pages 76 and 79 of our Memorandum and Order, but there we
3 were, at most, collaterally discussing and accepting the state-
4 ments made by the clients in your Motion for Summary Disposition.
5 So I don't think that what we stated at pages 76
6 and 79 are dispositive of the question or the Issue 1.d.
7 Do you agree, Judge Hetrick, or not?
8 JUDGE HETRICK: It seems to me that so far as it
9 appears, it may be regarded as a peripheral issue in the Order
10 regarding Motions for Summary Disposition.
11 Perhaps I'm being excessively cautious, but I
12 think the wording of Issue 1.d focuses very definitely on a
13 specific issue, which I think deserves a little more attention.
14 JUDGE WOLFE: In any event, I erred. I turned
15 back two pagestoo many in our Memorandum and Order of June 1,
16 and it seems that TMIA Contention 2.b.1 -- actually, pages 76
17 and 79 are addressed to TMIA Contention 2.b.2. But the reason-
18 ing is the same.
19 In any event, what is it you're seeking,
20 Mr. Churchill, some sort of guidance now? We are not going to
21 dismiss the contention at this late stage.
22 Do you want us to give you some further explana-
23 tion of what we sought in framing this Issue 1.d?
24 MR. CHURCHILL: No, Your Honor. I wanted to
25 point out -- yes, I was looking for guidance, but I think I've

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gotten it.

I wanted to point out that I did believe this issue had been encompassed. The main part of their Contention 2 was that corrosion would reinitiate -- or, actually, I think what they said is that we haven't demonstrated that it will not reinitiate; that was the main part of Contention 2. Then there were the sub-parts after. Those were the "becauses."

We put a lot of effort into our motion describing exactly why we believe it won't reinitiate. That, I think, the Board agreed with. Now it turns out, when we started to write our testimony for this other issue, that it became clear to us that the only purpose of the long-term corrosion test program was to provide or help provide the reassurance, the assurance that it would not reinitiate, and we have already established that.

Now, we do have our testimony on the record. We are perfectly happy to go forward with that. I think this has been helpful in that at least it puts it in context so that we can have in our minds how this relates to the issues that have already been considered in summary disposition.

We are willing to go forward with this testimony, Your Honor.

JUDGE WOLFE: All right.

Cross-examination, Ms Bradford?

MS. BRADFOrd: Yes.

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CROSS-EXAMINATION

MS. BRADFORD: On page 3 of your testimony on the bottom of that page you state that the tests were not designed to confirm that Licensee has provided reasonable assurance against the possibility of mechanically induced tube ruptures caused by various transients.

Does this mean that flow-induced vibration was not part of your long-term corrosion test?

WITNESS CRONEBERGER: The possibility of damage whether by flow-induced vibration or normal heat-up and cool-down cycles was treated as a separate issue in accordance with accepted industry code rules. It was not part of the corrosion estimate.

MS. BRADFORD: So the tubes that are a part of this test are not also undergoing the same conditions that they would see in steam generating?

WITNESS CRONEBERGER: The tubes in this test program are being exposed to cycling axial loads, which are a reflection of the heat-up and cool-down cycles.

As a result of analysis, it was concluded that in fact from a fatigue damage standpoint flow-induced vibration was not predicted to be a concern. So from a long-term standpoint, the long-term corrosion test did not simulate a flow-induced vibration effect.

MS. BRADFORD: Would it not have made this test

1 a more conservative one to subject the tubes to all of the
2 conditions that they may see, that they see during operation?
3 WITNESS CRONEBERGER: Again, the purpose of the
4 test was to evaluate corrosion damage and not mechanical fatigue
5 damage. As far as the objective in trying to understand
6 corrosion damage, it was determined that the loading cycles
7 simulating heat-up and cool-down were sufficient to predict
8 the effect of stresses on corrosion.
9 MS. BRADFORD: When a tube is corroded, does it
10 become weakened?
11 WITNESS GIACOBBE: You will have to define
12 "corroded." General corrosion would not weaken a tube, but
13 in specifically trying to address the point you would need to
14 clarify it.
15 MS. BRADFORD: I'm talking about numerous cracks.
16 Would that type of damage weaken the tube?
17 WITNESS GIACOBBE: The base metal, itself, in
18 regions away from the corrosion or cracks are not weakened.
19 The crack has to be taken for itself, and the extent of the
20 area that it takes up; to the extent that that reduces cross-
21 sectional area, that would reduce the load-carrying capability,
22 but the material, itself, maintains its full integrity.
23 MS. BRADFORD: You said away from the crack area;
24 what about at the crack area? Is that area weakened?
25 WITNESS GIACOBBE: I think I need to get at what

you are really trying to drive at. The corrosion mechanism affects a very localized area. To the extent that it has damaged that area, the area is damaged. That's true.

It is not some insidious thing that has an effect in the areas away from the corrosion areas. That area is still maintains full integrity. So to the extent that you have removed some metal or put a crack there, in any analytical work that we have done to study that, that would most definitely be taken into account.

MS. BRADFORD: I am not interested in the area away from the cracked area. I am interested in the localized area of the crack, and I'm just trying to determine whether that area would be weakened.

MR. CHURCHILL: I didn't hear a question there, Your Honor.

JUDGE WOLFE: I didn't either.

MS. BRADFORD: Will that area, the localized area of cracking, be weakened?

MR. CHURCHILL: Your Honor, I object to this question. It has been asked and answered at least twice.

JUDGE WOLFE: I couldn't hear the last two or three words of the question.

MS. BRADFORD: I asked if the localized area which contains the cracking would be weakened as a result of that cracking.

WITNESS CRONEBERGER: The answer to that would be yes.

MS. BRADFORD: And it would be then subject to -- that would be a stress area in terms of flow-induced vibration or other mechanical stress?

JUDGE WOLFE: Hold it. Is this another question now, or is this a continuation of the first question that has been objected to?

MR. CHURCHILL: The witness answered the question that was objected to before I could reassert my objection, so I think we are onto a new question.

JUDGE WOLFE: What did you say?

WITNESS CRONEBERGER: If I understood the question correctly, it was whether or not in fact the weakened area of a defect, weakened as a result of corrosion damage, was any credit being taken for the strength in the middle of that area?

JUDGE WOLFE: What was your answer?

WITNESS CRONEBERGER: My answer was we wouldn't give any credit to the strength in the vicinity of the corroded defect.

MS. BRADFORD: Thank you.

JUDGE WOLFE: All right. I didn't hear that.

MS. BRADFORD: Does this long-term corrosion test test if the corrosion has an effect on the ductility of

1 the tube?

2 WITNESS GIACOBBE: I think you have to go back

3 and look at all the work we have done to study the properties

4 of the tube. First off, from the active tube removed from

5 the generator, we did test the mechanical properties, ductility

6 if you will, of that tubing. That tubing has not shown any

7 loss of ductility. It maintains as full ductility as new

8 tubing. The long-term corrosion test program, itself, is not

9 designed to assess ductility, if you will. However, one can

10 make some qualitative inferences from the testing that we have

11 done; and in looking at the results to date, we have not seen

12 any loss of ductility.

13 MS. BRADFORD: The tests that the licensee did

14 on the initial corrosion test indicated that the steam

15 generator tubes at TMI are highly sensitized. Does this

16 condition, that is that highly sensitized condition, cause any

17 weakening -- just the actual sensitized condition of the tube?

18 MR. CHURCHILL: Your Honor, I would object to

19 this question. The issue is the adequacy of simulation of

20 operating conditions by the long-term corrosion test. I

21 think she is asking about -- I don't know what she is asking

22 about, but it doesn't have anything to do about simulation of

23 the operating conditions.

24 MS. BRADFORD: The documents that I read indicate

25 that the tube that is heavily sensitized is more susceptible

1 to corrosion and cracking, and I am just trying to find out
2 if that condition in itself, that being sensitized, has an
3 effect on the structure of the metal. I am trying to find out
4 why it is more susceptible to this corrosion.
5 JUDGE WOLFE: Are you asking whether they
6 simulated sensitized tubes; is that what you are asking?
7 MS. BRADFORD: No. They used actual tubes, I
8 believe.
9 JUDGE WOLFE: To tie this question in, you will
10 have to rephrase it or make it known how your question is at all
11 directed to the adequacy of the simulation of the operating
12 conditions.
13 MS. BRADFORD: When a tube is highly sensitized,
14 is the microstructure of that tube affected?
15 MR. CHURCHILL: Same objection.
16 JUDGE WOLFE: Try it once again. The third time
17 should be the charm.
18 MS. BRADFORD: I'll try it again. When a tube
19 is heavily sensitized, as the tubes at TMI-1 are, does that
20 affect the microstructure of that tube, and is that reflected
21 in your testimony?
22 MR. CHURCHILL: I have the same objection, Your
23 Honor. I don't see any relationship to the simulating of the
24 operating conditions in the test.
25 JUDGE WOLFE: Objection sustained.

We gave you three chances there, Miss Bradford.

MS. BRADFORD: In the long-term corrosion test, the studies do show that the actual steam generator tubes showed wear at 170 degrees; is that correct?

WITNESS GIACOBBE: I'm afraid you haven't given me enough to go on.

MS. BRADFORD: I think in the Battelle study -- that was reference document 62 --

MR. CHURCHILL: Your Honor, I might be premature in my objection. I might point out, however, that that report is not a report of the long-term corrosion program. It's a report dealing with what is called a short-term corrosion evaluation, and it was not designed to simulate operating conditions. It was designed to simulate the corrosion conditions that caused the cracking in the first place.

I think anything from that document would be well outside the scope of this issue.

MS. BRADFORD: I am simply laying some groundwork. I want to ask the witnesses if my assumptions are correct and if they agree with the statement, and how they took it into effect in the long-term corrosion test.

JUDGE WOLFE: We will see how you go along. You are always subject to a motion to strike on anything you get into that relates to the short-term testing. Anything that relates to the short-term testing may be stricken.

MS. BRADFORD: I will withdraw the question for the moment. I'm sorry.

Could you explain to me what a pickling process is?

WITNESS GIACOBBE: Sure. A pickling process is a process which, in reference to what we are doing here, refers to the tube manufacturing process. After a tube is formed and drawn to its shape, in a long shape, and then annealed, it will have a heavy metal scale on it. To remove that metal scale you subject the tube to an acid bath. This acid bath dissolves the oxide film on the surface of the tube.

MS. BRADFORD: And is that unique to each plant? I'm trying to find out if the pickling process at TMI is different than it might be --

WITNESS GIACOBBE: The pickling process is common. Two vendors may use different acids, but in general the pickling is a common process used in steam generator tubing.

MS. BRADFORD: In your long-term corrosion test, what sections of the tube are represented in that test?

JUDGE WOLFE: Miss Bradford, when you ask a question, always the last five or six words are lost. I don't hear you.

MS. BRADFORD: I'm sorry, Judge Wolfe.

JUDGE WOLFE: Please use the microphone.

1 Now start again, Miss Bradford.

2 MS. BRADFORD: In the long-term corrosion test,

3 what sections of tube -- that is what area of the tubes then

4 are represented?

5 WITNESS GIACOBBE: In the test program, we try

6 to take a sampling from a variety of locations such that we

7 would get an overall assessment of how tubes from various

8 locations would respond to the test, so we actually had tubes

9 from very high up in the generator where we had a lot of

10 cracking, and we had tubes from the mid section of the tube-

11 sheet, and we had tubes from the freespan, and then tubes from

12 various axial locations across the generator; so we tried to,

13 as best we could, get a good sampling of the tubes that were

14 in the steam generators.

15 MS. BRADFORD: How many tubes are represented

16 in the long-term corrosion --

17 MR. CHURCHILL: Your Honor, I just don't see how

18 this is related to the contention or to the issue, which is

19 the adequacy of simulating the operating conditions in the long-

20 term corrosion program.

21 MS. BRADFORD: Judge Wolfe, my last question is

22 as to how many tubes are being tested --

23 JUDGE WOLFE: How many what have been tested?

24 MS. BRADFORD: Tubes are being tested. I am

25 trying to determine the size of the sample, the data sample

1 on which they are basing their judgments.

2 MR. CHURCHILL: Your Honor, we weren't asked,

3 and they didn't raise questions about the results of this

4 test or the size of the sample or what was tested. The only

5 issue that was brought up and quoted here in their response

6 to the summary disposition and to your order was they were

7 questioning whether or not we simulated the operating conditions

8 adequately in this test. I don't mean to be too technical

9 and I don't mean to split hairs on this, but we have struggled

10 throughout this proceeding to try to understand what the

11 intervenors are getting at, and respond and prepare as best

12 we can.

13 In this case I thought for sure we knew what we

14 were up against, and now these questions seem just about

15 another subject altogether.

16 JUDGE HETRICK: I find it rather hard to put a

17 boundary that excludes the sample size from the question of

18 simulation of operating conditions in the tests. Perhaps one

19 could construct an artificial boundary there, but it seems to

20 me that it is a fair question.

21 JUDGE WOLFE: Objection overruled.

22 WITNESS GIACOBBE: Could I please have the

23 question again?

24 MS. BRADFORD: How many tubes in the steam

25 generator are being tested in this long-term corrosion test?

1 WITNESS GIACOBBE: I don't have an exact number
2 of tubes being tested. I can count them up. But when we look
3 at the samples and how to select samples, it was clear that
4 one could not pick a statistically large enough sample to
5 test every possible combination of tubes in the generator.
6 However, looking at the date and how the heats responded and
7 where the testing occurred, and what the properties of those
8 tubes were, we felt that if we took representative samples of
9 various heats and various types of damage shown on different
10 tubes, one could adequately bound the conditions that existed
11 in the generator, because clearly one could never test enough
12 tubes or look at 30,000 tubes in the generator, so we had to
13 look at look at what all of the data in total told us about
14 how tubes responded and take a significant sample from those,
15 and that's exactly what we did.
16 We tried to bound our conditions.
17 MS. BRADFORD: How many heat numbers, metal
18 heat numbers, are represented in the steam generator?
19 WITNESS WILSON: I can try to answer that. My
20 recollection is approximately 60 different heats.
21 MS. BRADFORD: And do these heats -- is it your
22 experience that the varying heats respond differently?
23 WITNESS GIACOBBE: No. We did, in fact, do a
24 very extensive analysis of heats and their response in steam
25 generators to corrosion. No, we could not find a correlation between

1 heat number and any propensity for cracking. It was an overall
2 random datum.
3 MS. BRADFORD: Did you conduct that test at TMI,
4 or was that at one of your contractors?
5 WITNESS GIACOBBE: We, in fact, did heat analysis.
6 MS. BRADFORD: Did you get any information that
7 there was, indeed, a difference between the heats that any
8 of your contractors who did the studies had found, that they
9 made a finding that there was a difference in susceptibility?
10 WITNESS GIACOBBE: Not on a heat basis. We found
11 nothing that indicated that a particular heat or group of heats
12 were any more susceptible than any other heat.
13 MS. BRADFORD: A licensee's document, Technical
14 Report 008, Revision 3, states that cracks would occur lower
15 in the tube in the areas more susceptible to intergranular
16 stress-attacked cracking. I think that's how it is put,
17 due to surface anomalies or residual stress.
18 What would cause the residual stress?
19 First of all, do you agree with that statement?
20 WITNESS GIACOBBE: I think I need to look at
21 that before I answer.
22 (Pause.)
23 MS. BRADFORD: I cannot locate a page number,
24 but would you agree with that statement that areas lower in
25 the tube are more susceptible to intergranular stress cracking

1 due to surface anomalies or residual stress? Would you agree
2 with that statement?
3 MR. CHURCHILL: Could I ask for a clarification
4 on what you mean? Lower in the tubes than what?
5 MS. BRADFORD: Closer to the lower tubesheet
6 area.
7 WITNESS CRONEBERGER: I really think we need
8 to understand the context in which that statement is made in
9 order to respond.
10 WITNESS WILSON: I will just make one gross
11 observation, that the actual experimental data indicates that
12 the cracking is all up high, not low, so that would be contra-
13 dictory to your conclusion.
14 MS. BRADFORD: Are there areas in the tubes other
15 than the transition zone and the heat-affected zone where one
16 would expect residual stress?
17 WITNESS GIACOBBE: I'm sorry; would you repeat
18 that?
19 MS. BRADFORD: Are there areas other than in the
20 transition zone and the heat-affected zone where one would
21 expect residual stress on the tubes?
22 WITNESS CRONEBERGER: The residual stress due
23 to the forming operation should be local to the rolled joint,
24 the transition, and immediately adjacent to the transition.
25 MS. BRADFORD: And there would be no other

residuals; there would be no other stresses on this tube other than in those areas?

WITNESS CRONEBERGER: From a residual stress standpoint?

MS. BRADFORD: Yes.

WITNESS CRONEBERGER: Only to the extent that there will be forming stresses.

MS. BRADFORD: That portion of the tube that passes through the support plate, is that exposed to a particular stress not seen in the rest of the tubing?

MR. CHURCHILL: Your Honor, I do think that at least this should be related somehow to the repair, itself. If she can relate that question to the repair, the repair doesn't take place near the support plates; it is all up inside the other tubing.

JUDGE WOLFE: Isn't that so, Miss Bradford?

MS. BRADFORD: Yes, it is.

I just want to make the comment right now that it is very difficult for me to separate out in my mind the need for the repair and the repair, itself. After all, the steam generator when it comes on line will rely on the full length of the tube, and there was damage in other areas of the tube other than that which is encompassed by the new joint.

JUDGE WOLFE: Are you saying there wasn't enough repair work done?

MS. BRADFORD: I'm asking what these corrosion --

JUDGE WOLFE: If that is your question, is that an issue in this proceeding?

The issue in this proceeding from the notice of hearing until now is the kinetic repair process, nothing else.

Is that an objection?

MR. CHURCHILL: Yes, sir.

JUDGE WOLFE: Sustained.

MS. BRADFORD: On the bottom of page 4, continuing to page 5, you discuss six heatup/cooldown cycles which have been completed. Are tubes subjected to load variations in this test?

WITNESS GIACOBBE: Tubes, in fact, are subjected to load variations to simulate not only operational loads, but also cooldown loads.

MS. BRADFORD: And what are those loads?

WITNESS GIACOBBE: The actual values are 500 pounds operational or 1,100 pounds cooldown.

MS. BRADFORD: It continues to say that final metallographic examinations are now in progress.

Have they been completed?

WITNESS GIACOBBE: They are still underway.

MS. BRADFORD: Can you explain to me, on page 7, the second full paragraph in the middle of the page -- that describes some test loops which were subjected to cooldown

1 cycles. That paragraph continues that, "These cycles provided
2 the most rigorous test sequence." Why was this testing more
3 rigorous than the rest of the testing?
4 WITNESS GIACOBBE: This particular phase of the
5 long-term corrosion test allowed for the introduction of oxygen
6 during the cooldown. If you recall from the failure analysis,
7 oxygen is a requisite for corrosion, so we actually introduced
8 oxygen to assure that the simultaneous effect of the environ-
9 ment load and oxygen were all coexistent at that particular
10 time; so that was the most rigorous portion of the test.
11 MS. BRADFORD: Were you able to detemine how
12 much oxygen was needed to activate the sulfate?
13 WITNESS GIACOBBE: In this particular test we
14 saturated with oxygen to preclude any threshold considerations,
15 so we had to saturate the solution with oxygen so that there
16 was more available oxygen present for the corrosion to take
17 place.
18 MS. BRADFORD: I understand that you suspect
19 that oxygen entered the system not only because the system was
20 open, but also through the HPI injection. Approximately how
21 much oxygen comes in through that system?
22 WITNESS GIACOBBE: I don't know that number off
23 the top of my head.
24 MS. BRADFORD: Do you estimate that it would be
25 a significant amount of oxygen?

WITNESS GIACOBBE: During the HPI, the solution that was entering the system was saturated with oxygen, so one has to calculate the dilution of oxygen in the system; I just don't remember the number.

MS. BRADFORD: Is that a normal situation that HPI flow is saturated with oxygen?

WITNESS GIACOBBE: No, that is not normal. That was done for a specific purpose at that time, and we do not normally introduce oxygen in water during cooldown.

MS. BRADFORD: Is the purpose that that is something that would occur during plant life?

WITNESS CRONEBERGER: My recollection -- if you are referring to the functional test in 1981, my recollection of that test is that we did perform a modification that provided a mechanical tie between the two trains. All we were trying to do at that time was to perform a test to demonstrate that, in fact, the system as modified functioned properly. There would be no reason for repeating that test in the future.

MS. BRADFORD: Just recently -- when you perform a bubble test, you do have to introduce air into the system; isn't that correct?

WITNESS GIACOBBE: That's correct.

MS. BRADFORD: How do you rid the system of oxygen after such an introduction? How is that oxygen removed?

WITNESS GIACOBBE: There are well-established

1 procedures for removing oxygen. I'm not sure you want to go
2 into the technica details on that.
3 MS. BRADFORD: Was that done after the most
4 recent bubble test?
5 WITNESS GIACOBBE: The generators are not filled
6 at this time. The system is still open. It will be once we
7 close the system down. The system will be de-aerated, but it
8 is not currently.
9 MS. BRADFORD: These long-term corrosion tests,
10 are they still ongoing?
11 WITNESS GIACOBBE: No. As we said, the tests
12 have been completed, and we are now in the final evaluation
13 phase of the program, taking specimens and constructively
14 evaluating them, and making metallographic specimens to
15 examine. That's the phase we are in right now.
16 MS. BRADFORD: And it tested the effect of the
17 joint under normal operating conditions?
18 WITNESS GIACOBBE: Yes. We had specimens in the
19 test program that had received the same type of kinetic
20 expansion and had the same transition region as we do in the
21 generator.
22 MS. BRADFORD: Can you tell me if corrosion
23 products -- we heard earlier today that corrosion products can
24 become wedged in the crevices. Would that have any effect on
25 the dimensions of the tube?

WITNESS GIACOBBE: I'm not sure if I understand. The corrosion products which I think you are referring to regarding the blocking of the defects, no, that does not affect the dimensions of the tube.

MS. BRADFORD: Not the dimensions; on the tube itself, does it have a damaging effect on the tube, itself?

WITNESS GIACOBBE: In reality, the tube is more -- the tubesheet tends to suffer corrosion rather than the tube.

MS. BRADFORD: If corrosion were to re-initiate -- well, let me ask you -- I asked this morning a question about the swipe samples. The other thing that the study noted was the distribution between each generator. For instance, in generator A it was concentrated most in the periphery, I think, if I can understand the diagram which I received, whereas in generator B 75 percent of the damage was in one-half of the generator.

Can you explain or has your testing -- have you been able to understand why that distribution was?

WITNESS GIACOBBE: The corrosion mechanism, itself, has been understood, and we believe we know exactly why tubes corroded. As to the exact reasons why, we have differences and variations from steam generator to steam generator, we do not understand why there would be differences. There are many, many parameters affecting corrosion. The three main ones,

of course, are stress, concentration or environment, and susceptibility. We know susceptibility was the same for all the tubes. We know there may be variations in stress and that could account for the possibility of why we got variations in location, and we believe the environment, the overall environment aspect, was the same; so there may have been some variations in stress. One cannot analyze that on an individual basis.

MS. BRADFORD: And so that was not taken into account within your long-term corrosion test?

WITNESS GIACOBBE: We chose worst case stress conditions, and that way we bounded the worst case.

MS. BRADFORD: I have no more questions.

JUDGE WOLFE: Mr. Au?

MR. AU: Mr. Dornsife will cross-examine.

CROSS-EXAMINATION

MR. DORNSIFE: In your summary on page 9 of your testimony you indicate that this test program provides a clear basis for evaluating, for evaluating steam generator tube performance over approximately a one-year period.

Do you plan to perform any additional corrosive testing, and what assurances do you have that one year is adequate?

WITNESS GIACOBBE: At this time we are not planning any additional corrosion testing. However, one would look at the corrosion mechanism which we are addressing now,

and that happens to be reduced sulfur corrosion, which, by our short-term corrosion test program that we ran, indicates that it is a very rapid corrosion phenomenon. We chose to go on to the long-term corrosion test program to add adequate assurance that any potential effects of long-term periods would not be overlooked, and we feel that the results have shown for this one year that we have not seen any damage in the sulfate-containing loops, and feel that that is adequate at this time.

MR. DORSIFE: Thank you. I have no other questions.

JUDGE WOLFE: Miss Wagner?

MS. WAGNER: I have no questions.

JUDGE WOLFE: Do you have redirect, Mr. Churchill?

MR. CHURCHILL: May we have just a moment?

JUDGE WOLFE: Yes.

(Pause.)

MR. CHURCHILL: No redirect, Your Honor.

JUDGE WOLFE: Are there Board questions?

JUDGE LAMB: What is the current status of these tests? Are these done, or are they still in progress? Are some of them completed; where are we on these tests?

WITNESS GIACOBBE: On the corrosion test program, the operational phase, the actual subjecting of the tubes to the environment is completed. We have disassembled the test

1 loops, and we are now doing metallographic destructive
2 examinations of the specimens.
3 JUDGE LAMB: So you do not intend to continue
4 these in the future?
5 WITNESS GIACOBBE: We do not.
6 JUDGE LAMB: Now, in your tests you introduced
7 oxygen into the system. Since you saturated it, presumably
8 this was not introduced in the same quantity that was experienced
9 or would be experienced in the operating system; is that correct?
10 WITNESS GIACOBBE: Any time that we open up the
11 steam generators for repairs, we, in fact, do expose them to
12 saturated oxygen conditions, and for that reason we wanted the
13 saturation when we went into that phase of the program.
14 JUDGE LAMB: When you say "saturated," do you
15 mean saturated with respect to the partial pressure of oxygen
16 in the air?
17 WITNESS GIACOBBE: That's correct.
18 JUDGE LAMB: And you feel that you get the
19 the saturated oxygen conditions when you open up the operating
20 units?
21 WITNESS GIACOBBE: When we go in to do mainten-
22 ance in the steam generators, we, in fact, achieve saturated
23 oxygen, which is approximately six to eight parts per million
24 of oxygen.
25 JUDGE LAMB: Does oxygen limit the reactions in

this system, in this corrosion mechanism that you have come up with?

WITNESS GIACOBBE: There is a threshold for oxygen as it affects the electro-chemical potential of the specimens over which we will not get corrosion. We have demonstrated that in the absence of oxygen or at low potentials the corrosion process does not occur.

JUDGE LAMB: Is that reaction rate proportional thereafter to the oxygen concentration, or does something else limit the corrosion?

WITNESS GIACOBBE: There are, of course, many things that would influence the corrosion; the concentration of the corrodant specie, and the potential. In reality, the effect of oxygen is to affect the electro-chemical potential. so as you vary oxygen you will vary electro-chemical potential. There will be a limit below which you will not get corrosion because the potential will be too low for the corrosion process to occur; but there will be a band, and once you are in that band there may be some influence on time, but in reality the corrosion will occur.

So to answer your question, if we are below, if we are de-airing as a normal operating condition, the corrosion process cannot occur. To say at what point we introduce oxygen so that now becomes corrosive, I don't have that number for you.

JUDGE LAMB: But in the saturated condition, what then is the limiting factor on corrosion? Is oxygen the limiting factor or is there some other constituent?

WITNESS GIACOBBE: Certainly if we were to remove the corrodant, as we did, now oxygen is no longer a factor at all. In the absence of reduced sulfur forms, there is no corrosion. Our tests have demonstrated that, and we, of course, have had our steam generators in an oxygenated condition on several occasions, and have gone in and done the eddy current testing. We have looked at known defects, and we have seen no change, so at this particular time we believe the system is such that we are not in a corrosion condition whatsoever, irrespective of the oxygen concentration.

JUDGE LAMB: Could you define for us -- or could someone on the panel please define for us the word "heats" as you have used it in your testimony some 15 or 20 minutes ago?

WITNESS GIACOBBE: Heats refers to the primary ingot from which a particular rod or batch of tubes was made. In other words, you pour an ingot. From that ingot there are billets made, and these billets are then ultimately transferred into tubing. So the heat is the identification given on that billet, and each individual tube from there on carries that particular identification.

JUDGE LAMB: So that in the steam generator you

have several of those billets which were the source of the tubing?

WITNESS GIACOBBE: That's correct. I believe we stated 60-some.

JUDGE LAMB: That's all I have.

JUDGE HETRICK: I just want to make a point about the heats. I think the word in your last question might have been ingot, not billet. The heat corresponds to an ingot.

WITNESS GIACOBBE: Ingot.

JUDGE HETRICK: I have one question about stress. Your testimony at page 8, paragraph 2 states that "specimens were loaded at a level corresponding to steady state loads during heatup, cold shutdown and operation."

These different situations refer to different aspects of normal operation; is that not correct?

WITNESS GIACOBBE: That is correct.

JUDGE HETRICK: Are there then some situations where stress could exceed, the accident situation?

WITNESS CRONEBERGER: Yes; clearly some of the accident transients might produce higher tube stresses than those included in the program.

JUDGE HETRICK: Would there be any point in trying to simulate such abnormal stress conditions in these corrosion tests?

WITNESS GIACOBBE: We attempted to do that by

1 putting in C-rings. If you look at the loadings of the C-
2 rings, we loaded those to the yield strength, which is in
3 excess of any load that would be experienced in the transient;
4 and it is for that reason that we put C-rings in, because we
5 could not test every possible load condition.
6 We felt that we would go to the maximum load
7 that one C-ring could tolerate, which was the yield strength,
8 and, hence, we would bound any other transient load that might
9 exist.
10 JUDGE WOLFE: Is there cross-examination on
11 Board questions?
12 MS. BRADFORD: No, I don't have any questions,
13 Judge Wolfe.
14 JUDGE WOLFE: Mr. Au?
15 MR. AU: No questions, Judge Wolfe.
16 JUDGE WOLFE: Miss Wagner?
17 MS. WAGNER: No questions.
18 MR. CHURCHILL: No redirect, Your Honor.
19 JUDGE WOLFE: It is now 5:00. The Board has
20 a long evening before it, from 7:00 until 10:00. I think under
21 those circumstances -- and it has been a long day for everyone
22 -- we will recess the evidentiary hearing and renew tomorrow
23 at 9:00. You are all welcome to attend tonight.
24 I would like you very much to be here, the parties
25 that is, from 7:00 until 10:00. We stand in recess.
(Whereupon, at 5:00 p.m. the hearing was adjourned, to be reconvened at 9:00 a.m. on Tuesday, June 17, 1984, in Middletown, Pennsylvania.)

CERTIFICATE OF PROCEEDINGS

This is to certify that the attached proceedings before the NRC COMMISSION

In the matter of: Evidentiary Hearing before the Atomic Safety and Licensing Board Panel

Date of Proceeding: July 16, 1984

Place of Proceeding: Capitol Campus, Middletown, PA

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

John A. Kelly

Official Reporter - Typed

John A. Kelly

Official Reporter - Signature

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