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UNITED STATES DISTRICT COURT
SOUTHERN DISTRICT OF NEW YORK

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

Plaintiffs,

80 CIV. 1683

:(R.O.)

-against-

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

Defendants. :

- - - - -x

Continued deposition of General Public
Utilities Corporation by ROBERT W. KEATEN, taken
by Defendants, pursuant to adjournment, at the
offices of Davis Polk & Wardwell, Esqs., One Chase
Manhattan Plaza, New York, New York, on Tuesday,
January 5, 1982 at 9:45 o'clock in the forenoon,
before Joseph R. Danyo, a Shorthand Reporter and
Notary Public within and for the State of New
York.



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PDR ADOCK 05000289
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WALTER SHAPIRO, C.S.R.
CHARLES SHAPIRO, C.S.R.

DOYLE REPORTING, INC
CERTIFIED STENOTYPE REPORTER
369 LEXINGTON AVENUE
NEW YORK, N.Y. 10017
TELEPHONE 212 - 867-8220

A p p e a r a n c e s :

KAYE, SCHOLER, FIERMAN, HAYS & HANDLER, ESQS.
Attorneys for Plaintiff
425 Park Avenue
New York, New York

BY: STEVEN GLASSMAN, ESQ.,

of Counsel

DAVIS POLK & WARDWELL, ESQS.
Attorneys for Defendants
One Chase Manhattan Plaza
New York, New York

BY: ROBERT F. WISE, ESQ.,

of Counsel

Also Present:

NINA RUFFINI

-oOo-

1
2 R O B E R T W. K E A T E N, having
3 been previously duly sworn, resumed and was
4 examined and testified further as follows:

5 EXAMINATION (continued)

6 BY MR. WISE:

7 Q You recognize you are still under oath
8 today?

9 A Yes, I do.

10 Q I would like to show you what has
11 previously been marked in this lawsuit as B&W Exhibit
12 186, which is a copy of what purports to be a
13 technical data report prepared by GPU Service, titled
14 TMI-2 Transient on April 23, 1978 Task Force Report.

15 Do you recognize B&W 186?

16 A Yes, I do.

17 Q Is that the task force report that you
18 participated in the preparation of concerning the April
19 23, 1978 TMI-2 transient?

20 A Yes, it is.

21 Q Would you look at attachment 1 to the
22 report, which appears at the page which has been
23 stapled for purposes of this litigation in the lower
24 right-hand corner 12470585. Attachment 1 appears to be
25 a memorandum to you dated May 2, 1978 from Mr. R. C.

1
2 Arnold. The subject is listed as TMI-2 Cooldown
3 Transient of April 23, 1978.

4 Do you recognize this memorandum?

5 A Yes, I do.

6 Q What is it?

7 A It is the memorandum from Mr. Arnold which
8 documented the formation of the task force and which
9 gives some specific direction to the task force.

10 Q Yesterday we discussed some of the things
11 that your task force did in order to carry out the
12 assignment. When did the task force begin preparation
13 of the written report which we see before us as Exhibit
14 186 in its final form?

15 A To the best of my recollection, some of the
16 material that appears on the final report was prepared
17 very early in the investigation, within the first week,
18 and the memorandum which is attachment 1 refers to a
19 preliminary oral report to be presented at a meeting
20 on Monday, May 8, 1978. That is the meeting that I
21 was referring to yesterday.

22 To the best of my recollection, right
23 after that meeting, I started pulling together the
24 information for the report and then that continued for
25 quite some time thereafter.

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2 Q Did you actually do the writing of the
3 report?

4 A Not completely, no. I received written
5 material from others that I incorporated.

6 Q Were you in effect, if you will, the editor
7 of the report, taking pieces that others had submitted
8 plus materials that you prepared yourself in order
9 to put together the entire report?

10 Q I think that is a fair characterization,
11 yes.

12 Q I note from the cover page a date next to
13 your signature which appears to be August 10, 1976. I
14 am sorry the Xeroxing is rather poor. It is not
15 entirely clear. It might be August 18.

16 In any event, was it sometime during the
17 period August 10 to August 20, when, to the best of
18 your recollection, this report was put into final form?

19 A I don't specifically recall the date, but
20 I have no reason to challenge the dates that are here.

21 Q Immediately to the right of your signature
22 is another signature which is rather difficult to make
23 out. Do you recognize that?

24 A Yes, I do.

25 Q Is that Mr. R. F. Wilson's signature?

1
2 A Yes, it is.

3 Q There is on the cover sheet a distribution
4 list and with a lengthy series of names. To the left
5 of the names is a column which contains asterisks next
6 to some of the names but not others. What is the
7 significance, if you know, of an asterisk or in some
8 cases or in all cases two asterisks, next to the
9 names of the people on the distribution chart?

10 MR. GLASSMAN: The significance on this
11 particular document?

12 MR. WISE: Yes.

13 A I note that at the bottom of the page
14 underneath that column there first appears the term
15 "Cover page only," and although it does not show in
16 this reproduction, I believe that in the actual form
17 used that that had a single asterisk in front of it.
18 I note then underneath that there is the notation
19 "Without appendices," and I don't believe that is a
20 normal part of this form.

21 To the best of my recollection, the people
22 who have double asterisks by their name received the
23 report without the appendices.

24 Q What was the reason for that, if you know?

25 A Simply to hold down the amount of paper

2 which had to be reproduced and distributed.

3 Q Perhaps my question wasn't clear. Why were
4 certain people on this list given the appendices and
5 others not? What was the distinguishing factor as to
6 who fell into which group?

7 MR. GLASSMAN: If you know.

8 A To the best of my recollection, I tried to
9 send the appendices only to people that I thought might
10 actually use them.

11 Q Were you the one who made the selection as
12 to which people would receive the appendix and which
13 ones would not?

14 A I don't remember.

15 Q Do you recall whether anybody made any
16 response to you or further comments after distribution
17 of this final report concerning its subject matter?

18 A I don't recall one way or another except,
19 as I mentioned yesterday, that work in analyzing the
20 transient with the RETRAN code which is alluded to in
21 this report continued on past that period of time.

22 Q Do you have any recollection of anyone
23 disagreeing with any of the findings or conclusions in
24 the report after the report was distributed? I am just
25 trying to determine whether this is the last word or

whether there is something else we ought to be looking at.

A I don't recall any disagreements with the findings in the report as they were issued.

Q Do you know of any further report on this incident, written report, done after the distribution of B&W 186, and I will exclude for a moment the RETRAN analysis TDR, which we'll come to later.

A With the exception of that report, I do not recall any other reports issued later on this transient.

Q I would like to ask you a few questions about the transient itself just to make sure I understand it.

Before we do that, let me ask you to look at what is marked as page 2 of the report. It is actually the fourth piece of paper in the document. It is listed as Table 1 and contains a list of the task force members and certain additional participants.

Is that, to the best of your recollection, an accurate reflection of the task force members and those who also participated?

A At this point in time, I frankly don't recall the roles that some of the people here played, but again I have no reason to challenge the accuracy

1
2 of the list.

3 Q Am I correct that of the task force
4 members, Mr. Seelinger and Mr. Toole were employees of
5 Met Ed and that the other four members, including
6 yourself, were employees of GPU Service?

7 A No, I do not believe that was correct. I
8 believe that Mr. Toole at that time was an employee of
9 the Service Company.

10 Q Was Mr. Seelinger the only member then of
11 the task force who was an employee of Met Ed?

12 A To the best of my recollection and
13 knowledge, that's correct.

14 Q Among the additional participants, Mr.
15 Lanese, Mr. Lentz, Mr. Moore, and Mr. Schmauss, were
16 there any Met Ed employees?

17 A To the best of my knowledge, no.

18 Perhaps I should clarify why that was true.
19 As I mentioned yesterday, there was a plant effort at
20 analyzing the transient which I believe consisted
21 primarily of Met Ed employees, and Mr. Seelinger served
22 as the go-between for this effort, which was primarily
23 the Service Company effort and the Met Ed effort.

24 Q In fact, I believe it is attachment 2 to
25 your task force report which begins at page 1247-0586

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as marked in the lower right-hand corner for purposes of this litigation. It is a copy of the Met Ed report on the incident, is it not?

A Yes.

Q That is marked in the upper right-hand corner page A2-3 through page -- it is difficult to read, but I believe it goes to page A2-87, and then there are an additional three pages which probably are 88, 89, and 90, but it is almost illegible on the copies I have. It may be also A2-91.

A I agree that it is illegible.

Q You see that the next page following that, which is marked as 1247 0676 for purposes of this litigation, starts attachment 3, which has been renumbered by someone in the upper right-hand corner TDR-001, which corresponds to the number of your task force report, and underneath that page A3-1?

A That's correct.

Q Would I be correct that you adopted, you or whoever typed this, adopted the convention of renumbering the attachments or appendices to your report, placing the prefix A followed by the attachment number followed by a dash for the page number of the particular memo or report or whatever it was?

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A I don't specifically recall that, but it would appear to be correct.

Q Going back to where I was a moment ago, which is the transient itself, if you would look at page 14 of your report -- do you have that?

A Yes.

Q Feel free to refer to anything in the pretrip sequence which is on page 6, but I think most of my questions will be directed at the events as they occurred during the accident.

At the left-hand margin of this sequence of events, there are what appear to be a series of times beginning with time zero and proceeding through the events in the accident.

Who prepared the sequence of events that appears here?

A I frankly do not remember.

Q Did you participate in the preparation of it?

A I don't have any recollection of participating in it.

Q You did review it, however, before it went into the final report, I take it?

A Yes.

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Q And you are familiar with it generally?

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A I was at the time the report was prepared.

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Q Could you explain the initiating event
which is listed as reactor trip due to NI 8 noise spike?

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MR. GLASSMAN: Objection as to form.

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MR. WISE: If you have an objection to
"initiating event," I will strike that part of
my question. I simply want to know what
started the accident without a review of all of
the conditions of the plant.

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MR. GLASSMAN: My objection is also based
on the fact that Mr. Keaten said he did not
recall participating in the preparation of the
sequence of events; although there is some
material that appears at the top of this page,
I assume your question is directed to his
recollection, not to his present review or
assumptions regarding the page in front of him
which he doesn't recall.

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MR. WISE: I think all I am looking for is
his recollection. If this sequence of events
helps to refresh his recollection, that is fine.
If it doesn't, and he isn't able to say at this
point what started the event, we'll go on to the

1
2 next question.

3 MR. GLASSMAN: Very well.

4 A You have more than once referred to this
5 event as an accident, and we have not to my knowledge
6 used that terminology in that it did not result in any
7 damage to the core or other major impact on the plant,
8 so we have referred to it as a transient rather than
9 an accident.

10 To the best of my memory, the sequence
11 was initiated by the reactor trip referred to here at
12 time zero which was caused by we believe a noise spike
13 in the nuclear instrumentation, and NI stands for
14 nuclear instrumentation.

15 Q Was it ever determined by your task force
16 what had caused the noise spike in the nuclear
17 instrumentation?

18 A I don't believe that we ever determined
19 exactly what caused it. My memory is, and it is
20 consistent with what that report says, there had been
21 previous problems with noise in that particular channel.

22 Q The second event listed on the sequence is
23 a turbine generator trip. I take it that is expected
24 to occur following a reactor trip?

25 A That's correct.

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Q The next event is a pressure spike in the B steam generator. What was that caused by?

MR. GLASSMAN: Objection as to form. The same objection as before. The question here is making assumptions based on a sequence of events which the witness did not participate in. I think you would do better if you went along and asked the witness his recollection of things without assuming all the way down that the particular list is or is not correct.

MR. WISE: I was only using the list because I thought it might help. If you want to do this without the list, that is fine, but Mr. Keaten was the chairman of this task force and has testified that he either wrote what is in it or else acted as editor with respect to what others wrote to put into it, and I think it is perfectly fair to set as a foundation for questions to come to get his knowledge and review the sequence of events.

I am only using this because it is in his report, and I thought it would be helpful.

MR. GLASSMAN: I have no problem with the general approach, but the form of the question

1
2 was objectionable insofar as it seemed to be
3 based solely on the particular page in front of
4 him.

5 BY MR. WISE:

6 Q You are free if you wish to mention any
7 other events or considerations that you now recall that
8 are not reflected here on this sequence of events.

9 MR. GLASSMAN: Objection. The statement
10 or question, and I can't tell which, of counsel
11 seems to assume that Mr. Keaten has already
12 confirmed each and every sequence of events
13 item listed here.

14 MR. WISE: Maybe we ought to clear that up.

15 Q Before you signed this report on the cover
16 page, did you read pages 14, 15 and 16?

17 A I believe that I did.

18 Q Did you note any objection to the material
19 that appears there?

20 A I don't recall that I had any objection,
21 but I did not in reviewing material like this that, to
22 the best of my memory, was prepared by someone else
23 necessarily go through and confirm in my own mind that
24 it was accurate in every stage. I am perfectly willing
25 to rely on other members of the task force for their

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individual expertise.

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Q In writing this report and chairing the task force, did you become familiar with the sequence of events that had occurred during the events?

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A I became generally familiar with it, yes.

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Q Going back to where we were before this discussion, following the turbine generator trip, what in your recollection is the next major event that occurred during this transient?

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A I recall that one or more of the steam safety valves were believed to have lifted.

13

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Q Are those located on the secondary side of the system?

15

A Yes, they are.

16

Q What is the consequence of their lifting?

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18

19

A It releases steam to the atmosphere and generally tends to reduce the pressure on the secondary side of the steam generators.

20

21

Q Would that have any effect on the parameters seen in the primary system?

22

A Yes.

23

Q What effect would it have?

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MR. GLASSMAN: I am not sure whether the question is directed to Mr. Keaten's current

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2 knowledge or analysis back then. Obviously this
3 is not of great weight at this point in the
4 examination, but I think the questions ought to
5 be clear so we know whether we're asking for Mr.
6 Keaten's current knowledge or what.

7 MR. WISE: I think all of these questions
8 concern Mr. Keaten's work as chairman of the task
9 force, investigating the event on April 23, 1978,
10 and are directed to his recollection of what the
11 various events that occurred at that time were
12 and what effects they had on the system
13 generally.

14 A In terms of the analysis that was done by
15 the task force at the time, my recollection is that
16 there was general agreement that lifting the steam
17 safety valves on the secondary side of the plant and
18 the consequent steam flow out these valves tends to or
19 tended to cool the primary side water in the steam
20 generator and thus to reduce the temperature in the
21 cold leg of the primary side.

22 Q Why does the release of pressure in the
23 secondary side result in a cooldown as you described it
24 in the cold leg of the primary side?

25 MR. GLASSMAN: Why did it?

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Q Why did it if the tense helps?

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MR. GLASSMAN: I like to keep the question

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clear for the record.

5

A When the safety valves lifted, the net

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result was an increased steam flow out of the steam

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generators. That steam is generated by removing energy

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from the primary side, so the increased steam flow means

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a greater energy removal from the primary side and thus

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a cooling of the primary.

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Q What effect, if any, did the cooling of the

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primary side that you have described have on pressure

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in the primary side?

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A As I believe we mentioned yesterday, the

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cooling of the primary coolant inventory causes the

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water to shrink, and the immediate effect of this is to

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reduce the water inventory in the pressurizer, and that

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in turn tends to immediately reduce the pressure of the

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primary side.

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Q During the event on April 23, 1978, did

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primary side pressure decrease?

22

A My recollection is that it did decrease.

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Q What at that time was the normal operating

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primary system pressure, approximately?

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A It was approximately slightly above 2100

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2 pounds per square inch.

3 Q To what level did the primary system
4 pressure decrease during the event, approximately?

5 A I don't recall exactly.

6 Q I think there are some charts which may be
7 helpful. If you would look two pages in front of the
8 sequence of events, there is a chart which is labeled
9 "Figure 4" on a piece of paper that bears the legend
10 "Burns & Roe, Inc." The chart has written in
11 handwriting "Primary pressure" and appears to show some
12 values for pressure against time. Do you see that?

13 A Yes, I do.

14 Q The chart shows a pressure at time zero
15 of approximately, as best I can read it, 2200 some-odd
16 pounds per square inch. It might be 2100. The
17 Xeroxing is very poor. A general downward slope on the
18 chart getting down to levels in the 700-pound-per-
19 square-inch area.

20 MR. GLASSMAN: Is there a question?

21 Q No. 1, do you recognize this chart?

22 A I frankly don't remember it very well.

23 Q Does seeing it now in any way refresh your
24 recollection concerning the amount of the decrease in
25 primary system pressure that occurred during the

1
2 April 23 incident? There may be other charts in the
3 report that may be more helpful.

4 MR. GLASSMAN: The chart speaks for itself.

5 Just so you understand, the question is
6 whether the chart refreshes your recollection.

7 A My recollection is that there was a very
8 substantial decrease in the primary system pressure.
9 I don't specifically remember the lower number as
10 indicated in the graph.

11 Q Do you recall that primary system pressure
12 decreased to a level at which the emergency
13 safeguard system was actuated?

14 A Yes, I do.

15 Q That emergency safeguard system was high-
16 pressure injection, is that correct?

17 A High-pressure injection is a part of the
18 emergency safeguard system, and HPI was initiated, yes.

19 Q Do you remember how far into the incident
20 high-pressure injection actuated?

21 Let me refer you to the sequence of events,
22 if it helps refresh your recollection. At
23 approximately one minute and eleven seconds, as
24 indicated on page 15 of the report, safety injection in
25 the A & B loops was initiated.

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2 MR. GLASSMAN: According to page 15?

3 MR. WISE: Yes. The notation reads
4 "Safety injection A/B. RC pressure 1630 PSIG.
5 Operator checks that he has normal actuation."

6 MR. GLASSMAN: Is the question --

7 MR. WISE: Does that help refresh his
8 recollection as to how far into the accident it
9 was that high-pressure injection came on?

10 A I don't specifically recollect the exact
11 numbers, but I do remember it happened quite soon after
12 the transient start.

13 Q Did your task force make any investigation
14 of operator action concerning HPI during the incident?

15 A I don't recall any such investigation.

16 Q There is a notation a little bit further
17 down in the sequence of events indicating that at one
18 minute and 17 seconds, safety injection was bypassed.

19 First, let me ask you, are you able to
20 interpret for us what is meant by the notation that I
21 have just pointed to?

22 MR. GLASSMAN: I object to the form, to the
23 use of the word "interpret." The document speaks
24 for itself.

25 A I am having great difficulty in terms of

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2 distinguishing exactly what I knew at the time that
3 this report went out, versus what I know now, but I
4 believe it is correct that I knew what that meant at
5 that time. My understanding of that term as it is
6 used here is a step that is taken by the operators when
7 the reactor experiences an automatic actuation of the
8 high-pressure injection fluid. The operator may then
9 bypass the signal which automatically actuated
10 high-pressure injection. This has in itself no
11 effect on high-pressure injection flow, but simply
12 gives the operator the ability then to control that
13 flow rate to the extent that he feels that he should
14 control it.

15 Q Was any investigation made as to why the
16 operators took that action during this incident?

17 A I don't recall any such investigation.

18 Q Do you recall whether the operators allowed
19 high-pressure injection flow to continue into the
20 system following their bypass of the automated, if you
21 will, aspect of high-pressure injection? If it is of
22 any help, let me refer you to the Met Ed sequence of
23 events as contained in attachment 2 to your report.
24 It appears at page 1247 0592 as marked for purposes of
25 this litigation. It is page A2-9 of your report.

1
2 If you have that before you and look down
3 the page to the time marked one minute and 40 seconds,
4 there is a notation of HPI flows in the four trains.

5 A My recollection is that high-pressure
6 injection flow was maintained by the operator at a
7 significant level well past the time indicated here
8 for bypassing the actuation circuit.

9 Q Did your task force question the operators
10 as to why they had done that?

11 A Why they had done what?

12 Q Left high-pressure injection flow running.

13 A I don't remember any such question.

14 Q Did you while you were preparing your
15 report have any question in your mind concerning the
16 operation of the high-pressure injection system and
17 its control by the operators during the event?

18 A To the best of my recollection, the task
19 force did consider the general question of whether the
20 operators had responded in what appeared to be an
21 appropriate fashion to the transient which occurred,
22 and my recollection is that the task force concluded
23 that the operators generally had acted correctly.

24 Q Do you have any recollection as to whether
25 the task force specifically considered their actions

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with respect to high-pressure injection as part of
its review of operator action?

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A I do not specifically recollect.

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Q Do you recall whether anyone brought to
your attention any practice or procedure generally
among the operators to terminate HPI flow during an
event as a matter of standard practice? Did anything
of that nature ever come to your attention while you
were working on this report?

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MR. GLASSMAN: During what kind of an event?

12

During any event?

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MR. WISE: During any event where it had

14

been actuated.

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A I have no recollection of that type of
discussion.

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Q If I understand your testimony correctly,
you cannot recall any examination of the reasons why
the operators left HPI running during this event. .

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A I can only repeat what I said earlier, that
I do recall that we considered the question of whether
the operators had generally acted in a fashion that the
task force thought was appropriate and that the
conclusion was that, yes, they had, but I do not recall
the details.

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Q Did the task force interview any of the operators?

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A As I mentioned yesterday, I believe the first principal activity on the part of the task force was to attend a meeting at Three Mile Island with some of the plant personnel for the purposes of discussing the transient. I frankly don't remember whether any of the operators involved were at that meeting or not.

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Q Do you know whether any members of the task force ever interviewed the operators in connection with this report?

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A I don't recall any such interviews.

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Q Who on the task force was responsible for evaluating the correctness or appropriateness, if that is the better word, of operator action during the event?

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A I don't remember.

Q Was that considered by you as chairman of the task force to be an important aspect of the task you had been assigned?

A I note that the second item in Mr. Arnold's memo which formally established this task force is "A review of the automatic response of the plant and the manual actions taken by the operator, the

1
2 consistency of both automatic and manual response with
3 the design philosophy for the unit..."

4 As chairman of the task force, therefore,
5 I certainly would have been interested in responding
6 to this part of the charter of the task force.

7 MR. GLASSMAN: The witness was reading from
8 page 1247 0585.

9 Q Are you able to recall any reason today
10 why the operators were not interviewed in connection
11 with preparation of the task force report?

12 MR. GLASSMAN: I don't think the witness
13 said they were not interviewed. He said he
14 didn't recall whether they were interviewed.

15 Q Do you know whether you personally
16 interviewed any of the operators?

17 A As I indicated earlier, I was present at
18 the meeting at Three Mile Island which had various
19 members of the plant staff present. I don't remember
20 whether some of those were the operators or not.

21 However, let me comment that this task force
22 was able to get very good information from the Met Ed
23 personnel with respect to what had occurred, and I can
24 remember that I felt very comfortable with the amount
25 of information that we had received.

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Q That would be information that was coming through Mr. Seelinger?

A He was the formal participant in the task force from the TMI staff, but I do not believe that our contacts with the Metropolitan Edison personnel were limited to Mr. Seelinger.

Q All I am trying to do now is to find out where you got your information about operator actions. As I understand your testimony, you don't recall interviewing the operators. Do you have any information which you can give us here today as to where, if anywhere, the task force was obtaining its information concerning operator actions during the event?

A To the best of my recollection, our sources were as follows: first, there was the initial meeting at Three Mile Island in which we discussed the sequence of events in detail. Second, there was the plant staff report on the transient, and my memory is that we received an early version of that basically about the start of our investigation.

Third, we had direct access to some of the data printouts, strip chart recorders, computer printouts, et cetera, and my memory is that some

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2 members of the task force took a fairly careful look
3 at the data printouts and that where there were
4 questions about what happened, whether it be the
5 operator response or anything else, that the people
6 involved would have called someone appropriate at TMI
7 and discussed that with them, and that might have been
8 Jim Seelinger and it might have been someone else.

9 That is all I recall about it.

10 Q Let's stop for a minute at this point and
11 talk about the data available concerning what went on
12 during the event. What data sources were there? For
13 instance, the term "reactimeter" has come up several
14 times.

15 Perhaps you could begin by explaining what
16 a reactimeter was and generally what it showed.

17 MR. GLASSMAN: The question is directed to
18 what data sources were available that were
19 reviewed in the course of this task force work
20 or what data sources were available in some
21 general source? I assume we're trying to focus
22 in on the questions.

23 MR. WISE: Yes, let's start with the data
24 sources that were available and that were used in
25 the investigation, and then I will ask the

1
2 question as to whether the task force ignored
3 other data sources that were available to it. I
4 guess I am assuming you looked at what data
5 sources that were available, but as your counsel
6 points out, that may be a false assumption, so
7 we'll square the corners and do it the hard way.

8 BY MR. WISE:

9 Q What data sources did you look at? And I
10 thought I began by suggesting the reactimeter. There
11 may be others.

12 A I did not personally look at all of the
13 data that was used by others in considering the
14 transient, so my recollection is not necessarily
15 adequate to give you a complete list of the data that
16 was considered. The reactimeter is a data logger
17 provided by B&W which, according to my understanding,
18 was intended primarily for use during the startup
19 testing of a nuclear plant. It automatically records
20 preselected signals and maintains a record of these.

21 My recollection is that the data from the
22 reactimeter was one of the things considered in
23 looking at this transient.

24 Q Does the reactimeter show information on
25 strip charts?

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2 A No, generally I believe the reactimeter
3 printout is a digital printout.

4 Q What other sources of information were
5 available to the task force, as best you recall?

6 A There were the summary sheets from the plant
7 computer which give a time phase record of changes of
8 state of signals that are monitored by the computer.
9 There were the analog strip chart records of those
10 signals which are monitored on analog recorders. And
11 our task force also used the plots which had been
12 prepared by the plant staff based on the same types of
13 data sources.

14 Q Do you have any recollection as to whether
15 the plant computer data available for the transient on
16 April 23, 1978 was complete?

17 A I don't remember.

18 Q Do you have any recollection as to whether
19 anyone ever brought to your attention any problem with
20 respect to the plant computer and the availability of
21 information it was supposed to show during the
22 transient?

23 A I don't remember.

24 Q Did it come to your attention that there
25 had been complaints concerning the slowness of the

1
2 plant computer during the event?

3 A I don't recall any such complaints.

4 Q Would you take a look at page A2-14 of your
5 report, which is part of the Met Ed report that appears
6 at page 1247 0597 as marked for this litigation. Look
7 at item 9, which reads, "Why the sequence of events
8 did not print out on the computer must be resolved."
9 Item 9 is a continuation of some comments made by the
10 Met Ed staff concerning equipment performance.

11 Do you recall reading this at or about the
12 time you were working on the task force?

13 MR. GLASSMAN: Is the question whether
14 Mr. Keaten recalls reading this particular line?

15 MR. WISE: Yes, and seeing this notation.

16 A Frankly, I don't remember.

17 Q Item 10 is noted, "The time lag in selected
18 parameters such as fluctuation in the computer
19 memory trip review must be resolved."

20 Do you remember that item as something
21 that came to the attention of your task force?

22 A I don't remember it, no.

23 Q Do you have any information as to whether
24 either of these two items mentioned in the Met Ed
25 report were ever resolved?

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A I honestly don't know.

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Q Do you know whether any investigation was made by your task force concerning the effect, if any, of these items on operator performance during the incident?

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A I don't remember.

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Q During the course of your task force review, did it come to your attention that the operators had been confused concerning what was happening during the event?

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A Not that I recall.

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Q Did it ever come to your attention that the operators had only "a marginal understanding" of some of what was going on during the event?

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MR. WISE: I am just asking whether that came to his attention. It either did or it didn't.

19

A I don't recall any such statement.

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Q Would you look a little further down the page under the notation "Philosophy," the second item, which reads, "We must stop and regroup when something is marginally working or marginally understood. Adverse affects" -- and I think it should be "effects" -- can be additive."

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Does that in any way refresh your recollection as to whether it was ever brought to the attention of the task force that there had been parts of the event marginally understood by the operators during its course?

A My recollection is admittedly vague, but to the best of my recollection, I did not interpret this comment as applying to the operators and their understanding and actions during the transient, but rather to apply to an incomplete understanding of the previous transient.

Q Do you recall that one of the aspects of the April 23 event was the so-called slow response of the feedwater valves?

A At this date and time, I frankly don't remember that.

Q Do you recall anything at all from the task force review which highlighted any problem with operator action?

A When you say problem with operator action, you mean an action that was taken or not taken by the operator that in retrospect the task force felt something else would have been preferable?

Q No. What I am driving at and have been with

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this entire line of questions is to try and determine to what extent the task force considered operator action as a significant part of this event. You have testified a little bit earlier that in the charge to your task force from Mr. Arnold, that was mentioned as one of the items that should be looked into, and you said that the conclusion was that operator action had been appropriate.

I am simply trying to determine whether there was anything that you can recall from the task force that concentrated on operator action as being a significant factor in this event or did you view it as being entirely an equipment problem?

A I don't recall any of the operator actions or inactions that the task force felt had contributed to the severity of the transient. The only operator action that I remember giving rise to a task force recommendation was that the control room operators at the time of the transient were not sure early in the transient whether the steam safety valves had stuck open, and since there was no indication of that in the control room, my memory is that we were told that they dispatched an operator to go to a location where he could see the exhaust from the steam safety valves and

1
2 thus visually confirm that they were in fact open, and
3 the task force felt that the instrumentation available
4 to the operators should be such that that type of
5 action should not be necessary, and that led to the
6 recommendation to provide some method of determining
7 from the control room whether the safety valves were
8 open or not.

9 Q Let me refer you to page A2-13 of the Met
10 Ed report, which is page 1247 0596 for purposes of
11 this litigation. That is the first page of the
12 "Conclusions" section which you will note by looking at
13 the immediately preceding page.

14 MR. GLASSMAN: From the Met Ed report?

15 MR. WISE: Yes.

16 Q You will see on that page at the top the
17 heading "Operator Action," and eight items are listed
18 beneath it.

19 The first item states, "Operator response
20 to reactor trip was prompt and correct with one
21 exception. The feedwater pump was not run back until
22 one minute and 20 seconds into the event."

23 Item 2, "While the operators responded
24 correctly to the reactor trip, they did not realize
25 the casualty they were really dealing with was a major

1 steam leak (through the relief valves)."

2 Do you recall reading those items which are
3 the first two items in the conclusions of the Met Ed
4 report at or about the time you were working on the
5 task force?

6 A Yes, I do have a vague recollection of
7 having seen that.

8 Q Did any information come to the attention
9 of the task force or to your attention indicating
10 that the matters listed in items 1 and 2 of the Met Ed
11 plant staff conclusions were incorrect?

12 A I don't recall any such.

13 Q Did your task force make any investigation
14 as to why the operators had apparently failed to
15 realize the casualty they were dealing with?

16 MR. GLASSMAN: Objection as to form. It
17 assumes they did not realize something in this
18 particular page. I don't think Mr. Keaten
19 offered testimony to that effect.

20 MR. WISE: I don't understand the objection.

21 MR. GLASSMAN: I think there was an
22 assumption in your question which was unfounded.

23 MR. WISE: I am reading from the Met Ed
24 report which Mr. Keaten incorporated in his task
25

1
2 force report. I am asking whether the task
3 force did anything, to Mr. Keaten's knowledge,
4 with respect to what is reported there.

5 MR. GLASSMAN: That is a slightly different
6 question. I will let him answer it in the
7 current form. You can look back at the record
8 and perhaps understand the difference. He can
9 answer this question.

10 A I frankly do not recall what we did with
11 respect to these two items.

12 (Recess taken)

13 BY MR. WISE:

14 Q Did it ever come to your attention on the
15 task force that the operators had complained about the
16 number of alarms that they saw during the April 23,
17 1978 transient?

18 A I do not remember.

19 Q Do you remember whether the task force
20 made any investigation with respect to the alarm
21 system at TMI-2?

22 A I don't remember any such investigation.

23 Q Did you perform any work with respect to the
24 alarm system at TMI-2 in connection with the task
25 force?

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A Not that I recall.

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Q I would like to show you what has

previously been marked as B&W 264, which is a memorandum that has been identified earlier as being written by Ed Frederick, whose name appears at the end, and was addressed to Jim Seelinger. It is dated May 3rd, 1978.

Would you look at item 3, which is on the second page, which reads, "The alarm system in the control room is so poorly designed that it contributes little in analysis of a casualty. The other operators and myself have several suggestions on how to improve our alarm system. Perhaps we can discuss them sometime, preferably before the system as it is causes severe problems."

Did anyone ever bring to your attention this comment by Mr. Frederick?

A As part of the investigation of the April 23, 1978 transient?

Q Yes.

A Not that I recall.

Q Are you aware that Mr. Frederick was one of the operators on duty during the April 23, 1978 transient?

MR. GLASSMAN: Is he now aware of that?

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Q Yes, are you now aware of that?

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A Not really, no.

4

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Q Obviously you weren't aware at the time the task force report was being prepared, I take it.

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A Not to my knowledge.

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Q Am I correct that you don't know one way or the other whether anybody ever talked to Mr. Frederick to get his comments as part of the task force review?

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A As part of the task force that I was chairman of, I don't remember exactly who in the plant staff we talked to.

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Q To your knowledge, did Mr. Seelinger ever bring Mr. Frederick's comment to the attention of the task force, his comment concerning the alarm system?

16

A I have no recollection of that.

17

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Q Do you recall whether there was any consideration given by your task force to the role of multiple casualties during the April 23, 1978 event?

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A I don't know how to interpret the question. The task force was considering the events which did occur, and my memory is that there was more than one event of interest, so in that sense, we were considering multiple events, yes.

25

Q Did the task force consider the effect of

multiple casualties on the operators and their ability, given their training and procedures, to handle such events?

MR. GLASSMAN: Is the question whether the task force considered this event and also considered the training of operators with regard to any such event? I am not sure I understand the question.

MR. WISE: I think the question is clear. Let's have it read back.

(Record read)

A As I said earlier, the task force that I was involved in generally concluded that the operator's response was appropriate, although my recollection has been helped a little bit by the item you showed me earlier, and I do vaguely remember some discussion of the fact that the operator might have terminated feedwater flow sooner, but as I think is explicitly stated in our task force report, that even so, we generally felt like the operator response was adequate. I don't remember any particular considerations past that point.

Q Let me read to you further from Mr. Frederick's memorandum to Mr. Seelinger. I am reading

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from the next to last page in Exhibit 264, item 9. "You might do well to remember that this is only the tip of the iceberg. Incidents like this are easy to get into -- and the best operators in the world can't compensate for multiple casualties which are complicated by mechanical and control failures."

Did Mr. Seelinger ever bring to the attention of the task force Mr. Frederick's comment?

MR. GLASSMAN: Objection. I think it has already been asked and answered that Mr. Seelinger -- at least Mr. Keaten did not recall Mr. Seelinger bringing this entire memorandum to the task force's attention or to Mr. Keaten's attention.

MR. WISE: I asked him before specifically with respect to the alarm system. Now we are on the effect of multiple casualties on the ability of operators to cope with an event.

A I don't remember Mr. Seelinger raising this item of the Frederick memo, no.

Q As a result of the investigation of the

1
2 April 23 incident, were any conclusions reached
3 regarding the need for better instrumentation
4 or different instrumentation to monitor the
5 position of the steam relief valves on the secondary
6 system?

7 A As I said earlier, it is my recollection
8 that the task force did recommend some method be
9 provided that the operators could know from the
10 control room whether the safety valves were open
11 or not, and I note on page 4 of the task force
12 report in the section titled Summary of Recommendations
13 that under "Actions Recommended To Be Completed
14 As Soon as Possible," item 3 is install a means of
15 monitoring when safety valves lift, and if practical
16 when they recede.

17 Q Was anything ever done about that
18 recommendation, to your knowledge?

19 A To the best of my recollection,
20 acoustical monitors were installed for that
21 purpose.

22 Q Were any other kinds of monitors
23 considered?

24 A I don't know.

25 Q Who did the work on that recommendation;

1
2 that is, following up on it after it was made?

3 MR. GLASSMAN: Which recommendation?

4 MR. WISE: The one considering better
5 instrumentation for the steam relief valves.

6 MR. GLASSMAN: You are talking about the
7 sentence Mr. Keaten just read on page 4 of
8 the task force report?

9 MR. WISE: Yes.

10 A I am not sure who did it.

11 Q Was any consideration given at that time
12 to providing different instrumentation for valves
13 in the plant other than the steam relief valves?

14 MR. GLASSMAN: Consideration by whom,
15 by the task force?

16 MR. WISE: Right. Or anyone else that
17 he can remember.

18 A I don't remember.

19 Q Was there any reason why the recommendation
20 in your task force report was limited to the steam
21 relief valves?

22 A I don't remember.

23 Q What was the instrumentation for the
24 steam relief valves as it existed at the time of the
25 April 23, 1978 transient, if you can recall?

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A I don't recall being made aware of any instrumentation in the steam safety relief valves.

Q Were you aware that there was an indication in the control room with respect to the valves showing whether or not they had in a layman's sense been instructed to open?

A On the steam safety valves?

Q Yes, existing at the time of the transient.

A No, I was not aware of any such.

Q Were you aware during your work in the task force that there had been another event at TMI-2 occurring on March 29, 1978?

A You are talking about my work in conjunction with this task force on the April '78 event?

Q During the period from April '78 through the time this report was finalized and distributed, during that period of time, were you aware that there had been another event at TMI-2 which had occurred on March 29, 1978? I am sure you know at this point the event I am talking about.

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2 A Yes, I do. I am simply trying to
3 remember what I knew in that time frame. To the
4 best of my recollection in that time frame I was
5 not aware of it.

6 Q Have you ever learned any reason to this
7 date why you were not made aware of the March 29,
8 1978 incident at the time you were working on the
9 April 23, 1978 incident?

10 MR. GLASSMAN: By whom?

11 MR. WISE: By anyone.

12 MR. GLASSMAN: I am not sure I
13 understand the question. Are you asking
14 whether he knows what other people thought
15 or didn't think, or are you just asking
16 whether anyone told him whether -- even
17 brought up the subject?

18 MR. WISE: Mr. Keaten was chairman
19 of the task force looking at the April 23,
20 1978 event. As we have seen, there were
21 various aspects to that which were of
22 great interest and may have become of even
23 greater interest in light of the Three
24 Mile Island accident that occurred almost
25 a year later.

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MR. GLASSMAN: We may disagree.

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MR. WISE: There was another event
also very significant.

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MR. GLASSMAN: We may disagree.

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MR. WISE: In the view of some people,
that occurred very shortly before that
April 23 event. Some of the recommendations
and conclusions that were reached in the
April 23 event, the investigation of the
April 23 event, might well have been fitted
from a review of the March 29 incident.

Mr. Keaten, as I think testimony will
show as we move through this deposition,
was intimately involved in investigations
following the Three Mile Island accident. I
think my question now is directed in a much
more general way than my questions up to
this point in the deposition have been to
whether he has had anything come to his
attention to this point as to why that task
force that was investigating the April 23,
1978 incident was not made aware of another
incident that had occurred less than a month
and a half beforehand at the same unit.

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2 A I cannot recollect any discussions or
3 communications on that subject at all, but in view of
4 your earlier comments, let me put the investigation of
5 the 1978 April transient in perspective a little bit.

6 Your questions have been concentrating on
7 the thermohydraulic behavior of the plant during that
8 transient and that is in fact one of the things which
9 the task force did consider, but I think it is also
10 important to note that from the standpoint of the real
11 impact on the plant, there were other aspects of that
12 transient that merited a great deal of attention,
13 namely, the failure of the bellows which were
14 associated with the safety valves and the discovery
15 that the transient had led to the injection of a
16 certain amount of chlorine into the primary system are
17 two items that come to mind immediately, so a great
18 deal of the attention of the task force was focused on
19 those types of items and was not restricted to simply
20 looking at the thermohydraulic behavior.

21 Given that as a background, it is not clear
22 to me why we would have been asked to broaden our
23 investigation to include the March incident as well.

24 Q Have you become aware that the March 1978
25 event at TMI-2 included a failed open PORV?

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A Yes, failed open in the sense that the signal, the demand signal to the valve, erroneously required that it stay open.

Q Are you aware today that following that event, work was done to provide additional instrumentation to the control room operators concerning the position of the PORV?

A I am aware that work was done to provide additional indication to the operators of the status of the demand signal.

Q To your knowledge, was there ever any cross-fertilization between those working on the additional instrumentation for the steam relief valves as a result of the April 23, 1978 incident and those working on the provision of additional instrumentation for the pilot-operated relief valve as a result of the March 29, 1978 incident?

A I don't know.

Q Are you aware of any reason why acoustical monitors were eventually placed on the steam relief valves but not on the pilot-operated relief valve?

MR. GLASSMAN: You are asking for Mr. Keaten's current knowledge, if he has such knowledge.

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A I played no role in the selection of the instrumentation for the PORV, and I have really no knowledge as to how the decisions were made.

Q Who would have that knowledge?

A The personnel who did the work, and I don't know who they are.

Q When was the first time that you personally became aware of the March 29, 1978 incident?

Let me make that question perhaps easier to respond to. Was it before or after the Three Mile Island accident on March 28, 1979?

A To the best of my recollection, it was after the accident.

Q Do you know whether anyone ever performed a review and report on the March 29, 1978 event comparable or similar to the review and report that you performed on the April 23, 1978 incident?

A No, I do not know.

Q Let me turn your attention back for a moment to high-pressure injection. Were there any consequences for the plant and its ability to restart from the fact that high-pressure injection had initiated during the accident and had continued for some period into it? I am sorry if I used the word

1
2 "accident." Incident or transient.

3 MR. GLASSMAN: I just want to make sure
4 that question relates to the incident in 1978.

5 MR. WISE: Yes, I am referring to the April
6 23, 1978 incident.

7 A The only impact that I can identify was
8 really sort of peripheral to the high-pressure
9 injection. It was associated with the fact that along
10 with the high-pressure injection was an injection of
11 sodium hydroxide, and the sodium hydroxide had a
12 relatively high level of chlorine in it, so I believe
13 that there was some work which was done in considering
14 the possible impact on the primary system of having
15 injected the chlorine.

16 However, to the best of my memory, that was
17 not by any means the item which determined the restart
18 schedule, and the solution that was recommended, and
19 to my knowledge taken, was to use an alternate supply
20 of sodium hydroxide which had a much lower level of
21 chlorine in it.

22 Q Was there not also consideration of
23 changing the parameters that would call for the
24 injection of sodium hydroxide with high-pressure
25 injection flow?

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A There may have been. I recall that there was a great deal of discussion of the sodium hydroxide arrangement, and I don't remember the details right now.

Q Do you recall what the reason was that people discussed this at great length?

Let me ask the question this way. Wasn't it true that the injection of large amounts of sodium hydroxide with the high-pressure injection flow had resulted in a condition that was expensive and messy to clean up following this incident?

A It certainly required some cleanup. I frankly don't remember any discussion of the expense associated with it. Again, I am having a continual problem distinguishing between discussions that occurred in that time frame plus later discussions of the sodium hydroxide system in other context, so my memory is not perfect as to just what was when.

Q As part of the task force investigation, did you become aware of any instructions or recommended actions given to the operators as a result of the necessity to clean up that injection of sodium hydroxide through the high-pressure injection system which was caused during the April 23, 1978 incident?

A Your question was specifically instructions

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2 to the operators?

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Q Yes. This thing made something of a mess.

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As a result of this, did it ever come to your

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attention that in fact the operators were being made

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wary of leaving HPI running because of the mess that it

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could create if it continued?

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A I am not aware of any such attitude. While

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you were asking the question, I was attempting to

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refresh my memory by looking at some of the items in

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the report, and as a result of that, I do now remember

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that we recommended that the logic under which sodium

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hydroxide be injected be changed so that it would be

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a less frequent event and would only occur when it was

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more likely to be needed.

16

Q Do you know whether that recommended change

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was adopted at TMI-2?

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A According to the report here on page 4,

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the comment is made that that recommendation has now

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been completed at the time of the issuance of the

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report. I don't specifically remember that, but I have

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no reason to challenge what the report says.

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Q You are familiar with a set of

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specifications usually referred to as "Technical

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Specifications" for the plant, are you not?

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A I am aware of the existence of such, yes.

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Q During your work on the task force, did it come to your attention that during the course of the April 23, 1978 transient certain of the tech specs for TMI-2 had been violated or exceeded, whatever the proper terminology is?

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A I frankly don't remember.

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Q Let me refer you to page A2-5 of your report, which is page 3 of the Met Ed report. It is marked page 1247 0588 for purposes of this litigation.

Would you look at that page and particularly the second full paragraph, which reads, "The event caused violations in technical specification action statement entries in that." Then there is a list of four items.

Would you review those for just a second and see if that helps refresh your recollection as to whether any technical specifications for the TMI-2 plant had been violated or exceeded during the April 23, 1978 incident.

MR. GLASSMAN: You are reading from the Met Ed report which is an attachment to Mr. Keaten's report?

MR. WISE: That's correct.

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2 A Yes, this does to some extent refresh my
3 recollection and on that basis I believe I do now
4 recollect that in fact certain tech spec limits were
5 violated.

6 Q What if anything was your understanding
7 of the consequence of a violation of a tech spec?

8 MR. GLASSMAN: Are you looking for the
9 legal consequence?

10 Q What was required within the licensee for
11 the plant in the event its tech specs had been
12 exceeded or violated?

13 MR. GLASSMAN: Objection insofar as you
14 are seeking a legal conclusion of what might be
15 required.

16 MR. WISE: I am not looking for the legal
17 conclusion. I am looking for his understanding
18 as to whether that was a matter of something of
19 concern that something had to be done about or
20 was something that was of no concern whatsoever
21 and he had no understanding of any requirements
22 that might be triggered by the fact that a tech
23 spec had been violated.

24 MR. GLASSMAN: Now you seem to be going to
25 Mr. Keaten's personal concern or lack of concern.

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2 If you want to ask whether he had some
3 understanding of some particular action to be
4 taken after this event, fine, but otherwise we
5 are getting into an area where we're asking for
6 him to answer questions which he is not capable
7 of answering.

8 MR. WISE: I don't know who else to ask
9 except Mr. Keaten to find out what he as chairman
10 of the task force thought the fact that certain
11 tech specs had been violated required.

12 MR. GLASSMAN: I am not sure of whom.
13 We're not here to find out his thoughts in some
14 abstract sense here. If you want to ask if he
15 did something or recommended that something be
16 done or knows anything was done, fine.

17 MR. WISE: I disagree. We're here to find
18 out his thoughts, because it may very well have
19 a great deal to do with what occurred.

20 You have examined at great lengths B&W
21 people on conclusions they reached concerning
22 the Davis-Besse transient, and I believe I am
23 entitled to ask what thoughts he had concerning
24 this April 23, 1978 transient.

25 MR. GLASSMAN: If he reached any

1
2 conclusions regarding this transient, he can
3 certainly testify to it.

4 MR. WISE: I want to know what his
5 understanding was of what the violation of a tech
6 spec required in the way of action by the
7 licensee. I am not asking for a technical,
8 legal opinion. I am just asking, as the chairman
9 of the task force, what his understanding was of
10 the consequence of the matters noted on this
11 page.

12 MR. GLASSMAN: I object as to form. If
13 Mr. Keaten can answer what he recalls his
14 understanding of what was to be done, fine.

15 A As best I can recollect, my understanding
16 at that time, violation of a tech spec would require
17 certain types of action, depending on what the
18 violation was. I think I believed at that time that
19 in some cases the technical specifications themselves
20 state what must be done if some requirement is not met,
21 but in general, based on my experience up until that
22 time, I believe I would have expected that an
23 evaluation would need to be made as to the impact on
24 the plant of the violation of the technical
25 specification and further, that there would be some

1
2 reporting requirements to the Nuclear Regulatory
3 Commission.

4 Let me also take the opportunity to point
5 out, however, that the fact that a task force was
6 formed of basically or mostly Service Company employees
7 was not in my opinion intended at all to relieve the
8 plant staff of obligations that they might have, for
9 example, under the technical specifications, but rather
10 was intended to assist the plant staff in providing
11 technical review of the incident.

12 (Lunch recess taken at 12:30 p.m.)
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A F T E R N O O N

S E S S I O N

(Time noted: 2:15 p.m.)

R O B E R T W. K E A T E N resumed

and testified further as follows:

EXAMINATION (continued)

BY MR. WISE:

Q Before the lunch break, we were looking at B&W Exhibit 186 which is the task force report and particularly at page A2-5, which is part of the Met Ed report that was an attachment to the task force report. You mentioned in your testimony just before the break that you were aware that violation of a technical specification could have reporting consequences for the NRC.

Do you know whether any report was actually made by Met Ed or GPU Service to the NRC with respect to the April 23, 1978 incident?

A I don't know.

Q Did you ever see a licensee event report for the April 23, 1978 incident?

A I frankly don't remember whether I did or not.

Q Are you familiar with what a licensee event report is?

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A Yes.

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A I don't remember.

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A Again, I don't remember.

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Q During the course of your work on the task force, did you become aware that any of the tech spec violations that had occurred during the April 23 incident might under certain circumstances require a plant shutdown?

Q Specifically, do you recall whether the tech specs would require a plant shutdown if it were concluded that the bubble in the pressurizer had entered the hot legs of the primary system?

Q You don't remember that being a topic of concern within the task force?

A As I indicated earlier, and maybe I can state it a little more clearly, the task force that I was involved in was not concentrating on violations of technical specifications or reporting requirements. We were concentrating on technically what had happened and what we felt were the technical implications of what had happened in support of others who might be worrying about those things.

Q Was it your practice during the period you were working on the task force to keep a notebook,

1
2 personal notebook of matters relating to the things
3 you were working on?

4 A It was my habit, as best I recollect, at
5 that time to keep notes generally in a spiral
6 stenographer-type pad where there was some reason why
7 I wanted to keep the notes, but not necessarily notes
8 of every telephone conversation or even every meeting
9 but just where I felt it was appropriate to keep them.

10 Q You put things in there that you thought
11 were significant?

12 A In some cases, yes.

13 MR. WISE: I would like to have marked as
14 B&W Exhibit 337 a photocopy of what appears to
15 be a portion of a spiral notebook.

16 (Portion of a spiral notebook was marked
17 B&W Exhibit 337 for identification, as of this
18 date.)

19 MR. WISE: Let me state for the record that
20 B&W 337 contains a photocopy of the front of the
21 notebook with handwriting at the top which reads
22 "R. W. Keaten, Book No. 1, from April 19, 1978
23 to September 1, 1978." The remainder of the
24 exhibit consists of handwritten notes which appear
25 to have been copied from the notebook.

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BY MR. WISE:

3

Q Do you recognize Exhibit 337?

4

A It appears to be a copy of a notebook which

5

I kept.

6

Q Will you look through the handwriting and

7

tell us if that appears to be your handwriting.

8

A Yes, I believe it is.

9

Q Would you look at the page which has been

10

marked for purposes of this litigation in the lower

11

right-hand corner as 3795. The top of the page has the

12

heading "RCA Staff Meeting, April 24, 1978."

13

Am I correct that RCA would refer to Mr.

14

Arnold, Robert Arnold?

15

A Yes.

16

Q I note that the date April 24 would be one

17

day following the April 23rd, 1978 transient at TMI-2.

18

Do you see the first notation underneath the heading

19

indicating "TMI-2 SG coupling leak? Trip due to spike

20

on NI-8, got safety injection - blew liner out of

21

valves (bellows liner)?"

22

A Yes, I see that.

23

Q I take it that refers to the April 23

24

incident?

25

A I believe it does. I will have to tell you

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that the first item there, the SG coupling, if that is the word, right now I don't recall that one at all.

3

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Q SG would stand for steam generator?

5

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A That would normally be the way I would use that, yes.

7

8

Q Would you look now at page 3805, which is several pages after your initial notation.

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Let me ask you first to turn to page 3800. There is a heading there "Task Force Meeting at TMI-2, May 2nd, 1978" and then some notations, including the names of various people.

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Am I correct that this note reflects your notes of the meeting at the site following formation of the task force about which you have testified earlier today?

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A That certainly is what it appears to be.

Q Would you look at the list of names

appearing immediately underneath the heading. I take it RWK would be you?

21

22

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A That's correct.

Q There is then a list of Bob Cutler, Lou

Lanese, Jim Moore, Bill Schmauss, Ed Wallace, Ron Toole, Rich Lentz and Jim Seelinger. Then Jim Floyd, Sandy Levin, Dick Heward, Steve -- and I can't read that --

Page?

A It looks like P-o-j-e.

Q Do you know who that is meant to refer to?

A No.

Q The following name is almost impossible for me to read. Ed something, and you have a question mark following it. Do you have any better recollection today than you had at the time as to who that was?

A No, I do not. I can't read it either.

Q The following name appears to be Bill Gunn.

A I believe that is correct.

Q Do you know Mr. Gunn?

A Yes.

Q Who was he?

A I frankly don't remember what his role in the organization was at this point in time.

Q Was he a Met Ed employee?

A I am frankly not sure.

Q The final name is John Barton. Do you know who Mr. Barton was?

A I know who he is, but I am not sure that I remember what his position was at this point in time.

Q Was he a Met Ed employee or GPU Service?

1
2 A Again, I am not sure. Let me explain the
3 problem that I am having. At this point in time,
4 since TMI was in the process of its startup testing,
5 it is my understanding that there were both plant
6 staff members who would be Metropolitan Edison employees
7 and GPU Service Company employees functioning in the
8 startup and test role, both involved in the plant
9 operations, and I simply can't recall who was where.

10 Q Werethere other people present at this
11 initial meeting than those you have indicated here?
12 Did you attempt at the time you made these notes to
13 get a complete listing of the people who were present,
14 or was this a selective listing, as best you can
15 recall at this point?

16 A As best I can remember, it was not a
17 selective listing, but I am not sure that I got all
18 of the names.

19 Q Do you know whether any of these people
20 whose names we have just reviewed were control room
21 operators who were present during the transient?

22 A I don't know that any of them were. There
23 are at least two names on here that I have really no
24 idea what their role was, and they may or may not have
25 been control room operators.

1
2 Q That would be Mr. Poje, and the name
3 following his which is illegible?

4 A That's right, and also I am not sure to
5 what extent John Barton might have been involved in
6 plant operations.

7 Q Would you take a quick look at the page
8 immediately preceding the one we have been discussing
9 that is marked 3799 in the lower right-hand corner.
10 At the top of the page is a notation RFW. Would that
11 be Mr. Wilson?

12 A That would I assume be Mr. Wilson.

13 Q There is a list of seven items following
14 that notation. Do you recall if you had a conversation
15 with Mr. Wilson concerning these items?

16 A I do not specifically remember such a
17 discussion.

18 Q You see item 3 listed there, which says
19 "Events Recorder." Do you remember at any time
20 discussing with Mr. Wilson the events recorder at
21 TMI-2 in connection with the April 23 transient?

22 A No, I do not.

23 Q The fourth item is "Gas Bubble." Do you
24 have any recollection of discussing with Mr. Wilson the
25 issue of a gas bubble in connection with the April 23,

1
2 1978 transient?

3 A I don't specifically remember discussing
4 that with Dick Wilson. As I stated earlier, I do
5 have a general memory that what happened with respect to
6 gas bubbles outside the pressurizer was one of the
7 things that the task force was initially asked to
8 consider.

9 Q Do you have any information as to why the
10 task force was asked to consider that?

11 A The only thing which I recollect now is
12 that somehow the question was raised as to whether or
13 not it was possible that there had been any uncovering
14 of the core. If that had happened, it would be
15 important for us to know about it, and that is the
16 only thing I remember with respect to the gas bubble.
17 There may have been other things.

18 Q Who raised that concern?

19 A Again, I don't remember specific
20 conversations with anyone. I just remember that that
21 was one of the items that we were asked to consider.

22 Q The seventh item on this page indicates
23 sodium hydroxide properties. Do you recall having a
24 conversation with Mr. Wilson about sodium hydroxide
25 properties in relation to the April 23, 1978 transient?

1
2 A Again, I don't remember a specific
3 conversation. I do have a vague memory of having it
4 brought to my attention in some way or another that
5 there was some question with respect to chlorine
6 contamination in the sodium hydroxide.

7 Q Do you have any recollection of any
8 conversation at all with Mr. Wilson at or about the
9 time the task force was put together as to what it was
10 going to do?

11 A Frankly, I am drawing a blank. I find it
12 perfectly credible that we did have such a conversation.
13 I find it credible that these are items that we
14 discussed, but I can't remember that conversation.

15 (Discussion off the record between the
16 witness and his counsel)

17 Q Beginning on page 3800 as marked for
18 purposes of this litigation, and proceeding for the next
19 several pages appear to be some notes taken at the
20 time of the May 2nd, 1978 meeting. Would that be
21 correct, that the material that follows immediately
22 and is numbered in sequence beginning at page 3800
23 with 1-4 and continuing with numbers 3801 with numbers
24 5 through 7 and so on to 3803, where No. 12 is
25 indicated, were all notes that you compiled during the

1
2 course of the May 2, 1978 meeting?

3 A I believe that is correct.

4 Q On page 3803, a line has been drawn about
5 three-quarters of the way down the page and a new entry
6 starts, NI-8, which has been underscored. Does that
7 indicate that this was -- that the material that
8 follows was learned at some other time or is it an
9 indication to you that these notes continue to be from
10 the May 2nd, 1978 meeting?

11 If it would help, you might wish to look at
12 page 3816, which has as a heading "Task Force Meeting
13 May 3, 1978" and a whole new set of numbered items.

14 A To the best of my recollection, the line
15 that you referred to on the page that has been marked
16 3803 was not the completion of the meeting minutes,
17 but that they continued on past that point. Although
18 I am not absolutely certain, I think that it is likely
19 that the meeting minutes continue through and including
20 the page that has been marked 3815.

21 Q What is a feedwater latch system?

22 A It is a protective electrical system which
23 acts under certain conditions to terminate feedwater
24 flow to a steam generator.

25 Q Did that system play any part in the April

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2

23, 1978 transient?

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A I have a vague memory of some discussions about the feedwater latch system. I don't remember any specifics right now.

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Q Would it control the operation of valves through which feedwater is channeled to the steam generators?

9

A I believe that is correct.

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Q Let me refer you to page 3805 of your notes as marked for purposes of this lawsuit. Would you look down towards the bottom of the page and look at the last two notations. One of the notations is "FW latch system - designed for steam line break - shuts FW control and block valves."

16

17

I take it in that notation, FW would refer to feedwater?

18

A I believe that is correct.

19

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Q The following notation reads, "Operator sees signal to valves, but not whether valves are closed!" and immediately to the left of that note are two vertical lines indicated in the margin.

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Do you recall whether during the course of the review on May 2nd, 1978 it was brought to your attention that the operators had seen a signal to the

1
2 feedwater control and block valves but that that
3 signal had not told them whether or not the valves were
4 actually opened or shut?

5 A No, I don't recall that.

6 Q Do you recall whether the task force at any
7 point looked into the instrumentation with respect to
8 this system and the associated valves to determine
9 whether or not it should be changed?

10 A The valves you are now referring to are the
11 feedwater and control block valves?

12 Q Let me ask you. Looking at your notes
13 here which indicate immediately before the comment
14 concerning the signal to the valves that you were
15 discussing the feedwater latch system and the feedwater
16 control and block valves, are you able to recall today
17 which valves you were talking about in your final
18 comment on that page?

19 A I don't specifically remember this entry,
20 so I don't remember what valves it was referring to.

21 Q I asked you earlier this morning whether
22 there was any problem with respect to the steam relief
23 valves and the instrumentation as it existed before the
24 April 23 incident. Just to make sure, it is not your
25 recollection now that this comment refers to the

1
2 position of the steam relief valves? By "this comment,"
3 I mean the one about the operator seeing the signals
4 to the valves but not whether the valves were actually
5 opened or shut.

6 A No, it is not my recollection that this
7 refers to the steam safety valves.

8 Q Do you recall during your work on the task
9 force becoming aware with respect to any valves,
10 whether or not it is the feedwater control and block
11 valves or some other valves, of a problem concerning
12 the operator seeing only a signal to the valve rather
13 than an actual position indicator for that valve?

14 A No, I don't recall becoming aware of any
15 problem associated with that, and it is gratuitous
16 information, but I suspect that is why I don't remember
17 this.

18 Q I note that you put an exclamation mark
19 after your comment and then drew two vertical lines
20 immediately to the left of it. Was it your normal
21 practice to do that for all comments?

22 A No.

23 Q In fact, there is none other on that page
24 that is so marked, is there?

25 A That's correct.

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Q Was it your practice to make these notations only with respect to those things that you thought were more significant than others?

A I have used that notation to I believe mean more than one thing, always in the direction of highlighting it in some fashion.

Q Do you know whether the task force ever investigated the instrumentation on any valves with respect to the question of operator ability to have a direct indication of the position of the valves?

A I don't recall any such investigation.

Q Are you able to say today what the instrumentation was for the feedwater control and block valves at the time of the April 23, 1978 incident?

A No, I am not.

Q Would you look now at page 3816 of your notes which relate to, according to the heading, the task force meeting on May 3rd, 1978. You see there immediately underneath the heading indicating the date the notation "Action Items" and then following that a list of items, numbered items?

A Excuse me just a minute.

Q Is there something you would like to clarify?

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A No, I was just puzzled by something I saw.

I don't mind telling you what it is that puzzled me. I was surprised I did not see Gary Broughton's name in the list of people that were at the meeting.

Q We're back to page 3816 and the action items listed there. What was the purpose of your making this listing as best you can recall it now?

A I believe that these notes were made in conjunction with the process that I described earlier in which various considerations associated with the transient were assigned to one or more members of the task force to investigate.

Q There are numerous notations here, some of them for Ed, and I take it that would be Mr. Wallace?

A Yes.

Q And Rich would be Mr. Lentz?

A Yes.

Q Bob, who would that be? You had more than one Bob on this team?

A I believe that would be Bob Cutler.

Q Jim would be Mr. Seelinger?

A I believe that is correct.

Q And there are several notations for RWK. I take it that would be yourself?

1

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A Yes.

3

Q There is also a notation at one point for Sandy. I take it that would be Mr. Levin?

4

5

A I believe that is correct.

6

Q The second action item is gas bubble. Would it be correct that that referred to the formation of a bubble in the primary system outside the pressurizer?

7

8

9

A Yes, I believe that is correct.

10

Q And the two people assigned to that were Mr. Wallace and Mr. Seelinger, according to this note?

11

12

A According to this note, that's correct.

13

Q Do you recall whether they were in fact the people who were asked to look into that?

14

15

A I do recall that Mr. Wallace in fact did review the transient, including the thermohydraulics, which would include this item. I do recall that Mr. Seelinger had independently done that, I believe in fact in advance of formation of this task force.

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My earlier puzzlement was associated with the fact that I did not also see Mr. Broughton's name on this item.

21

22

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Q Do you believe Mr. Broughton worked on this problem, that is, the gas bubble?

24

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A To the best of my memory, he did

1
2 participate in the evaluation of the thermohydraulics
3 of the transient. I do not remember specifically
4 whether he performed an evaluation of the gas bubble
5 per se.

6 Q Let me go forward for a moment to the next
7 page, 3817, item 22, which reads, "Logic for operator
8 action - need to develop simplified version -
9 recommend," and the word "recommend" has been
10 underscored. What did you mean by that comment?

11 A I don't remember.

12 Q Was there any concern at the time regarding
13 the ability of the operators to find and carry out
14 the correct procedure during the course of a transient?

15 MR. GLASSMAN: Objection insofar as you
16 are asking for internal thought processes of
17 somebody else.

18 Q Isn't it true that you in writing this note
19 were in fact pointing out a concern that the task
20 force had developed about the ability of operators to
21 find and follow the appropriate procedure during the
22 course of a transient?

23 A I don't specifically recall what this was
24 referring to except that I have a very vague memory
25 that this may refer to either the writeup or the

1
2 information we received verbally from the plant staff
3 with respect to what the operators had done and why
4 they had taken the actions that they did, and I am not
5 certain, but I think that what the note was referring
6 to was the need to be able to present a simpler version
7 of that story to the GPU and Met Ed management that
8 we were going to be meeting with in a few days in
9 explaining the operator response. I don't interpret
10 that and I don't recall that it referred to a concern
11 that the operators were not able to find the right
12 procedure.

13 Q The following item is No. 23 and reads,
14 "Logic for ESF injection defeating." Do you recall
15 to what that item referred?

16 A I don't recall what it referred to. I note
17 in that one and the previous one that those don't
18 appear to have been assigned to anyone. Again, the
19 best I can do is to give you what vague recollection I
20 do have, which is that in drawing up this list of
21 action items, we were pointing toward what was for the
22 task force a very near-term meeting with management in
23 which we needed to give them our initial conclusions
24 and recommendations, and I vaguely remember that some
25 of the things that were in this list were directed

1
2 toward being able to describe to management what had
3 happened rather than necessarily pointing to something
4 that we had identified as a problem area.

5 Q You had headed this list "Action Items,"
6 and do I take your last answer to be that some of
7 these were items that you did not think required any
8 action but were simply descriptive?

9 A To the best of my memory, the action item
10 that was referred to there was to get the information
11 into a form where we could present it in a
12 comprehensible fashion to the management that was going
13 to be reviewing this the following week.

14 Q Do you recall whether you ever received
15 information concerning the logic behind defeating
16 the ESF injection?

17 A I frankly don't recall, and a major problem
18 here is my being able to separate out what I knew as
19 a result of this transient versus what I later learned
20 as a result of the 1979 TMI accident.

21 Q Do I understand your testimony to be that
22 while you have difficulty separating out in your mind
23 between what you now know and what you have learned
24 since the accident and what you may have learned since
25 the investigation, you are testifying that you did

1
2 receive some information with respect to the logic
3 behind defeating ESF injection as a result of this
4 investigation?

5 A No. I am testifying that I can't remember
6 whether I did or not, and my attempt to remember it is
7 complicated by what happened later.

8 Q So at this point you are not able to say
9 one way or the other whether you ever got any further
10 information with respect to item 23 on your list?

11 MR. GLASSMAN: Asked and answered.

12 MR. WISE: It was not.

13 A I cannot specifically remember whether I
14 did or not.

15 MR. GLASSMAN: That is about the third time
16 it has been answered.

17 Q Would you look at item 27, which reads,
18 "New scheme for safety injection - Lou." Do I take
19 it Lou would be Mr. Lanese?

20 A I believe that is correct.

21 Q What was meant by item 27?

22 A I am not certain, but I believe that that
23 refers to the possible change in the logic for
24 injecting sodium hydroxide.

25 Q That is the problem we discussed briefly

1
2 this morning concerning the consequence of injecting
3 sodium hydroxide into the primary system with the
4 high-pressure injection flow?

5 A I think a more accurate statement of what
6 was intended here was that it was a consideration of
7 whether there might not be a different set of initiating
8 signals for that injection that would be preferable.

9 Q Did you make any attempt to find out what
10 system was employed at TMI-1 for sodium hydroxide
11 injection or the lack thereof in connection with
12 high-pressure injection?

13 A I don't remember whether we discussed the
14 Unit 1 system in this regard or not.

15 Q Did it ever come to your attention that the
16 system at TMI-1 was very different with respect to the
17 injection of sodium hydroxide?

18 A In what time frame?

19 Q Before the Three Mile Island accident on
20 March 28, 1979.

21 A I am just not sure. I have the continuing
22 problem of trying to figure what I learned when.

23 Q Would you look now at page 3819 of your
24 notes. About a quarter of the way down the page, there
25 is a wavy line and then a heading "TTF - 5/4/78- Action

1
2 Items." Do I take it that TTF referred to your task
3 force?

4 A I believe that is correct.

5 Q Would you look at the first item that you
6 have got noted there. "1. Transient Review. A, We
7 are having problems with feedwater control prior to
8 trip - high pressurizer level, popped pressurizer
9 relief, et cetera - level dropped significantly - where
10 did the water go. Apparently out of normal SS
11 operation - see temperature AV."

12 I have attempted to fill out what I believe
13 to be abbreviations on your part. You are not bound
14 by my reading. If I have mischaracterized anything
15 that you wrote there, please let me know.

16 A I believe I agree with your characterization
17 of the abbreviations.

18 Q Your comment indicates that you had learned
19 that the plant was having problems prior to the April
20 23 incident, as you note here. Isn't that correct?

21 MR. GLASSMAN: Are you asking whether the
22 comment indicates that or whether he now
23 recollects that?

24 MR. WISE: Whether he now recollects it.

25 A I recollect that there were some problems

1
2 in feedwater control prior to the trip.

3 Q Were those problems in fact resulting in
4 high pressure level and relief through the
5 pressurizer relief valve?

6 A I frankly don't remember that.

7 Q Do you recall with whom you had
8 conversations concerning this topic?

9 MR. GLASSMAN: Objection. Lack of
10 foundation. He didn't say he had any
11 conversation.

12 Q You didn't make this up out of thin air,
13 did you?

14 MR. GLASSMAN: He didn't say he recalled.

15 A To answer your question, I do not believe
16 I made it up out of thin air.

17 Q I only asked that because your counsel was
18 uncertain as to whether or not we needed a foundation
19 or I should say your counsel believed we needed a
20 foundation for whether or not you learned this from
21 someone else.

22 MR. GLASSMAN: It still hasn't been
23 established whether Mr. Keaten recollected any
24 conversations related to this.

25 MR. WISE: That is what I asked. I presume

1
2 he had conversation with someone. Who he learned
3 this information from.

4 A I do not remember who I learned it from.

5 Q Would you look briefly at the following
6 page, 3820, and see item 1 listed as gas bubble. About
7 midway down the page, there is item 1, gas bubble,
8 and immediately below that, it says "Pressurizer relief
9 had blown about 50 times in last 24 hours due to
10 sluggish" and I am afraid I can't read the next word.

11 A I believe the next word is "heater."

12 Q -- "heater control - operators had
13 improved things somewhat (blowing once per hour)."

14 Do you recall to what that comment had
15 reference?

16 A I believe that it referred to problems that
17 the operators were having with the controller for the
18 pressurizer heaters.

19 Q Had that resulted in challenges to the
20 pressurizer relief valve about 50 times in the previous
21 24 hours?

22 MR. GLASSMAN: You are asking for Mr.
23 Keaten's recollection?

24 MR. WISE: Yes, all of my questions are
25 directed to Mr. Keaten's recollection.

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A I do not recall any specific numbers such as the ones that you used, but I also should comment that the concept of this type of an operation being a challenge to the pressurizer relief valve is something that postdates this event, and my recollection is that the attitude at this time was that this was a normal function of the pressurizer relief valve or PORV.

Q Just so it is clear, the numbers that I used in my question had come from your notebook.

A Yes, that appears to be correct.

Q Did the task force give any consideration to this particular item and the consequences it might have for the reliability of the pressurizer relief valve?

A The only thing which I recollect associated with this item was a general opinion on the part of the task force that the heater controls should be made to function correctly.

Q Did anyone consider the possibility that repeated lifting of the pressurizer relief valve as many times as indicated in your notebook may have had an adverse effect on the reliability of that valve?

A I don't recall one way or another.

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Q Did anyone look into the number of openings and closings and the conditions under which that valve was designed to operate?

MR. GLASSMAN: You are talking about during the course of this task force work?

MR. WISE: Yes.

A Again, I don't specifically recall one way or another. As part of the activities that were going on in evaluating the transient and the consequences of the transient, there were discussions between GPU/Met Ed personnel and B&W personnel about some aspects of this transient. Whether the question of the PORV was raised, I don't know.

Q Let me go back to page 3819, the preceding page. We've discussed item A under your action items for May 4, 1978. Before we leave that, let me ask one or two other questions.

The notation at the end of that first comment reads, "Apparently out of normal SS operations - see T-av." What was meant by that comment?

A I frankly don't remember what it meant. SS is not an abbreviation as far as I can recall that I normally use.

Q Have you used SS to stand for steady state?

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A That is possible.

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Q You are not able to recall now whether that is what you meant here or not?

5

A I really do not.

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Q Do you recall any significance of T-av with respect to this comment?

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Perhaps I can clarify my question. You have noted "See T-av" following your comment. Would looking at the T-av tell you something about the items that you have mentioned in this comment, namely, high pressurizer level, popping of pressure relief valve, a significant drop in the level, and out of normal operations?

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MR. GLASSMAN: You are asking for Mr. Keaten's interpretation of this particular item now rather than his recollection of whether it meant anything to him?

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23

MR. WISE: No, I am trying to refresh his recollection and test his recollection about this item. I am not asking him to interpret it today, except insofar as he is interpreting it, he is recalling what he meant then.

24

A I don't recall what I meant then.

25

Q Let me now move on to the next item in your

1
2 list, which is preceded by a B, "Operator doesn't
3 really have good knowledge of what is happening -
4 seems to react too quickly according to procedure
5 rather than thinking."

6 What specific operator actions did you have
7 in mind when you wrote this comment?

8 A To the best of my recollection, this was
9 generally referring to actions associated with control
10 of the feedwater and/or emergency feedwater system,
11 but I don't remember the specifics.

12 Q Did you believe at the time that
13 improvement was needed in operator understanding of
14 the basic concepts governing the operation of the
15 system during a transient?

16 MR. GLASSMAN: You are asking for his
17 current recollection of what he believed back
18 then?

19 MR. WISE: Yes.

20 A I don't recall that I personally had a
21 strong viewpoint with respect to that one way or
22 another. I don't recall that I personally did any real
23 evaluation of the type of operator actions that are
24 referred to here, and my recollection, albeit a vague
25 one, is that I was reflecting what others who were

1
2 doing that evaluation were telling me.

3 Q You have this comment listed as an action
4 item. What action was taken about this item?

5 A I don't recall that this task force per se
6 took any specific action with respect to this.

7 Q Would you look at item D listed on that
8 page, which reads, "Sequence of events was inferred --
9 some alarms which should have been expected are not
10 shown."

11 Is it true that there were alarms that
12 one would have expected in a transient of the type that
13 occurred on April 23, 1978 that in fact had not gone
14 off?

15 A I am sorry. I don't remember that
16 particular item.

17 Q Do you remember whether any action was
18 taken on this action item?

19 A I am not sure that I agree that this is an
20 action item. What you said earlier about this having
21 a heading of "Action Items" is true, but in reviewing
22 these notes here and on the following page, I notice
23 that where there really was an action item, that it
24 specifically is called out as such, and I believe what
25 happened here is that although I headed these notes

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2 "Action Items," I in fact included things that were
3 just interesting information and not action items.

4 Q Did you consider at the time that the
5 failure of expected alarms to go off was only an
6 interesting item rather than something that required
7 action?

8 A I don't specifically recollect this item,
9 so I don't remember what I might have had as an
10 attitude toward it.

11 Q Would you go back to page 3817 for a
12 moment and look at item 24, which reads, "Look at
13 discharge pipe plugging rumor." After that the
14 notation is "Jim (check" something which I
15 cant read and "design," and again I can't read the
16 remainder of that comment, and the parentheses is
17 closed.

18 Do you have any recollection of that item?

19 A First I want to correct something I said
20 earlier. You asked me if the entry "Jim" on these
21 lists would refer to Jim Seelinger. At that time I
22 said yes. Now I am not sure that that is true. I
23 think that it might have referred to Jim Moore.

24 Q Before we return to your recollection of
25 this specific item, let me follow up on that for a

1
2 moment. In the operations of the task force, did you
3 give assignments both to Mr. Moore and Mr. Seelinger,
4 or did you give out assignments only to those people
5 who were employees of the Service Corporation serving
6 on the task force?

7 A In general, I believe that there were some
8 of the items which needed to be done that Jim
9 Seelinger agreed to do or to participate in, but the
10 best of my memory is that the meeting on May 2nd which
11 was the first meeting was the only meeting that was
12 held at Three Mile Island and that the other meetings
13 were held in Parsippany, and further, that Jim
14 Seelinger remained at the Island.

15 Q If we could go back to item 24, which was
16 the comment, "Look at discharge pipe plugging rumoer,"
17 do you have any recollection as to what that comment
18 referred to?

19 A At this relatively early stage in the task
20 force's activities, I have a general recollection that
21 a lot of our attention was directed toward the issue
22 of the bellows and bellows liners and what had caused
23 the failures there. I have a very vague memory that
24 someone had thought that some of the discharge piping
25 downstream of the bellows and liners had been either

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plugged or that with the steam safety valves open,
that a critical flow regime might exist in that piping.

3

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Q This is piping on the secondary side of the
system?

5

6

A It is really -- it is the piping between
the steam safety valves which were on the secondary
side of the system and the atmosphere.

7

8

9

Q What if anything came of this item?

10

A I don't remember that anything came of it.

11

12

Q Was it ever determined whether in fact those
pipes had been plugged?

13

14

A Let me clarify my previous answer, which
wasn't very explicit.

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To the best of my recollection, the
evaluations which were done indicated that this item
was not significant in being a contributor to any of
the transient or the damage.

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Q That helps clarify your previous answer,
but I would still like an answer to my last question,
which was, was it ever determined whether or not those
pipes had in fact been plugged?

23

24

A To the best of my memory, there was never
any evidence that indicated that they were plugged.

25

Q Turning back to page 3820, at the top half

1
2 of the page in large capital letters, you had written
3 "Action" underscored, and then the following comment,
4 "List all added and missing items for Met Ed writeup"
5 and review with Seelinger - Wallace," and then beneath
6 that, "Review Wednesday trip - Lanese," and beneath
7 that, "Get TMI-1 transient-Lanese compare with TMI-2."

8 Had there been a transient at or about this
9 time at TMI-1?

10 A I don't recall what that refers to.

11 Q Do you recall whether the task force ever
12 made a comparison between the April 23 incident at
13 TMI-2 and some other incident at TMI-1?

14 A No, I don't recall.

15 Q Did you ever perform any work with respect
16 to any transients at TMI-1 before the date of the
17 accident on March 28, 1979?

18 A As I indicated yesterday, as a part of
19 attempting to bench mark the RETRAN model for TMI, we
20 have looked at certain transients that occurred in
21 TMI-1, and I frankly don't remember the exact time
22 frame, and the extent to which that was done before
23 versus after the accident.

24 Q Have you ever reviewed or seen a transient
25 report or analysis concerning any events at TMI-1

1
2 involving the pilot-operated relief valve
3 malfunctioning in any respect?

4 A I do not recall any TMI-1 transients
5 associated with a malfunctioning PORV.

6 Q Are you aware of any transients at TMI-1
7 before the accident at TMI-2 which resulted in
8 saturation in the primary system outside the
9 pressurizer?

10 MR. GLASSMAN: You are asking for Mr.
11 Keaten's current knowledge?

12 MR. WISE: Yes.

13 A I do not recollect any such.

14 Q Are you aware of any transients that
15 occurred at TMI-1 before the TMI-2 accident which
16 resulted in initiation of high-pressure injection?

17 A I don't recall one way or another.

18 Q Did you ever receive any information back
19 from Mr. Lanese concerning any comparisons that he
20 may have made between the April 23, 1978 incident and
21 any other transients, whether at TMI-2, TMI-1 or some
22 other plant?

23 A I don't recall.

24 Q At some point during the April 23, 1978
25 transient, the operators did reduce HPI flow, isn't

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that correct?

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A Yes, I believe that is correct.

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Q Was it ever of concern to you during your work on the task force that the operators had done so?

6

7

A I do not recall that the task force found that the reduction in HPI flow was inappropriate.

8

Therefore, I don't recall that there was any concern about it.

9

10

Q You may have misunderstood my question.

11

Regardless of whether in this particular accident the reduction in HPI flow was appropriate, was there any

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concern on the task force that you were aware of about

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whether the operators had correctly understood the

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situation at the time they terminated HPI or reduced

16

its flow?

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MR. GLASSMAN: Objection. I am not sure

18

it is clear to me from the question what situation

19

you are talking about.

20

MR. WISE: The transient.

21

MR. GLASSMAN: I am not sure what you mean

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by "whether the operators understood the

23

transient." What aspect, what initiating event?

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I am not sure what you have in mind. This is

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clearly a different question from the earlier one.

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Maybe the witness can answer, if he understands what it is, but I am not sure I do.

A I don't totally understand the question either, but perhaps I can answer a more restricted question that will get to your --

MR. GLASSMAN: Let Mr. Wise rephrase it.

MR. WISE: I can perhaps rephrase it.

Q I understand from your testimony that the task force concluded that the operator action during the April 23, 1978 event in terminating or reducing the HPI flow had been appropriate.

My question now is a different one. That is, whether the task force was concerned, to your knowledge, whether the operators at the time they terminated or reduced HPI did so for the right reasons.

A I do not recall any concern expressed by the task force on that subject.

(Recess taken)

BY MR. WISE:

Q Were you at any time concerned during your work on the task force with whether the operators had been able to correctly distinguish between a steam line break and a loss of coolant accident?

A I don't recall such a concern.

1
2 Q Would you look at page 3826 as it has been
3 marked for this litigation, which is a further page of
4 your notebook in Exhibit 337, and look at the comment
5 about halfway down the page. It says, "Talk to John
6 Barton-request Ron Toole be present." Underneath that,
7 "How did operator know no LOCA."

8 Were you in the practice of referring to
9 a loss of coolant accident by the abbreviation LOCA?

10 A Yes.

11 Q Do you recall the comment as it appears on
12 page 3826 that I just read to you?

13 A I see on that same page that there is
14 another related entry up at the top where it says
15 "Recommendation short-term operator training on
16 simulator - steam line break versus LOCA."

17 Q Does any of this refresh your recollection
18 as to whether or not you were concerned about the
19 operator's ability to identify and correctly
20 distinguish between a steam line break and a loss of
21 coolant accident?

22 A I don't recall that, and I also note that
23 does not appear, as far as I can tell, in any of the
24 recommendations in the task force report.

25 Q Did you ever get an answer to the question

1
2 noted in your notebook, "How did operator know no
3 LOCA?"

4 A I frankly don't remember that at all.

5 Q Do you remember any conversations with Mr.
6 Barton or Mr. Toole concerning this matter?

7 A No.

8 Q What areas was Mr. Barton working on for
9 the task force, if any?

10 A To the best of my recollection, he was not
11 working on anything for the task force.

12 Q Do you have any information today as to
13 why the notation suggests that you talk to John
14 Barton with Mr. Toole present concerning this item?

15 A I don't have any recollection at all of
16 that, and I further note that the way that this is
17 arranged in this notebook and the way I normally keep
18 notes, I do not necessarily assume that these two items
19 are related.

20 Q With respect to your short-term
21 recommendation which you noted in answer to one of my
22 previous questions, do you know whether anything was
23 ever done to follow up on that? That short-term
24 recommendation was "operator training on the simulator
25 steam line break versus a LOCA."

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2 MR. GLASSMAN: You are talking of the entry
3 at the top of this page?

4 MR. WISE: Yes, page 3826.

5 A Again, I don't remember that. I don't
6 remember making it as a recommendation, and I don't
7 remember, if it was made as a recommendation, what if
8 anything was done.

9 Q Did the task force, to your knowledge, ever
10 determine whether the operators knew they had no loss
11 of coolant accident at the time they terminated
12 high-pressure injection during the April 23, 1978
13 incident?

14 A I don't recall.

15 Q I would like you now to look at B&W Exhibit
16 186, which is your task force report, and we're going
17 to be looking at the attachment or appendix to your
18 report prepared by Met Ed. If you look at page A-2-16
19 of your report, which is marked for purposes of this
20 litigation as 1247-0600, that page is titled
21 "Recommendations/Action Items." Following it through
22 page A-2-19 are a series of recommendations contained
23 in the Met Ed report. Do you see that?

24 A Yes. This particular copy appears to have
25 a page missing.

1
2 MR. WISE: Unfortunately, for whatever
3 reasons, in the microfilming, B&W Exhibit 186,
4 apparently page 17 of the Met Ed staff report
5 which was re-marked page A-2-17 in the task force
6 report, was missing. We have another copy of
7 the Met Ed report which was also marked in this
8 litigation as B&W Exhibit 246.

9 While we took a short break, we obtained
10 from Exhibit 246 a copy of page 15 of the Met Ed
11 report and counsel for plaintiffs has had an
12 opportunity to compare it as it existed in the
13 original Met Ed report, and the witness now has
14 that page before him. I don't think it is
15 necessary to insert it into the actual exhibit.
16 For whatever reasons, the exhibit was marked
17 without that page, but so the record is clear,
18 that page should have been part of the Met Ed
19 report and was part of the Met Ed report marked
20 as 246.

21 I also note that Exhibit 246, which was
22 marked earlier, has a cover memorandum signed by
23 Mr. Seelinger and dated May 4, 1978, which
24 indicates that the finalized report is being
25 forwarded under cover of the memorandum. There

1
2 is a lengthy list of individuals listed as
3 receiving a carbon copy. Among them is Mr. Keaten.

4 With that out of the way, we can go back
5 to the questioning.

6 BY MR. WISE:

7 Q Again let me turn your attention to the
8 recommendations and action items in the Met Ed report.
9 Would you look at the action items for equipment
10 changes. Item 10 says, "Computer problems with the
11 sequence of events and memory trip review need to be
12 resolved -- Fels -- prior to startup."

13 Do you know what the notation "Fels" means?

14 A Yes. It refers to Mr. Bill Fels, who was
15 a member of the computer group.

16 Q Did the task force at any time learn that
17 the computer problems with the sequence of events and
18 memory trip review had been resolved?

19 A I don't recall that the task force was
20 informed that the computer problems had been solved.
21 I don't recall in the sense of one way or another.

22 Q Item 12 indicates as follows: "Provide
23 some indication for main steam relief valve position.
24 A temporary microphone from the vicinity of the valves
25 to the control room has been suggested. In this way,

1
2 the operator could at least detect independent of
3 analyzing console indication that the relief valves
4 are open. GPUSC -- Toole -- prior to startup."

5 Was this recommendation followed up on by
6 your task force?

7 A The recommendation from the task force that
8 I was a part of was to provide some means of knowing
9 whether the valves were open, and eventually, if
10 practical, some method of knowing when they reclose.

11 In our task force report, this item as
12 listed is complete, and I believe that in fact it was
13 listed as complete, based upon the action that was
14 indicated in the Met Ed report.

15 Q In discussing that item, I notice this time,
16 and also once before when you mentioned it, that you
17 added the qualifying phrase "if practical" with
18 respect to installing some form of instrumentation to
19 give the operator direct indication of whether the valve
20 had reclosed.

21 What do you mean by "if practical"?

22 A To the best of my recollection, the item
23 was worded that way to indicate the task force's
24 perception of a difference in priority between the need
25 for a signal to show when the valve had opened and a

1
2 signal that would let the operator know when it had
3 reclosed, and so the wording was to indicate that we
4 felt it was of higher priority to get a signal that
5 would let the operator know when the valves were opened.

6 Q Would the provision of a signal to let the
7 operator know when the valve had opened in some way
8 make it less practical to provide him also with a
9 signal for when it closed?

10 A Not necessarily.

11 Q I am still having difficulty with the
12 qualification "if practical." What was it about the
13 provision of a signal to indicate closure of the
14 valve that required the qualification that it be done
15 only "if practical"?

16 A My recollection is that the task force was
17 led to believe that it might be in fact very difficult
18 to accomplish the detection of the valve closure
19 because of the way that the valves were designed.

20 Q What would make it difficult?

21 A I don't remember the details, but I believe
22 it was our understanding that, given the design of
23 the safety valves, there was no obvious way to put the
24 type of mechanical indicator that is frequently used
25 to detect valve motion in other types of valves, and

1
2 whereas, as I indicated in the Met Ed recommendation,
3 there appeared to be a reasonably straightforward method
4 of providing to the operator some indication that the
5 valves had opened, we had not identified any comparable
6 method of doing it for valve closure.

7 In addition, the recommendation was based
8 upon the perception that from the standpoint of value
9 to the operator in operating the plant during a
10 transient involving the steam safety valves, that it
11 was more important for him to know that the valves had
12 opened.

13 Q The microphone device would tell him that
14 the valve had opened, is that correct?

15 A One or more valves had opened.

16 Q Is it true that device would, however, not
17 be a reliable indicator of closure of the valve?

18 A If more than one valve were opened, I don't
19 believe the microphone would give reliable information
20 about when and if individual valves closed. It might
21 be used as an indication that all valves had closed
22 once that were true.

23 Q It is true, is it not, that such a
24 microphone would not be a reliable indicator if the
25 valve had only partially closed? In other words, there

1
2 is a possibility that the valve could be entirely
3 opened, entirely closed, or somewhere in between, and
4 the microphone would not help very much with respect
5 to a situation where the valve was neither entirely
6 closed or entirely opened?

7 MR. GLASSMAN: Are you asking for Mr.
8 Keaten's opinion or whether this was discussed
9 in the task force?

10 MR. WISE: Whether this was considered in
11 the task force in connection with these
12 recommendations.

13 A To the best of my recollection, there was
14 some discussion about partial closure and the fact
15 that microphones would not be particularly useful in
16 indicating that.

17 Let me also clarify the reason for the
18 task force's recommendations in this regard. It bears
19 upon the difference in priority.

20 To the best of my recollection, the task
21 force generally felt that something like a microphone
22 which would tell the operator, yes, he had one or
23 more steam safety valves open, and then eventually, yes,
24 they are all now closed, probably would fulfill the
25 needs of the operator, and the desire, to the best of

1
2 my recollection, for having more specific information
3 on when valves opened and closed individually was
4 really for the basis of a later reconstruction of a
5 transient as contrasted to what the operator needed
6 during the transient, and so we would and, to the best
7 of my memory, we did perceive that although that would
8 be in some sense desirable, it was a lower priority
9 than providing the information to the operator that he
10 could really use.

11 Q Was there any consideration given as to
12 whether there was some device or form of instrumentation
13 which would give a direct indication of the position
14 of the valve, not just whether it was entirely open
15 or entirely closed, but a direct indication of exactly
16 what the position of the valve was?

17 A To the best of my recollection, we were
18 told that no one had come up with a good scheme for
19 doing that.

20 Q Who told you that?

21 A I don't remember.

22 Q Was it someone within the GPU system or
23 an outside group?

24 A I don't know.

25 Q Let me ask you generally with respect to

1
2 the recommendations and actions contained in the Met
3 Ed staff report. Did the task force consider those
4 recommendations and actions as items that the task force
5 needed to examine and resolve itself?

6 Let me withdraw that. That is probably a
7 confusing way to put the question.

8 What use, if any, did the task force make
9 of the recommendations and actions proposed in the Met
10 Ed staff report?

11 MR. GLASSMAN: The question is directed
12 to recommendations generally of a Met Ed report,
13 not to specific items?

14 MR. WISE: That's correct.

15 A I don't recall that the task force
16 directly used these recommendations per se in its
17 activities. I certainly believe that we were aware of
18 them, and furthermore, with Jim Seelinger participating
19 in our task force as well as in the Met Ed activities,
20 it provided some consistency between them, but the
21 best of my recollection is that the task force tended
22 to develop its recommendations on its own and then
23 look to see where there was overlap between the two,
24 and clearly there was overlap between the
25 recommendations, but there was not, for example, an

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attempt to integrate the two sets of recommendations
into one joint set of recommendations.

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Q Was that because there was disagreement
within the task force with some of the recommended
items in the Met Ed plant staff report?

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A Not that I recall. I think it was more
a reflection of the fact that the two sets of
recommendations were developed to some extent
independent of each other, and furthermore, that the
recommendations as they appear in this report were
really documented for historical reasons in the sense
that many of the recommendations shown here as
indicated in the report had already been completed by
the time that the report was issued.

16

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Q In your last answer, you referred to this
report in here. I take it you were referring to the
task force report which is B&W 186.

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23

A That's correct.

24

25

Q You were contrasting it with the Met Ed
staff report which has been marked separately as 246
and also is included as an appendix to the task force
report?

A That's correct.

Q Would you look at page A-2-18 in the task

1
2 force report. It is page 16 of the Met Ed staff
3 report. You will see at the bottom the heading
4 "Training." Underneath that there are two items. Do
5 you know whether, or did the task force make any review
6 to determine whether or not the training items listed
7 on page 16 and carried over onto the following page were
8 actually followed?

9 A Not to the best of my recollection.

10 Q Would you look at the recommendations listed
11 under "Other," particularly the first item, which calls
12 for "Precalculate the exact volumes of critical piping
13 runs and tanks from various taps and capture in a
14 procedure. Such a procedure would have helped in
15 quickly analyzing the pressurizer situation and in
16 determining the core remained covered."

17 That is the way it reads. Apparently a
18 word is missing. To your knowledge, was such a
19 procedure ever written?

20 A I don't know.

21 Q Did the task force take a look at that
22 recommendation?

23 A I don't recall the task force specifically
24 considering this recommendation.

25 Q Would you look at the second recommendation

1
2 and the third, both of which discuss the alarms, and
3 in the second recommendation, the statement is made
4 "Escalate the alarm window correction program in
5 priority. This will eliminate an excessive lighted
6 number of panel alarms at the base line condition
7 and give the operator a better chance to focus on what
8 to respond to."

9 Do you know whether anybody ever did
10 anything about that?

11 A To my knowledge, the task force made no
12 attempt to track that recommendation, and I don't know
13 what happened.

14 Q Finally, item 3, which reads "Add
15 additional alarm acknowledgement capability in the
16 control room. Currently, the operator at the controls
17 has to go across the control" -- and I believe the
18 word "room" has been omitted -- "to read an alarm and
19 then back to the center console to acknowledge it.
20 GPUSC -- Toole -- determine GPU position."

21 Did the task force look into that
22 recommendation?

23 A To the best of my knowledge, no.

24 (Continued on next page)
25

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Keaten

199-A

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Q Do you know whether anyone at GFUSC did?

3

A I don't know.

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(Time noted: 4:55 p.m.)

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7

ROBERT W. KEATEN

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Subscribed and sworn to

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before me this day of

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1982.

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CERTIFICATE

STATE OF NEW YORK)
 : ss.:
COUNTY OF NEW YORK)

I, JOSEPH R. DANYO, a Notary
Public of the State of New York, do hereby
certify that the continued deposition of
ROBERT W. KEATEN was taken before
me on TUESDAY, JANUARY 5, 1982 consisting
of pages 92 through 199-A;

I further certify that the witness had
been previously sworn and that the within
transcript is a true record of said testimony;

That I am not connected by blood or
marriage with any of the said parties nor
interested directly or indirectly in the matter
in controversy, nor am I in the employ of any
of the counsel.

IN WITNESS WHEREOF, I have hereunto set my
hand this 18 day of JANUARY 1982,

Joseph R. Danyo
JOSEPH R. DANYO

I N D E X

WITNESS

PAGE

Robert W. Keaten (resumed)

94

E X H I B I T S

B&W

FOR IDENTIFICATION

337 Portion of a spiral notebook

151

-oOo-

UNITED STATES DISTRICT COURT
SOUTHERN DISTRICT OF NEW YORK

-----X
GENERAL PUBLIC UTILITIES CORPORATION, :
JERSEY CENTRAL POWER & LIGHT COMPANY, :
METROPOLITAN EDISON COMPANY and :
PENNSYLVANIA ELECTRIC COMPANY, :
Plaintiffs, : 80 Civ. 1683 (RO)
-against- : AFFIDAVIT
THE BABCOCK & WILCOX COMPANY and :
J. RAY McDERMOTT & CO., INC., :
Defendants. :
-----X

STATE OF NEW JERSEY)
COUNTY OF MORRIS) : ss.:

I have read the transcript of my deposition taken on
January 4, 5, 6, 7, 8, 19, 20 and 22, 1982 and together with the
attached corrections, it is accurate to the best of my knowledge
and belief.

Robert W. Keaten
Robert W. Keaten

Signed and sworn to before me this
27th day of October, 1982.

Alice J. House
Notary Public

ALICE J. HOUSE
NOTARY PUBLIC OF NEW JERSEY
M. Commission Expires March 7, 1985

CORRECTIONS OF ROBERT W. KEATEN

September 1982

<u>Page</u>	<u>Line</u>	<u>Correction</u>
36	13	"Seward-7" should read "and Seward-7"
81	16	"Mr. Broughton" should read "Mr. Schmauss"
121	7	"time phase" should read "time phased"
133	16	"recede" should read "reseat"
243	6	"Jim Seeinger" should read "Jim Seelinger"
333	16	"pumps were turned" should read "pumps turned"
354	20	"communication" should read "coordination"
354	21	"center. Although" should read "center, although"
408	18	"on" should read "a"
420	3	"believe" should read "believed"
460	12	"sentences in" should read "sentences and"
461	9	"can shoot out," should read "can shoot at it."
463	11	"I am" should read "I am not."
465	16	"regard as things of undesirable" should read "regard as undesirable"
467	9	"eminet" should read "imminent"
470	25	"could" should read "would"
482	8	"value." should read "valve,"
490	20	"How did you reach" should read "Had you reached"
494	19	"already" should read "satisfactory"
506	9	"effect, indicating" should read "effect, indicates"
510	11	"If I had known it was the other valve, I" should read "If they had known it was the other valve, they"

<u>Page</u>	<u>Line</u>	<u>Correction</u>
525	5	"Q" should read "A."
525	23	"that it would" should read "that would"
529	5	"pressurized" should read "pressurizer"
539	21	"that. My" should read "that, my"
543	19	"reactant" should read "reactor"
544	3	"the" should read "this"
551	14	"is" should read "or"
560	9	"steam leak" should read "steam line."
561	25	"steam leak" should read "steam line."
580	15	"about" should read "against"
589	3	"in" should read "and"
608	18	"uncertain" should read "referring to"
638	16	"Q" should read "A."
640	18	"task force intended" should read "task force had not intended,"
641	8	"ever time" should read "every time."
652	20	"sponser" should read "assistant"
679	8	"I recommend" should read "I recommended"
684	14	"JRT-GARB" should read "JRT-ORB."
693	5	"of" should read "by"
693	7	"Mr. Lanese's" should read "Mr. Lucien's"
719	18	"Q" should Read "A."
742	23	"second" should read "section"
743	24	"alternative is" should read "alternatives."
744	18	"in" should read "and"

<u>Page</u>	<u>Line</u>	<u>Correction</u>
755	18	"extent" should read "accident"
768	7	"an independent view" should read "interview"
781	17	"do take actions on" should read "do take actions which"
781	18	"turns" should read "turn"
792	16	"his" should read "the"
801	4	"I do recollect that" should read "I do recollect this."
812	13	"instruction" should read "instrumentation"
825	5	"their" should read "the"
825	6	"current" should read "occurrence"
829	3	"in" should read "of"
847	13	"A" should read "Q."
866	23	"accusations" should read "actions"
868	6	"to a degree" should read "to agree"
868	14	"opinion" should read "importance"
867	7	"a waiver" should read "aware"
872	23	"on" should read "from"
876	16	"from" should read "to"
882	6	"differentiation" should read "differential"
883	24	"differentiation" should read "differential."
894	8	"doesn't" should read "accident"
895	24	"discussing" should read "discussing,"
895	25	"it as part" should read "as part"
900	19	"only" should read "any"

<u>Page</u>	<u>Line</u>	<u>Correction</u>
900	20	"by one person" should read "by only one person"
918	10	"made" should read "may"
942	15	"steam" should read "sneak"
954	17	"system." should read "system,"
964	3	"A" should read "Q."
974	11	"Q" should read "A."
983	12	"and" should read "in"
999	18	"Mr. Keaten" should read "Mr. Glassman."
1009	19	"Q" should read "A."
1015	8	"Q" should read "A."
1023	3	"culled" should read "called"
1024	3	"their qualifications." should read "their environmental qualification."
1033	22	"arrive a" should read "arrive at "
1036	5	"Q" should read "A."
1039	21	"I believe aware" should read "I believe I was aware"
1043	9	"suction tank," should read "storage tank"
1048	3	"contingent" should read "contentions"
1048	7	"remember exact words" should read "remember the exact words."
1050	23	"hand" should read "and."